Final analysis on the tenants engagement and communication strategies

4.8

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Deliverable 4.8

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Lead & author	Kathleen Zoonnekindt (Savills)
Contributor(s)	PFP, ATER, 1892
Reviewed by	SinCeo2, DEXMA, EnergyPro
Authorised by	Chalmers

DOCUMENT HISTORY

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1	May - June 2019	Post-renovations interviews and Green Neighbours final version	Savills
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Executive summary

In the current deliverable 4.8 we present:

1) In the first part of the deliverable, the results of the social evaluation work that engaged tenants in the evaluation of renovations before and after interventions in the three-pilot sites are presented. This social evaluation protocol has been developed by SAVILLS' sociologist in the DREEAM project and has proven its efficiency during three years to perform social evaluation in energy efficiency projects. The analysis presents the results of interviews and investigation of the following:

- Feedback from building managers and employees of the three building owners involved in the DREEAM project who directly manage the pilot site where the DREEAM renovations were performed;

- Feedback from a selected group of tenants in the pilot sites who experienced the DREEAM renovations process;

- Experiences of tenants with the DREEAM project renovations and outcomes;

- Comparative analysis of tenants' life quality inside their dwellings and the pilot site area before and after renovations (thermal comfort, access to energy, fuel poverty situations, renovations expected, collective feeling in the building with neighbours, relations with the building owner);

2) In the second part, we present the innovative approach developed in the DREEAM project by the sociologist to co-design the engagement programme with tenants about energy efficiency, energy saving tips to train tenants in eco-actions and to fight against energy poverty and the rebound effect after the end of DREEAM renovations. The very positive outcomes of our innovative approach called GREEN NEIGHBOURS are described in this second part with concrete tools to replicate the GREEN NEIGHBOURS programme such as:

- Design process involving sociology, ethnography, co-design, UX and Design Thinking;

- Collaboration and ideas from tenants in the three pilot sites to develop the most accurate tools to empower tenants with energy consumption and eco-actions for environment;

- Final prototype of GREEN NEIGHBOURS programme to engage and train housing companies employees and tenants in energy saving and eco-actions.

The current deliverable 4.8 describes the work performed from 31.03.2017 to 30.09.2019 for the sociological evaluation and co-design process by Savills in collaboration with a group of DREEAM partners involved in this task (PFP, ATER, 1892, Chalmers).

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1 Partners involved in the deliverable 4.8

Key contributors:

Kathleen Zoonnekindt - Savills (Work Package leader, Task leader, coordinator of interviews, social evaluation, User Experience Research, creator of co-design tools and Green Neighbours programme).

Other contributors:

Latif Patel, Samuel Lawrenson, Derek Watters (PFP), Sabina Manente (ATER), Sophia Tybussek, Cathleen Beck, Dirk Lönneker (1892) (co-preparation of interviews, participation in social evaluation with tenants, engagement of tenants in Green Neighbours);

Izabela Kurkowska (Chalmers), (support of the coordination with building owners).

2 Reminder - Methodology

2.1 Before and after evaluation of the social impact of renovations

The sociological evaluation methodology of the interviews with tenants and building owners' employees is described in the deliverable 4.2.

The deliverable 4.2 introduced the methodology of qualitative interviews and sociological enquiries, and the present deliverable 4.8 presents the comparative results of the sociological analysis performed before and after renovations in 2016, 2017, 2018 and 2019.

The initial analysis of the sociological evaluation before renovations is presented in the deliverable 4.4 "Tenant engagement programme".

The methodology presented in the deliverable 4.2 described the 4 key steps of our before/after approach:

The deliverable 4.2 was validated.

The deliverable 4.4 was validated and presented the results of the Step 1 where SAVILLS successfully performed the sociological evaluations before renovations in the 3 pilot sites (Germany, Italy, UK). In 2016 and 2017.

The current deliverable 4.8 presents the work process and synthetic results of the step 2, step 3 and step 4.

2.2 Factors evaluated in our protocol of interviews before and after renovations

1) Household structure

- Number of households' members
- Age and gender of household members
- Occupation and key patterns of living inside the dwelling (information useful to establish the number of hours when tenants stay inside the dwelling during weekdays and week-ends)

2) Social information affecting energy performance calculations: household occupancy profile

- Household structure and change in occupancy before and after renovations that can affect the energy consumption

3) Energy equipment affecting energy performance calculations

- Key equipment owned by the tenants that involves additional electricity consumption (like cooling/Air Conditioning or anti-humidity devices, and additional electric radiators)

4) Thermal comfort indicators collected during the interviews

- Perception of the thermal comfort in each room
- List of radiators used regularly, and the set point usually selected by the tenants
- Presence of damp/mould
- Presence of air leaks/air draughts
- Difference of temperature and thermal comfort feeling between the different rooms/orientations/floors;
- Humidity perception;
- Presence of damp, mould & condensation;
- Air velocity and air leaks that affect thermal comfort perception or the use of radiators

5) Renovations expected by the tenants to improve the life conditions and thermal comfort in the dwelling

- **User Experience (UX) to identify mis-uses of equipment or uses that involve over-consumption of electricity, water and heating**

- User experience of the equipment to heat the dwelling (like the newly installed storage heaters, ventilations, boilers installed during renovations)

- Use of electric equipment

6) Documentation with pictures and videos inside the dwelling (subjected to tenants' approval)

- Relevant quotations/explanations given by the tenants during the interviews to illustrate the situation in the dwelling. Pictures, videos (subjected to tenants' approval)

7) Mapping of answers on a paper or digital map

- Mapping of answers on a map of the property given to the tenants during the interviews to facilitate the exchanges and compare the answer before and after renovations

8) Identification of fuel poverty issues

We have used the qualitative indicators promulgated in the final report of the European fuel Poverty and Energy Efficiency project – funded by Intelligent Energy Europe[1] (EPEE) project to detect fuel poverty in our interview guideline. (The indicators underlying a potential fuel poverty situation include: budget dedicated by the households to the electricity, heating & water; self-restriction of appliances or heat use, "ideal budget" for energy expenses and comparison with the real budget spent, presence of damp, mould & health issues related to the difficulty to heat or to cool in summer (a non-exhaustive list).

We questioned during our evaluation:

- Tenants' perception of energy costs (we have exchanged with tenants during interviews on any potential difficulties they have in paying the energy bills and we recommend doing so in other social evaluations)

- Origin of energy poverty: house structure (lack of insulation, poor windows, air leaks), equipment (low energy efficient equipment), energy tariff (not adapted), uses (over-consumption of heating, low information on energy efficiency options, User Experience)

- Capacity to pay for electricity, gas or heating bills

- Expectations of energy saving, and ideal energy budget compared to existing budget

[1] Référence : https://ec.europa.eu/intelligent/projects/en/projects/epee

- Lack of information on energy bills calculations from tenants' perspective

9) Bill analysis to determine the level of energy poverty (subjected to tenants' approval) and the impact of renovations on energy poverty

- Consulting real-metered based bills with the approval of tenants during interviews for their heating and electricity or gas consumption before and after renovations during similar periods of time, is a very important step to identify energy poverty issues, and/or over-consumption post-renovations. This step also allows identification of which tenants need information after the renovations to save money by learning how to adapt their use of energy and the equipment installed during the renovations.

2.3 Sampling method and tenants engaged in our programme

We have adopted a qualitative method to collect data and a socio-anthropological approach to select the sample of our interviewees involved in the interviews before and after renovations.

Our strategy has been to select a limited number of interviewees who reflect well the diversity of key household archetypes in each pilot site according to specific criteria (household size, structure of the household, gender, age, occupations, property size, property type, orientation).

This qualitative selection process is often used in qualitative sociological and anthropological researches in the field of consumption, urbanism to study with a limited number of individuals, the key representations, values, attitudes, User Experiences and practices existing in a bigger group of citizens or users with similar characteristics.

The selection of tenants interviewed in 2016, 2017, 2018 and 2019 was based on the households' diversity of the entire pilot site described in preliminary interviews by PFP, ATER and 1892's local managers.

Then in 2016 and 2017, SinCeO2 and SAVILLS identified the key criteria and the archetypal types of dwellings and households to integrate in the social evaluation and to monitor closely during all the duration of the project, following the initial interviews with local building managers.

Our final qualitative sampling integrates the diversity of households' archetypes living in the three pilot sites according to the specific criteria listed previously and validated with the three building owners[2].

[2] For more explanation related to the "qualitative sampling" – see our detailed methodology in the deliverable 4.2.

2.4 Analysis of interviews

- The analysis of BOs employees' interviews and tenants' interviews before renovations has been presented thematically both in the deliverable 4.2b and the deliverable 4.4 *(Requirements of BO for the DREEAM platform).*

- Each household has been assigned a code during the analysis and in the deliverables.

- The sociologist has anonymized the information allowing to identify the household/tenants from their quotations or information (such as names expressed during interviews or other personal details).

- The tenants who accepted to be quoted by name and have pictures and videos taken are quoted in communication materials to promote the DREEAM project and presented in pictures in this deliverable.

- All the interviews performed before and after renovations have been recorded when tenants agreed to be recorded. When audio recording was not possible, the sociologist took note of tenant's answers during the interviews and used the live mapping of property's map by tenants in addition to the notes for the analysis

- The audio records of interviews have been used by Savills' sociologist only to transcribe the interviews but have not been used for any other purpose than the sociological analysis work and will not be transferred to any other parties.

- The audio records of tenants' interviews will be erased at the end of the DREEAM project.

3 Lessons learned from Social evaluation

3.1 Consultation on tenants' life conditions before and after renovation by an independent expert is an important completion of the technical analysis

Qualitative data on thermal comfort (humidity, air leaks, inside temperature which often differs between dwellings), life habits in the buildings, user experience and social cohesion cannot be captured in a technical audit or in quantitative survey.

- The social evaluation before renovation consisted in interviews and observations of users' experience with a selection of tenants (of various age, family structure, occupation) that are located in different parts of the building(s) and pilot sites;

- In our sociological approach, we have adopted a qualitative methodology with in-depth interviews with tenants. The qualitative approach is the more relevant method to study tenants' consumption patterns, user experience and life conditions in their dwellings;

- Building managers in the 3 pilot sites have confirmed the relevance of our protocol with semi-guided interviews lasting one hour with a guideline created for DREEAM project to study the various dimensions of tenant's life conditions and energy uses in their dwelling. This guideline is now replicable for other renovation projects after the DREEAM project;

- Tenants were interviewed about their thermal comfort, energy habits, uses of equipment, user experience, expectations for renovations & local community life;

Social evaluation must be carried by independent parties and by experts in the field of Social Science and Humanities especially the fields of sociology and anthropology – not by housing companies' employees just as the energy audits that are performed by independent experts to guarantee independent and trustful results;

- This data should not be captured only by social workers employed by housing companies as they don't have the skills for this expertise, the time to analyze the data, and they are not independent from housing companies;

Our sociological qualitative approach is a positive completion to the technical analysis in the DREEAM project as data collected with tenants improves the quality of statistical analysis performed by energy performance analysts.

- In particular the social evaluation allows the collection of the occupancy profile for each household visited, the uses of equipment, the habits that lead to over or under-consumption, the changes in lifestyle, occupancy or uses. This data is crucial for the energy performance analysis before/after renovations.

- These qualitative data can only be collected during social evaluation directly with tenants and are crucial for energy performance analysis to build a baseline of energy consumption for each pilot audited with a high level of accuracy. In particular the occupancy, the uses of equipment,

the types of energy consumption are factors that directly affect the use of energy and that must be verified in the calculation of energy performance before and after renovations to guarantee that energy saving calculated are directly linked to technical interventions rather than linked to behavior change (e.g. changes in occupancy, changes in uses of equipment, purchase of new equipment, over-consumption).

Social evaluation with interviews in the home of tenants can also complete technical quality checking evaluation at the end of renovations.

- During our interviews post-renovations, several technical details observed during interviews which surprised the building managers and were not identified in the technical quality checking performed before, for example in one pilot site all tenants were supposed to receive a time thermostat but some tenants only received a simple thermostat with different setting and remote controls. Only interviews inside the home of tenants can offer an in-depth overview on the final life conditions and installations of equipment as experienced by tenants.

- Social evaluation has a value to identify technical interventions that are not done according to the plan in completion to the technical quality audit at the end of renovations.

For future replications: social evaluation of energy uses and tenant's user experience (UX) with equipment should be carried – as energy efficiency audit – by skilled and independent Social Science Researchers commissioned to visit the pilot site and to carry qualitative evaluations with a selection of households.

3.2 Face-to-face interviews inside the home of tenants is the most appropriate method to evaluate the socio-economic impact of energy efficiency projects

Qualitative semi-guided interviews are a relevant and efficient method to collect trustful answers from tenants. Other SSH methods to collect data such as quantitative surveys or focus groups are not relevant for the evaluation of renovations on tenants' life conditions for several reasons:

- **The project managers and social workers of the pilot sites don't think that tenants would take the time to read in detail the questions in a quantitative survey about energy uses, User Experience (UX) of equipment before or after renovations:**

"It is impossible to make only a questionnaire: it's impossible by letter for the questionnaire, you have to ask personally and directly the questions, if you give them a questionnaire they won't give the real answers, or they won't answer, we need to meet them and ask directly" (ATER employee-2017).

- With the method of quantitative questionnaire, few tenants would read it and send their answers, the engagement would probably be low and the answers not accurate;

- **Quantitative surveys or focus groups don't allow visiting the homes of tenants and observing and documenting under their guidance the problems they experience in their everyday life with equipment and renovations;**

- **Quantitative surveys and focus group don't allow analysis of the user experience (UX) of tenants inside their homes with their bills, their equipment (radiators, boilers, equipment) and establishing the information that they need in the context of renovations;**

- For complex topics like thermal comfort and energy saving habits, it is needed to interact with tenants one to one to check that they have well understood the various questions, to question several times the relevance of their answers by asking practical examples illustrating their answers. Answers given by tenants in a survey questionnaire would potentially be biased or not precise and it would be impossible to check that tenants have understood the questions;

- Asking about the "how" in interviews (practical examples of "how" in real-life by interviewed tenants) is a classic and efficient tool in sociological qualitative interviews (Becker, 1998) and is difficult to ask in questionnaires;

- **The most relevant approach is a method involving semi-guided interviews and User Experience research (UX) inside the home of tenants and guided by them.**

3.3 Tenants prefer interviews to questionnaires and feel that they are truly listened with our protocol of interviews and mapping

Most of the tenants we interviewed prefer face-to-face interviews than quantitative surveys on paper, email or by phone.

"I think it is good. You need a feedback, you do all this for the estate but you need the feedback of people!" (W.UK.2019)

"If you send a satisfaction evaluation form, people will put it in a bin. With interviews, people give genuine answers. It is not intrusive, if someone knocks and you don't have time to answer to questions you just say it. Putting it on paper is difficult, I found it better if I can talk during an interview". (W.UK.2019)

"Meeting with tenants, yes it is necessary and we should engage more the tenants and question them, it is much better that way, you have to ask them, it makes a difference to understand before and after the renovations from the tenants'" (A3.Germany.2019)

Tenants seemed to appreciate that an external and independent expert performed the interviews before and after renovations and not only employees of the housing companies, as the answers cannot be biased in favour housing companies with an independent interviewer.

Questionnaire surveys are not relevant to question the User Experience and expectations of tenants:

> **"I prefer face to face meetings and face to face interviews. If you get a form, a survey there are things you want to ask in a form but you can't ask. As a tenant, there can be something you also want to explain, it is just not a piece of paper than can do it" (L.UK.2019)**

Tenants appreciated our interview guideline that is not considered intrusive but at the contrary offers the opportunity to take the time to truly listen to tenants.

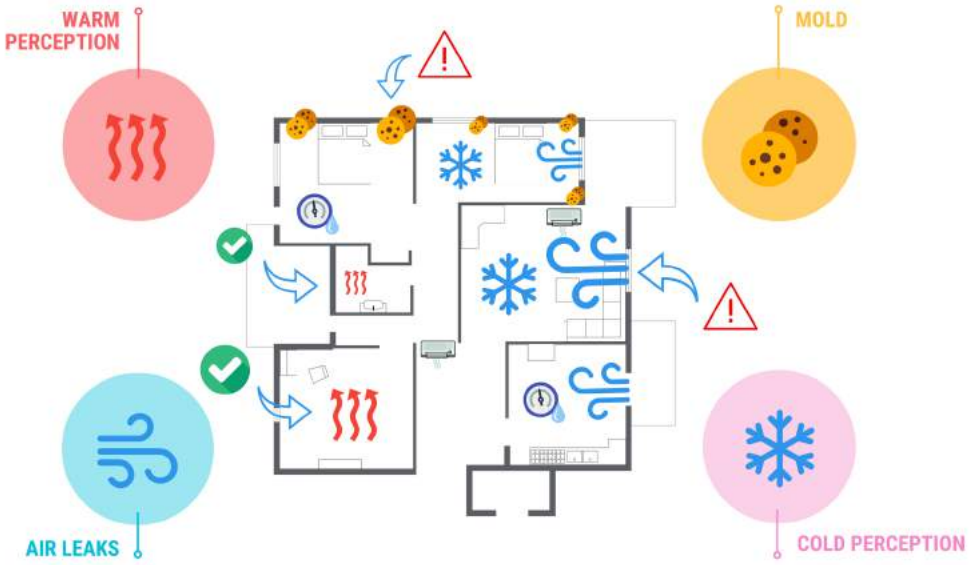
> **"I think it is good already, the time is ok, it shouldn't be shorter, if you rush everything the questions, the answers it is not good, the time of one hour is good for the interview" (L.UK.2019)**
>
> **"The interview is very useful! I like you very much for your professionalism during interviews (…) it is not intrusive, you are very sympathic, there is no problem" (B1.Italy.2019)**
>
> **"I think it's useful both for tenants and for the project the interviews, it's a face to face experience with people, I like the interviews very much, I totally agree with the idea of these interviews and I would very much like to receive energy saving advises, I would like the guide also (…) I am an old lady, the world is changing a lot and I ask myself how I could do better about consumption in general" (B2.Italy.2019).**

3.4 Mapping and tactile ICTs are efficient during social evaluations

During the social evaluation, we developed the idea of using maps of tenants' properties. We gave to tenants a map of their apartment that we discuss issues with them live while going through the semi-guided interview guideline. This mapping concept was integrated in interviews from 2016 to 2019 with positive feedback from tenants.

The mapping allows us to compare precisely the results of the interviews before and after renovations. The concept is to use a rigorous protocol of guideline, in-home visits, observations and consultations with mapping like in a technical audit but for the social dimension.

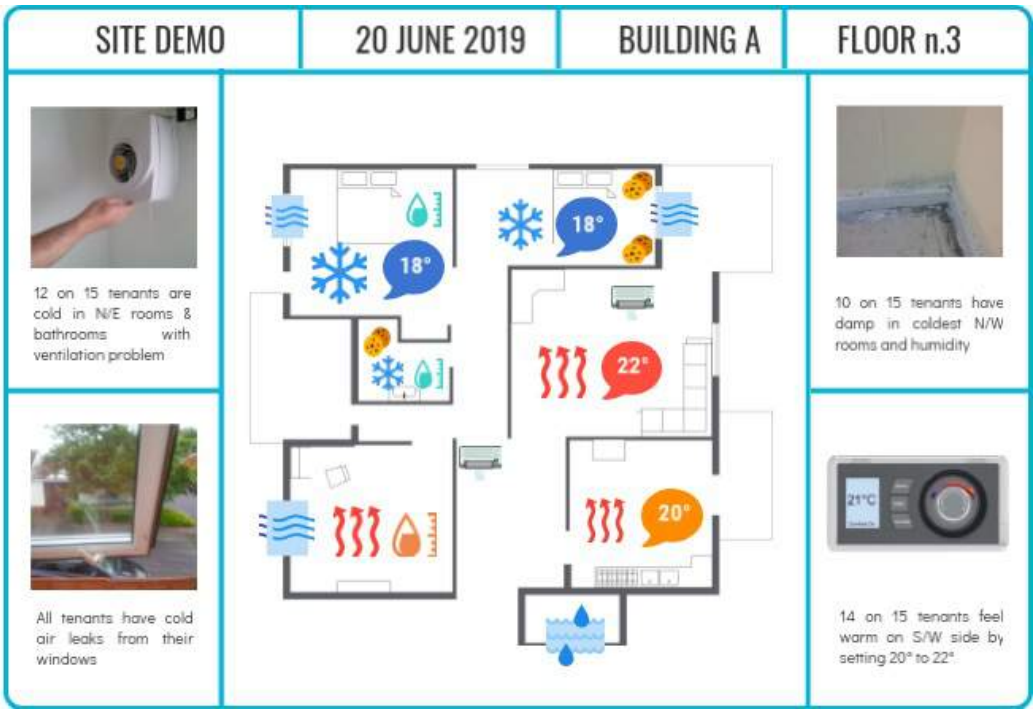
Tenants are very proactive during this mapping exercise: they participate actively in the mapping, they show us on the map and in person their answers, the map really help tenants to elaborate more precise answers.



Then we bring again the same maps commented on initially by tenants before renovations to the interviews after renovations to compare before and after answers. Tenants can also check their answers before renovations and compare them with their current life conditions, this is a very transparent and collaborative approach that tenants appreciate.

This participative method allows us to check that we have properly understood the tenants by completing the map inside their apartment together with them. The mapping approach is particularly interesting in situations when the sociologist does not speak the local language and a translation is needed, with the map, interactions are easier.

In addition to the map, we document visually the various equipment and uses that tenants show us during the visits with pictures and videos.



During the process of interviews, the sociologist coordinates the questions and controls the social evaluation process and a representive of the housing company is present during the interview to guarantee a good link with tenants and to help with the translations.

Our method of social evaluation is innovative as it is not common nowadays to evaluate the life conditions of tenants comparatively before and after the renovations, and to make these evaluations both with real visits inside the homes of tenants and with a visual mapping.

Social evaluation is a good way to determine and document visually the human experience of technical renovations, and to listen to the viewpoint and experience of citizens who live with these renovations and new equipment on daily basis.

Social evaluation can be very useful for housing companies to:

- Report and communicate publicly on the lessons learned during renovations from tenants and employees' viewpoints;
- To capitalize on the knowledge gained about equipment and renovations to improve tenants' life quality;
- To prove that this social evaluation is impartial when performed by an external sociologist.

Social evaluation offers a vivid and empathetic understanding of the positive impact of renovations on tenants' life conditions and on the negative experiences.

Tenants expressed in general a high level of satisfaction with these interviews and this mapping exercise as it shows to them the interest that the housing company and the sociologist has in the tenants and their situation, they feel truly listened during these visits at their home, they feel more involved and they can ask questions about renovations and express their expectations for improvements if they have any.

The key factors of success of our sociological approach:

⇒ Listen humbly to the voice of tenants and have a strong empathy for them;

⇒ Be transparent about the purpose of the research;

⇒ Take the time to be informative about GDPR;

⇒ listen to the real experience of tenants without trying to "teach" them first;

⇒ take the time to observe tenants using their equipment without commenting;

⇒ design solutions with an incremental process involving several steps of consultations and co-elaboration of the tools with tenants;

⇒ develop synergies of investigation methods from Design Thinking approach, socio-anthropology of consumption and design ethnography




Our programme Green Neighbours, developed after two years of co-design and iterative process between 2017 and 2019, allowed us to recruit tenants in each of the three pilot sites, these tenants agreed to become Green Neighbours ambassadors after the end of DREEAM project and to help the other tenants living in the pilot site with their energy consumption and new equipment.

This is a positive achievement for the sociological dimension of the DREEAM project as the Green Neighbours programme has been co-developed between the Savills's sociologist, tenants and social workers. Our initial objective was to engage tenants after the end of renovations to avoid the rebound effect, to help tenants to make saving after the renovations and to help them to use the new equipment installed during the renovations.

The concept of Green Neighbours coordinated and developed by Savills' sociologist with tenants and social workers involves key elements that are particularly positive according to the residents and employees:

⇒ Co-design solutions are better than simply consulting residents, co-design is a key factor of success. We have adopted an approach with direct collaboration of tenants and employees on graphics, texts, concepts, design, layouts, etc.

⇒ Tenants have given a lot of very good ideas to design the Green Neighbours programme to the sociologist, these ideas have been integrated to build a final programme that is syncretic of the various ideas, proposals and creativity of the tenants interviewed and consulted individually in the three pilot sites during two years.

⇒ Empowerment and transparency: our objective was to build tools that ambassadors and then tenants can use in their everyday life. We developed our approach by giving a lot of attention first to understand the difficulties of tenants about the information and knowledge they have related to energy consumption. The time dedicated to better understand tenants' perceptions and experience with energy, and equipment inside their homes is another crucial aspect of our approach.

⇒ **Mixing sociology, design ethnography, co-design and UX was a key to succeed: it is possible and positive to develop solutions for citizens in energy efficiency projects by mixing approach and methodologies from the field of Social Science and Humanities (SSH), design and User Experience research. Social innovation in the field of energy will require to work in a transdisciplinary manner with a synergy between various methods of data collection to build solutions that are really adapted to the values, habits and experience of citizens.**

Berlin Pilot site – After renovations interviews - 2019

C2: "We have a group of well-informed neighbours and it's a good idea this little poster on the doors. Some of my neighbours would be good Green Neighbours. I think the best would be for Green Neighbours to have this little equipment to show, plus a poster Green Neighbours on the door, plus a poster in the lobby and this table on the fridge. I would be interested to have the meter for a long time. you can put one plug meter somewhere over in month and see the results, for example we can see that we consume so much in standby!"

A1: "It would be good that you give more advises on the energy efficiency and how to make saving. I think it's a good idea to put the Green Neighbours tag on the door or on the window to let the other tenants know that you are a Green Neighbour and you can help them for energy-saving".

A1: "Yes it's a good idea, I am okay to become a Green neighbour, I could help other tenants. We could also talk about the Green Neighbours during our next community party in September".

C2: "If I have this guide for Green Neighbours and advises, yes I could speak to the tenants. I also have the idea that we could organize collective meetings with a group of Green Neighbours, to exchange. We are a group of active neighbours in the area and you need someone to guide the other tenants, it is very important".

A4:"I am interested in this initiative to raise the awareness of tenants about environment because I participate in sustainability seminar, we try to identify the definition of being sustainable and how to change the behaviours and how to educate people on climate".

A2:"It would be good to give personalized advises in collective meetings to learn on tips and from other people too in the building, what they do that works. I like the idea of an engagement programme with tenants. There is a global problem of understanding, we should re-educate people on the rules of recycling in the building, on energy uses. There are problems of exchanges between cultures, some people don't understand the recycling and how to do it respectfully. Some other tenants don't care at all, we should inform them (…) It would be good indeed to compare our consumption and the real costs before and after adopting saving habits, and also to know more about our environmental impact. It would be interesting to make an exhibition with pictures on the other tenants in UK and Italy, what they have experienced".

B2:"I am interested by advises and also by tips, I received advises from my neighbour".

B1:"I am interested to participate to collective meetings, to make training on energy tips, I know a lot of tenants, I am member of the settlement committee every second Wednesday per month, where tenants can come and ask questions. I think we could organize a meeting around the idea of community for environment, to give advises to tenants. There is a need of inter-cultural energy and environment advisors for the different cultures in the community, to explain how to recycle, to use energy, equipment. There is also a need to create links between generations as younger tenants don't come to the settlement committees. The best way to inform is with common meetings, posters are guide but some tenants won't read them".

A3: "I am interested yes to make savings and to receive potential tips from consumers. I don't receive information or tips from my electricity provider, I receive information from 1892 and even more information would be good about energy consumption. I pay €100 per month and it's okay".

A3: "Eco-coaching is a good idea".

A4: "About the idea of eco-coaching I think it is a very good idea to compare the different equipment and to estimate the long-term impact of new behaviours and the impact of adopting saving habits, it is really important".

3.5 Social evaluation and co-design with tenants are key factors of success towards socio-ecological sustainability in energy efficiency projects

Insights from tenants are important to build a well-designed renovation concept that will improve the socio-ecological sustainability of the renovated district and the life quality of tenants.

This concept of "socio-ecological sustainability" is one of the key aspect of our approach and is directly inspired by the best energy renovations projects experienced in Sweden that integrated tenants at the different steps of design and decision-making process (Tunström, 2015).

In particular, we developed our approach on the previous following social experiments:

⇒ Hallbara Ålidhem project with deep collaboration and co-design of solutions with tenants;

⇒ Järva project with environmental education offered to parents and children;

⇒ Illawara Project that involved tenants in the communication material in New-Zealand;

⇒ The training of "energy referents tenants" by ACER Modena in Italy

Several successful projects on energy efficiency and deep renovations have integrated the social dimension such as the multi-awarded "Winter Garden" project in Umea (Sweden).

This project has demonstrated:

- the importance of studying the life conditions and energy consumption patterns of tenants prior to renovations;
- the excellent ideas and proposals of tenants to build better architecture adapted to the real needs of tenants
- the crucial role of tenants' acceptance and involvement through local information campaign to reach the expected energy efficiency results.

3.6 GDPR compliance

Our protocol is highly appreciated by tenants because we are very transparent and we took the time at the beginning and at the end of interviews to clearly explain to tenants how the data collected during their interviews will be used, stored and communicated publicly. We recommend following the same protocol to guarantee that tenants are aware about the future uses of the information they give to us during their interview

Most tenants are not yet well informed about GDPR, and data right issues so this is the role of housing companies' employees and sociologist researcher to inform them about their rights and to be as transparent as possible with them before, during and at the end of interviews. A copy of the consent form should be given to tenants with the contact information that they can use if they want to withdraw from the research study or to receive more information about their participation. We also believe that it is positive to not use family names in public reports even when tenants agreed to do but to only use codes or 1st name (A1, C3, Martin, Laura, etc.) for privacy protection.

3.6.1 Before starting the interview

- Deliver to each tenant interviewed the letter of consent
- Explain GDPR compliance and their rights
- Explain the purpose of these conclusive interviews
- Ask the consent of tenants or not to record the interview for accuracy in later analysis;
- Ask tenants their consent or not to be taken in pictures and some parts of their apartment too;
- Let the tenants read the consent letter while answering to questions if needed;
- Only start the interview once tenants have agreed to the conditions mentioned.

3.6.2 After the interview

- We ask tenants if some information they gave during interviews should be erased or not mentioned even anonymously in public reports;
- We ask if tenants agree to be quoted and pictured in reports, newsletters, public materials by using their first name only or a code (not their family name) and we show them example of public communication on DREEAM project;
- We ask at the end of the interview to tenants to sign 2 versions of the consent letter and tick each box;
- We give 1 signed version of the consent letter with also the signatures of the landlord's employee and the researcher to tenants (directly at the end of the interview or later by email or post mail);
- The housing company keeps a copy of the 2nd signed letter of consent and transfer a digital copy to the researcher;
- Letters of consent are stored in GDPR compliant storage solutions by housing companies and researcher.

3.6.3 Use of personal data, anonymization, GDPR compliance

- The family name and address of households won't be integrated in any report presenting the result of interviews (both working document, public and confidential reports);
- Age, gender, household structure, activity will only be used anonymously for statistical purposes (global statistics on tenants in the buildings) and to identify potential correlations between gender, age, household structure and energy consumption patterns, and renovation expectations;
- If tenants agree to be named in reports, we will only use their first name but not their family name – linked to their quotes and data (example: Robert – Berlin Pilot "quotation", C2 "quotation");
- Reports where information related to the exact address, floor, dwelling are delivered are communicated only to the housing companies and to the energy auditor commissioned to evaluate the energy performance of the pilot site;
- The consent letter and final interview guideline are provided to tenants both in their native language and in English.

3.6.4 Consent letter

DREEAM project – Final qualitative semi-guided interview – Social Impact evaluation

I, the undersigned, confirm that (please answer yes or no in the box as appropriate):

1.	I have understood the purpose of the final interview in DREEAM project and I have been given the opportunity to ask questions about my participation in it.	(Yes or no)
2.	I understand that other project partners will have access to the data collected during the interview only if they agree to preserve the confidentiality of the data and if they agree to the term specified in this form.	
3.	I understand that my participation to the interview is voluntarily and that I am free to withdraw at any time.	
4.	The procedure regarding data collection of my interview and pictures have been clearly explained to me.	
5.	I consent to the interview being audio recorded.	
6.	I understand that personal data will be collected during interviews (such as age, habits, opinions) and I agree that the data collected during interviews is used in an anonymous way in public reports, social media and communication material.	
7.	I agree that my 1st name is used in public communication material related to the content of my interview such as personal quotes and opinions.	
8.	I agree that pictures and videos of me and my home are collected during interviews are communicated by the project in public material.	
9.	I have understood that I am free to request that my personal data are erased by the project team at any time without giving reasons.	
10.	I, along with the Research and Manager, agree to sign and date this informed consent form. A copy of this consent form signed by all participants has been delivered to me.	

Participants:

Name of Interviewee	Signature	Date
Name of Researcher	Signature	Date
Name of Manager	Signature	Date

3.6.5 Sample of interviews in the three pilot sites

UK Pilot site - Padiham

	Numbers
Households interviewed before renovations	15 (20 tenants)
Households interviewed after renovations	8 (8 tenants)
Number of co-design sessions	11

Germany pilot site – Nettlebeckplatz

	Numbers
Households interviewed before renovations	14 (16 tenants)
Households interviewed after renovations	9 (11 tenants)
Number of co-design sessions	10

Italy Pilot site - Treviso

	Numbers
Households interviewed before renovations	18 (22 tenants)
Households interviewed after renovations	7 (8 tenants)
Number of co-design sessions	8

4 UK Pilot site – Social evaluation before and after renovations

4.1 Thermal comfort before and after renovations

4.1.1 Before renovations

A clear division between tenants in energy poverty and the other residents in Padiham

There was a clear distinction in our sample of interviewees between 8 households with low thermal comfort and 7 households with decent or good thermal comfort in 2016. The key factor explaining this difference between tenant's thermal comfort was the income level and the budget allocated to energy to keep the dwelling warm, the exposure to wind, air leaks with the orientation of the dwelling and the insulation quality of the dwelling. There was also a clear distinction in the Padiham pilot site between tenants who could afford energy bills, even quite high energy bills, and tenants unemployed receiving social benefit who struggled to pay their bills.

Before the renovations in 2016, the distinction between energy poor tenants and tenants who could afford to keep their home warm was well illustrated in our group of interviewees. **7 households of 15 had a positive perception of the thermal comfort inside their dwellings in 2016** (households A, B, C, H, I, M, O). These tenants expressed that their apartment was not cold and was comfortable and they could afford to heat their apartment. For this group of tenants, the toilets and bathroom could remain cold sometimes, but it didn't decrease their general feeling of thermal comfort (especially for n°C). **But 8 households of 15 had a negative perception**, **their apartment was cold to very cold and even freezing in the following rooms:** living-room, bedrooms, bathroom, toilet, hallway, the 2 little spaces/rooms on the ground floor and rarely in the kitchen due to cold air draughts (households: D, F, G, J, K, E, L, N) and in these 8 households, 7 households had an additional heating equipment.

> **J: "In winter it's freezing".**
>
> **K: "The kitchen is cold because of an important draught under the two doors in the entrance and in the kitchen".**
>
> **L: "It's very cold (in the kitchen and in the bathroom) because it's on the north side".**

Some tenants were staying at home during the day and suffered from energy poverty

In 2016, 9 of 15 households visited were composed of at least 1 tenant spending most of the daily hours inside the dwelling either because they were unemployed or retired. These tenants were suffering the most from the cold inside their home as they could not afford to heat their home decently with the heat loss due to the old windows, the poor insulation and the obsolete radiators, and in addition they had to experience coldness during most of the day as they were staying at home most of the time. The situation was particularly unfair for them: energy was too expensive but they would have had to heat 8 to 10 hours more their dwelling than active tenants to keep a decent temperature inside.

4.1.2 After DREEAM renovations

After DREEAM renovations in 2019, tenants previously living in a situation of energy poverty and with low thermal comfort in 2016 expressed a high satisfaction about the renovations.

- Their life quality inside their home has changed with a new feeling of warmth inside; Tenants can use all their rooms during the day in winter as the heat is very homogenic, they can use several radiators and warm several rooms. Before renovations the same tenants were restricting themselves to using the 1 or 2 rooms that they could afford to heat in winter. Some tenants expressed that before renovations they were worried to get out of bed in the morning due to the cold and were literally afraid of the winter and the cost of energy to maintain a minimum of warmth inside;

- Good thermal comfort has improved the health of 2 tenants who had a lot of cold and sore throats before renovations due to high levels of humidity and low temperatures inside, but the same tenants did not experience similar health problems since the end of renovations;

- Some tenants spend less money for their electricity and heating (between 30% to 50%) since the renovations and we have collected their bills to verify this difference. We will monitor this positive impact during a second winter in 2019/2020 with the help of PFP social worker;

- The combination of the efficiency of new heaters and the insulation work is perceived as really high by residents in their everyday life experience of the winter 2018/2019. Several tenants now only need to use one radiator in the living-room to keep all the rooms of the dwellings at a comfortable temperature in winter thanks to the combination of new storage heaters, windows and insulation;

- The combination of the high quality of insulation and the new windows has a very positive effect on the heating energy demand needed to keep the dwelling warm: according to tenants, after renovations it is much quicker to warm their dwelling compared to before and they lose the heat very slowly, the dwelling stay warms very long even after shutting down the heaters:

- The humidity feeling has decreased a lot thanks to the new insulation and ventilation system, this positive impact has another additional benefit: the thermal comfort perception has increased precisely because humidity has decreased (humidity tends to increase the feeling of coldness in residents in general);

- The general feeling of happiness to live in the area has changed considerably especially for the tenants living previously in energy poverty, now tenants are glad to live in their apartment, they feel “at home”, some tenants are now proud to live in the pilot site of Padiham when this area was having a bit of a bad reputation before, and these tenants are not afraid anymore of the long cold months of winter;

- **Some tenants in Padiham are probably - thanks to the renovations - not part of the category of energy poor residents anymore, which is a very positive social impact for DREEAM project.**

> **"Before in the evening, it was really getting cold but not anymore, it does feel warmer, the windows are absolutely fantastic, the new heaters are fantastic! The have seriously done a good job!" (S.UK.2019)**

4.2 Radiators use before/after renovations

4.2.1 Before renovations

Old storage heaters were not energy efficient and were very expensive to run

The key complaints received by PFP from the tenants in 2016 were linked to the storage heaters, the air leaks and the humidity levels inside the dwellings. Storage heaters were only used on 2 sites managed by PFP in Clitheroe and Padiham and in these two sites, tenants had difficulties maintaining a thermal comfort without spending an excessive amount of money.

> **"It's not new that we are getting complaints about these heating systems, people don't like them (…) It's going to be over 30 degrees today but tomorrow it's going to rain, it's very unpredictable in the UK" (Local manager – 2016)**

Tenants were losing money with the storage heater system

Before renovations, tenants had to anticipate the weather one day in advance the to set the level of heat to store in the bricks, the heat was then stored during the night (using Economy 7 - a low price energy tariff). The heat was then released during the day depending of the setting chosen by tenants (mechanical vents stopping or releasing the heat). The control of the heating was indirect and the power and vent scale buttons were not very fine/precise. Tenants experienced many days where they have stored heat in the bricks for nothing, or at the contrary the weather was worst and tenants haven't stored enough heat and the dwelling remains cold the day after as no heat has been stored in the bricks. The consequence was a loss of thermal comfort very often during the year, and energy and money loss with excessive consumption.

> **"The storage heaters don't work very well, some storage heaters don't give enough heat (…) we do make a damp inspection and we repair the storage heaters to make sure it's working properly when we have complaints from tenants (…). Some rooms are colder than other rooms, generally when the repairmen come for the storage heaters, they have discussions with tenants to explain that they are old and some parts are obsolete. In the past few years, the major issue was the storage heaters" (Local manager – 2016).**

4.2.2 After renovations

Tenants interviewed are very satisfied with new radiators and surprised by their efficiency

All the tenants we interviewed are very satisfied with the new radiators. They declare that these new radiators are more efficient, easier to use and less expensive to run than the previous ones. Several tenants experience a high thermal comfort by setting their heaters from 14° to 21° and they are very satisfied and get enough warmth with a low temperature setting, and without having to use higher temperature settings such as 24/25° to feel comfortable.

> **(S):"The new heaters are fantastic! Before we didn't have any option, it was charging from 11pm to 6am, but the new heaters have 6 different programmes, it does heat overnight, and it is a mix of storage and direct heaters".**
>
> **(A): "When I put 14°-16° it is warm! We don't need much radiator now, just in the bedroom and the living room, I don't put the heater on in the kitchen, the hallway and the other bedrooms".**
>
> **(P): "It's positive, the old radiators they were really horrible".**

Some tenants have already observed a real impact of renovations and new heaters on their energy bill: they save money since the end of renovations

Some tenants already noticed the difference of their spending on energy since they use the new storage heaters, and they don't have to use any extra heaters since the end of renovations.

> **(W):"I put 21° but I started to find it too warm, so I put 19°. In really cold days, I put 21° but when it is really too cold. Before you had to charge the radiators all night and sometimes before the end of the next day, I had no more heat after 6pm. Now all I use is the radiator, I don't use anymore my additional panel radiator to get warm at the end of the day, I just use the Quantum radiator now. Before I used the additional radiators everywhere even with the other heaters on, I had to heat constantly but not anymore! It's the reason why I was paying 40 Pounds per week for electricity, now with the new radiators I pay around 35 Pounds per week if I put 21° and about 30 Pounds per week if I put 19°".**

There is a slight difference of efficiency perceived by some tenants between the new storage heaters and the new direct heaters, with a preference for the new storage heaters that are perceived more efficient and less expensive as they use Economy 7 tariff.

(W): "I put 19° to 21° in the living-room, in the hall and bedrooms. I didn't turn the radiator on in the kitchen during the winter. They have installed two different heaters in the two different bedrooms, but I prefer the storage heaters than the direct heater because it uses the day time tariff and they are less efficient. I dit it once, I put 23° on these direct radiators, but it was not really that much warm until 23°, after 24°-26° it was ok but that must be expensive so I don't use them".

Many tenants express the need to be coached to use new heaters

During interviews post-renovations we have observed that many tenants don't know how to use the heaters' control menu and the different options to save energy and money. The main reason is that the information given to them by the installation technician was too complicated and the guide they received from the equipment supplier is too complicated.

(S2): "I don't know how to use the new radiators".

(S): "The tenants interested, they are asking questions about energy, but some other tenants are simply not interested at all about energy. There is too much information in the manual on radiators, it has to be very simple".

After analysing the interviews, we can establish that there are four types of users in our group of interviewees concerning the management of new heaters:

Category 1: Tenants who don't want more information about the heater and who learned alone how to use them. The tenants are already **"experts"** and know well the different setting modes. They don't think they need more information but sometimes we noticed that they make mistakes during in-home visit. It is interesting to ask them how they use their radiators menu and setting to identify potential mis-uses and to help tenants to correct them and to benefit the most from the different energy efficient mode of new heaters.

Category 2: Tenants who are interested to receive more information because they want to make saving but don't know very well the different options proposed by the heaters, especially the timer options that are a bit complicated for users who are not familiar with electronic controls.

In this category of tenants we observed 3 types of users: the "positive" users with tenants who are interested to learn how to use their heater in the most efficient way with a direct interaction with a neighbour or an expert, or social worker, the "no-guide" users who only want advises delivered to them in face-to-face at their home or in collective meeting but these tenants didn't read the guide and would not read a new guide in the future, and the "no-touch" users, with tenants who need direct assistance to settle the options and timers of their heaters, and who are a bit afraid to change any of the setting on the heater's menu.

(L): "It was confusing the explanations by the technician for the equipment, I just wanted to know what to do, it was something about the pipe, it was confusing".

(A): "They showed me how to use the radiators, but it would be better to have explanations in simpler terms than what we had. I try to not boost on the radiator, you can choose how much you boost, it's easy, the heaters are a little bit difficult to understand, the main menu is easier to use".

(B): "Sometimes people put 21° all the time because they don't really know how to set it. I never switched off the radiators, I leave it all the time. They showed me how to use it but they were too fast to be honest, I have information somewhere but I don't know where I put it".

Figure 1 - Segmentation of heaters' users in Padiham after renovations

⇒ **Tenants' quotes post-renovations about heaters**

(L): "I used to feel cold and damp now it's comfortable, you can tell by touching the walls, I don't feel cold anymore in the living-room. Before I just stayed upstairs in the bedroom because it was too cold downstairs".

(W): "I was amazed how the renovations make the room warmer even in the toilet and bathrooms, they have removed the fan heater and it is warm, before you had to use the fan heater in bathroom for 10 mins, they have put a new fan heater but I don't need to use it anymore to feel warm! All the rooms are warm now, before the toilet upstairs, the hall, the cupboard room and the bathroom were cold, now even without the radiators the room are not cold, they stay warm, before the rooms were really cold".

(A): "You don't have to use the boost button anymore, the rooms are a lot warmer everywhere, I feel more comfortable everywhere".

(B): "The kitchen is really warmer, I don't need to heat upstairs, I put radiators only in the living-room. I don't need to put a high setting to have a good temperature inside. I think what they did was remarkable! I was really cold in the morning. They came and did the job, the renovations look lovely".

(S2): "It is a lot warmer now upstairs, even without the heating on, I only use the radiator in the living-room, and it is enough to feel warm in the apartment".

(W): "With the new windows, it is a lot better, it does feel warmer and it is a lot cheaper now with the new renovations, I got to spend 50 Pounds a week before and now I spend 25 Pounds a week. I have to put only 14° on the radiator and it's okay! I don't even need to put radiators upstairs".

(P): "It is definitely warmer inside since the renovations, I set 22°, it stays roughly around 22° and if it's really cold I put 24° on the radiator. I only use the radiator in the living-room and in the bedroom, they put a storage heater in the hallway but it's useless, I don't use it so they could have saved money".

4.2.3 Rebound effect observed in Padiham pilot site

Some tenants are over-consuming after renovations with a negative effect on energy performance

A potential risk of over-consumption and rebound effect was noticed during the post-renovations visits in 2019 as tenants enjoy the new comfort offered by their new radiators. We can notice below an illustration of the rebound effect observed on the pilot site of Padiham, tenants use more energy after the renovations to heat their dwelling than before renovations. These illustrations show the calculations made from the ICTs devices installed inside the home of tenants to monitor their electricity and gas consumption, the censors to

monitor the inside temperature that is directly linked to the use of heater in winter, and the energy performance after renovations.

The over-consumption illustrated after renovations is a real issue that can be addressed with by building information and engagement tools for tenants to help them understand their misuses, their over-consumption and the impact on energy efficiency and their bills.

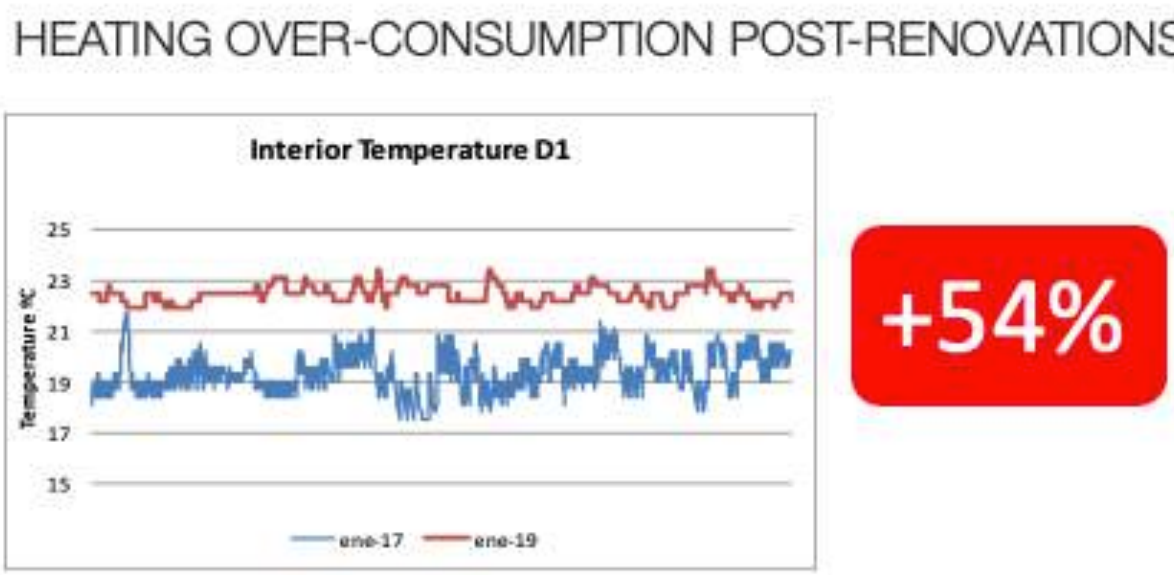


Figure 2 - Rebound effect illustrated with an example from Padiham pilot site with 54% of over-consumption after renovations. The tenant has changed her heating habits (the temperature inside has changed from 19° before renovations in 2017 to 23° deg

One tenant spends more for her energy bills after renovations because she over-consumes electricity by setting the heater at maximum temperature and by using the boost-button

One tenant expressed that she pays more now for electricity after the renovations than before renovations. After the interview inside her home, we can make the assumption that the tenant is over-using her radiator and enjoys having 25°/26° inside her flat. Her consumption is high due to this excessive temperature setting. We have observed at least 4 tenants over-consuming inside their flats during our visits, 3 tenants amongst them were in situation of energy poverty before renovations and they benefit greatly from coaching on the use of equipment post-renovations to avoid over-spending after renovations.

(S2) "I don't know how to use the new radiators, I just put 14° and I use until 26° sometimes and then you can feel the warmth. I think the new radiators are better, but I only use the radiator in the living room and it is enough to warm for the entire apartment. I pay more for energy per week now, I pay 50 to 60 Pounds per week now if the heater is on, before I used to pay between 30 to 40 Pounds per week it could be due to the weather. I put auto-boost; it has always been like that. I put higher temperature now on the radiator, I put 25°, before I could only turn on and off but I couldn't change the temperature on the radiator".

Some tenants put 25°/26° (maximum temperature) and get used to live in a very warm temperature after renovations

> **(B): "It is quite pleasant the temperature inside now and radiators are on at 21° all the time day and night. The old storage heaters were not good, it took a long time to release the heat. I like my rooms to be warm, I think the new radiators are easy to use. I set 21° all the time, it is a bit decadent because it feels really warm, sometimes I put 23°. It gets really hot in the night with a peak at 3am".**

4.3 Air draughts, ventilation and windows before/after renovations

4.3.1 Before renovations

The extra consumption of heating was mostly linked to the low energy performance of the dwellings, and the presence of important air draughts/air leaks through several rooms, despite that loft insulation, cavity wall and double glazing in most properties were installed a few years ago.

A majority of the tenants we have interviewed experienced important air leaks and heat loss in their dwellings. For a majority of tenants who answered yes, the air draughts were localized between the 2 entrance doors and around the windows.

- Several tenants had put tap/scotch on the windows ventilation to limit the air draughts.
- 4 households had no air draughts: G,I,H,M
- 11 households d air draughts: A,B,C,D,E,F,J,K,L,N,O, and this affected considerably their thermal comfort.
- Amongst these 11 households, 6 households had <u>both</u> air draught and condensation: A,J,K,L,N,O

> **(A): "There are air draughts in winter. I have put white plastic around the frame to avoid the air draught. There are seal breaks on the windows, there is condensation inside the windows. Entrance doors have a gap under with lots of air draught. Either way it's a wind tunnel".**
>
> **(B): "There are draughts on all windows. In bedrooms there are draughts, in my bedroom the curtains are blowing when there is wind. In the living-room, the draught is not so much terrible that I feel uncomfortable in my sofa with the window behind. Walls are insulated, I'm not feeling cold".**

(C): "The ceiling is very windy, there are two air draughts from the ceiling trap. PFP has put black seals 2 weeks ago and it's a bit better, but windows are too old. There are draughts under the entrance door".

(D): "Kitchen is a bit cold with the gap under the door entrance and the ventilation. I put a towel on the kitchen ventilation to stop the air. There is a big door gap with air under the entrance doors. Windows are sealed properly but on the entry side (north face), the walls are cold".

(E): "There are air leaks on the windows".

(F): "There are draughts in the kitchen and a big air current between the kitchen and the entrance. The ventilation system in the kitchen doesn't shut down so I closed it with a knife, we stopped it completely".

(J): "There are draughts all around the windows and more on the north side. When there is wind, it's an air tunnel, you have strong air current, and if you open the windows, they will bang and move".

(K): "There is a draught between the entrance doors (gap) in the kitchen and in the entrance".

(L): "There is air draught underneath the doors in the kitchen and in the entrance. There are draughts everywhere on every window".

(O): "On the top of each window there is a gap, an old system of air ventilation that creates an important cold air current".

(N): "There are air draughts in kitchen, and when it's windy in the adult bedroom (facing north)".

4.3.2 After renovations

Tenants are very satisfied with the new windows and about the fact that air draughts have disappeared after renovations. This is the 2nd most important positive impact of renovations according to tenants after the new isolation: new windows have radically changed the inside thermal comfort and stopped the strong heat loss due to air draughts experienced by tenants before.

(L): "Before you could not seat by the window in the living-room because of the draught, now there is no more draught after the renovations, there is only air

draughts now from the extract fan in the kitchen, the bathroom and from the front door".

(W): "there are no more draughts, new windows are very good, before you could hear people talking so the windows are also good for sound proofing and draughts"

(A): "There are no more draughts no"

(B): "The air draughts are none anymore expect upstairs"

(S): "There are no more draughts and condensation"

(P): "I am quite impressed with the new windows, they did the job quite nicely and there is not a single bit of draught now with the new windows. Now when it's windy, I don't feel it anymore, it was draughting all the time before, now it's brilliant…No draughts, nothing!"

(A): "The only thing with the new window, I can hear more noise but there are no more draughts so it is very good for the draughts".

There are only 3 complaints about the ventilation:

- 1 complaint with one problem that is linked to the active ventilation from the roof
- 1 complaint about the open vent on the side of the window
- 1 complaint about the remaining draughts under the door entrance

(S): "The only problem I see is the ventilation, in winter it is absolutely freezing with this vent and in summer it's very hot. The ventilation is in direct correlation with the temperature in the attic, and the temperature in the attic is almost the same than the temperature outside in winter, and it is warmer in summer so all the cold air is put inside in winter, and the warm air in summer, the ventilation makes no sense at all for me"

(L): "The ventilation in the kitchen was there before, there is no flap and it is open air so when it's windy outside, it gets cold inside with air"

(B): "There is one problem: the air draught on the entrance door and it's difficult"

4.4 Humidity before/after renovations

4.4.1 Before renovations

Before renovations a group of tenants in the sample interviewed experienced lower thermal comfort due to excessive humidity.

- There was a real humidity feeling in 6 households: B,C,D,J,M,N
- There was no humidity feeling for 9 households: A,E,F,G,H,L,K,N,0

Before renovations: humidity feeling increased the perception of coldness of 6 households on the 15 households interviewed:

> **(D): "Bedrooms are humid and it feels cold".**
>
> **(J): "There is a general sensation of humidity in the apartment. I dry my clothes in the hallway instead of using a dryer. I let the humidity extractor in the bathroom and the kitchen open all the time but it feels cold. There is problem of humidity with the extractor in the bathroom when it's raining. Water was coming inside the bathroom and dripping, pouring down water on the toilets".**
>
> **(M): "There is condensation on the bedroom window, on the living-room windows. No condensation though in the kitchen. There is a lot of condensation and with the humidity, the air feels like there is a lot of dust".**

4.4.2 After renovations

The tenants interviewed after the renovations who were part of the group suffering from humidity before renovations are very satisfied as the perception of humidity and a damp feeling has disappeared or decreased a lot for most tenants.

> **(L): It is better now for the humidity, you don't feel the same anymore"**
>
> **(P): "It's a lot better now"**

4.5 Damp

4.5.1 Before renovations

There was a presence of damp according to tenants in 7 dwellings n° B, F, G, J, L, M, N

⇒ The tenants commonly describe the presence of black spots and damp mostly in the bathroom, and on the wall angles around specific windows;

⇒ The presence of damp and worst of mould is often directly linked to a misuse of ventilation except for the tenant n° F who declares that she ventilates regularly.

⇒ The problem of damp is in the household J directly linked to a **"poaching action"** (De Certeau, 1990) on the ventilation system meaning that tenants don't use the ventilation system accordingly to its original function/optimal scenario as they blocked the holes of ventilation, by putting tissue and napkins in the holes supposed to let the air go through (**tenants "resist" and refuse to use the ventilation system in its more energy efficient way for various reasons like comfort, avoiding air leaks/air velocity feeling, etc.**). These mis-behaviours are recognized by tenants themselves - there would probably be no damp or mould without this type of action but they continue to have the same behavior because it gets cold with ventilation and they feel a lot of air current through the ventilation system.

B: "On the bathroom ceiling there is mould, I open the door and the windows after the shower".

J: "Yes, there are black spots in the bathroom, at the angle with the hallway. In the bedroom, it was blowing cold air, so I put tape on the vent/aeration and after some black spots appeared, but in the living-room where there is no tape, there are no black spots so there is no problem of damp".

G: "There is a lot of damp in this house".

M: "Yes, there is damp in the living-room around the 2 windows".

N: "Yes, there are condensation and mould on the kitchen window, only in the kitchen. Here specifically there is inside condensation. The ventilation doesn't work in the kitchen".

⇒ There was a particular problem of mould in the households L and F.

> **L: "Yes in the living room, I painted on the mould, there was damp before on all the window side in the living-room. But there is no mould in the kitchen, despite that the ventilation is not working, the ventilation block is closed by default, it doesn't work. There is mould on the angles around the windows in the bedroom (1st floor)".**
>
> **F: "Yes in the bathroom there is black mould, in the living-room (on the windows), and on the wall under the living-room window. In the bathroom, in the two bedrooms, in the toilet a bit too, in the kitchen, you have mould around the windows".**

4.5.2 After renovations

The damp has disappeared in the households interviewed in 2016, except for one household where the problems remains.

> **L: "In the two bedrooms on the north west side there was damp but it's not there anymore, they cleaned, they bleached the wall and it is gone"**
>
> **W: "I had mould in the living-room, in the kitchen, on the south wall, it was soaking wet! I had like little mushrooms. There was mould in the bathroom, it has not come back yet, I have checked every single day since the renovations but there is no more mould. Now never, it is perfect! We used to paint every year to cover the mould".**

There is resistant mould in only one of the households interviewed:

> **(S): I have tried to clean it in the bathroom, but it came back again the mould after the renovations, the problem is the cold"**

4.6 Condensation

4.6.1 Before renovations

There was a presence of condensation especially around or inside the windows for 8 households (A,G,N,J,K,L,M,O)

G: "It's just condensation on the windows, before we had mould, even mushrooms in the living-room but it's been fixed now after that the kitchen has been refurbished. There is condensation on each window every morning, but we don't open the windows or we lose the heat. We turn the fan on when we take a shower in the evening (the ventilation installed by PFP). The fan is noisy".

J: "Yes, there is condensation on one window on the north side, and condensation and humidity around the ventilation in the kitchen".

K: "Yes, there is condensation on kitchen window and living-room window's bottom. The window has been changed in the living-room and there is no more problem of humidity or mould. No ventilation block in the kitchen so we open a bit the window all day long".

L: "There is condensation on the windows in the bedrooms".

M: "There is condensation and mould on the kitchen window, only in the kitchen. Here specifically there is inside condensation. The ventilation doesn't work in the kitchen".

O: "There is condensation between the two glasses of the windows".

Figure 3 - Condensation on the windows before renovations

4.6.2 After renovations

The condensation has disappeared in the households interviewed in 2019.

> **W: "There is no more condensation, before I was drying the air with a little machine "a catcher" for humidity, I had to do it every day and if I was not doing it, the walls and windows were making water drops! So it was feeling humid, with moisture".**
>
> **A: "There is no more condensation, no damp even the bathroom dries up now!"**
>
> **B: "The condensation is almost non-existent now"**
>
> **S: "there are no more draughts and condensation"**

4.7 Additional benefit of renovations: a better health for tenants

4.7.1 Before renovations

Before renovations, 9 households opened their windows to ventilate every day and 3 households didn't ventilate each day. 3 tenants in our sample had to ventilate regularly to avoid bad physical symptoms, if they didn't ventilate during the night in 2016, they felt bad in the morning with either breathing difficulties or dizziness, but unfortunately due to the low insulation levels before renovations, some tenants could not ventilate to avoid losing heat. The tenants who didn't ventilate explained that they didn't want to lose the heat, and because they didn't necessarily feel the need to ventilate in the more occupied rooms such as the bedrooms or the living-room.

> **K: "In the bedroom, if I don't let the windows open during the night I don't feel well, it feels bad, it was the same problem in my former apartment. If we aerate other rooms, we turn off the switch on the side of the radiator".**
>
> **M: "Due to asthma problem, we keep several windows a bit open during the day. We create air current to dry the air".**
>
> **J: This tenant expected to have better isolation with also less humidity feeling and a solution to improve the air quality that can create according to him throats problem and some dizziness in the morning.**
>
> **C: This tenant avoided opening the windows to not lose the heat.**
>
> **J: "I let the living-room and bedroom windows closed all the time".**

4.7.2 After renovations

After renovations, some tenants noticed that their health symptoms improved and for one particular tenant the breathing issue has disappeared after renovations:

> **P (J 2016): "Before I had a sore throat all the time especially when the heating was on, now I don't have any since the renovations, it doesn't feel as dry as before, it feels lot more like gas central heating these new radiators, it's positive, the old radiators they were really horrible. I don't have no more respiratory problems, I used to have bad cold and sore throat but not anymore".**

4.8 Energy poverty issue before/after renovations

4.8.1 Before renovations

No official definition of fuel poverty is set out yet in the EU and there is a need to *"define common indicators and relevant quantitative data to characterize on a same basis the situation in the different countries" (European fuel Poverty and Energy Efficiency/Intelligent Energy Europe)*[3]. For a majority of households interviewed in 2016, tenants experimented self-restrictions to use energy and many households were in situation of fuel poverty if we refer to the particular definition established in the UK: *"a household is in a situation of fuel poverty when it has to spend more than 10% of its income on all domestic fuel use, including appliances, to heat the home to a level sufficient for health and comfort".*

During our interviews in 2016 and 2019, we have used the qualitative indicators proposed in the final report of the European fuel Poverty and Energy Efficiency project[4] (EPEE) project to detect fuel poverty and we integrated these indicators in our interview guideline.

In our analysis, we integrated the conceptual map and key metrics listed by the Trinomics Research Project for DG Energy[5] with the following key indicators to investigate when trying to determine a situation of energy poverty:

- ⇒ The household energy system: energy service demand, energy use and expenditure;
- ⇒ Drivers that impact the affordability of household energy services and could lead to energy poverty;

[3] Reference : https://ec.europa.eu/intelligent/projects/en/projects/epee
[4] Reference : https://ec.europa.eu/intelligent/projects/en/projects/epee
[5] Reference: https://ec.europa.eu/energy/sites/ener/files/documents/Selecting%20Indicators%20to%20Measure%20Energy%20Poverty.pdf

⇒ Key factors influencing or causing energy poverty, specifically relating to i) physical infrastructure, ii) policies, and iii) socio-economic & demographic factors;

⇒ Outcomes. These are (in part) resulting from households being in a situation of energy poverty.

Table 2-1 Key energy poverty metrics in the EU

Initiative	Energy poverty metrics	Approach
ONPE	• 10% energy cost ratio	Expenditure-based
	• Low Income High Costs (LIHC)	Expenditure-based
	• Survey data on lack of heating discomfort	Consensual-based
EU Fuel Poverty Network	• % of households unable to afford to keep their home adequately warm;	Consensual-based
	• % of households in arrears on utility bills	Consensual-based
	• % of households living in dwellings with a leaking roof, damp or rot.	Consensual -based
Insight_E Observatory	• % energy expenditures	Expenditure-based
	• share of energy cost in low income household revenue	Expenditure-based
UK Fuel Poverty Statistics Report	• LIHC	Expenditure-based
Belgian Energy Poverty Barometer	• **Measured Energy Poverty (MEP) extent**: households in the lower five deciles of equivalised incomes whose energy expenditures were higher than threshold • **MEP depth**: energy poverty gap (in €) *above* "acceptable" energy bill	Expenditure-based
	• **Hidden Energy Poverty (HEP) extent**: households whose energy bills are "abnormally low" • **HEP depth**: energy poverty gap (in €) *below* "acceptable" energy bill	Expenditure-based
	• **Perceived Energy Poverty (PEP)**: number of households that report having financial difficulties in heating their homes sufficiently	Consensual-based
Energie-Control Austria	• Households below established poverty "risk" threshold AND with above-average energy costs[13]	Expenditure-based
Report "Energy Poverty in Spain"	• MIS (Minimum income standard)	Expenditure-based

Figure 4 - "Selecting Indicators to Measure Energy Poverty" - Trinomics - 18th May 2016

We have collected the bills of tenants for the heating and electricity and gas consumption and we have exchanged with tenants during interviews on their potential difficulties of pay the energy bills. Our conclusion is that most of tenants in the UK pilot site interviewed before renovations in 2016 were in

a situation of fuel poverty, with a group of tenants in high energy poverty spending more than 10% of their income in energy expenditure. Some tenants paid for their electricity half the price of their property rent:

⇒ Some tenants were paying GBP 90 a week, so between GBP 300 and GBP 400 per month for the rent, and they were paying around GBP 30 to 50 per week for the electricity and between GBP 120 to GBP 200 per month for their energy expenses;

⇒ One tenant was paying GBP 60-£100 per week for electricity, this tenant had a low income;

⇒ Another tenant was paying around GBP 300 per month for electricity, this tenant also contacted the electricity supplier about the high bills. The electricity supplier advised that the storage heater should be serviced regularly, the problem was probably coming from the use of the old inefficient storage heaters.

A: "Before in winter, 90% of my income was going to the tariff meter. For the previous 12 years I struggled with the top-up system before switching to the tariff plan. They should make a pre-payment set, it should have a basic level of consumption with a budget for extra consumption. Before I was on pre-payment meter, you have an added payment for monitoring, and I have changed with (supplier name) to a standard payment with direct debit. I have a standard meter. It allows us to pay £100 per month when before it was £70 a week only for the heating".

Most of tenants of our sample considered in 2016 that the cost of energy was too expensive for their budget.

⇒ 11 households of 15 interviewed believed that their energy costs were too high (10 of them had all electricity and only 2 households with a mix electricity and gas).

⇒ Only 4 households considered that their energy costs were not too expensive:

- 1 household of these 4 households had a mix of electricity and gas;
- 1 household of these 4 considers thought that the electricity consumption was fine except for the costs related to the use of radiators (C: "it's ok but the cost of normal radiators is too expensive compared other electric radiators");
- 3 households of these 4 households who considered that the energy cost was ok, had a direct debit system either by monthly or bi-weekly direct debit, and they consider that they benefit economically from this system compared to the pre-payment system.

The turn-over of tenants in Padiham in 2016 was directly linked to the expensive cost of heating in Padiham properties: tenants with high bills were often looking to move out as they could not afford the bills. In some situation, tenants were obliged to cut their electricity and heating consumption drastically to be able to stay within the allocated budget they have for energy. One tenant mentioned that there is a saying in UK «eat or heat ». Some tenants, (especially those with a pre-payment meter), determine only when they top-up their meter how much money they have left for essentials including food. Concretely when they put money in their pre-payed electricity meter every day or every couple of days they can see how much money left they can use on electricity or gas and they determine if they will be able to pay to achieve a minimum level of heat and use other appliances like the oven in the next coming days – or not. Many tenants in 2016 had difficulties to top-up their electricity meter in the winter.

4.8.2 Expectations of tenants for energy budget after renovations: a reduction between 30% to 50%

The target or ideal budget for electricity consumption expressed by many tenants in 2016 was around 40 to 50% less than their current expenses in winter. In summer the ideal budget was around the same to 30% less.

> **Local Manager in Padiham: "For a number of years, we have customers who have moved out because they couldn't afford the energy cost in the properties. They could get a cheaper property, with the same level of rent but not as expensive for the energy in the property".**
>
> **A: "If I had one budget objective? It would be £25 to 30 a week over the wintertime".**
>
> **D: "Ideally I would like to pay £20 a week for electricity (instead of £40)".**
>
> **F: "My objective? To pay maximum £30 every 2 weeks and if I can save £10 each week" (compared to the current budget of £35 every 2 weeks for electricity and gas in summer and £60 every 2 weeks for electricity and gas in winter).**

4.8.3 Supporting practices for tenants in energy poverty by PFP

The problem of budget skills within vulnerable households is well known and documented by the housing company PFP. This is a topic that they have integrated in their management of tenants and in the selection process of their future customers. PFP makes affordability checking and an analysis of the tenants' income and their future expenditures in the dwelling they are applying before accepting to rent them a new apartment. PFP participates positively in this manner to avoid energy poverty situation with their customers.

PFP also helps tenants in energy poverty with advice and checking what social benefits are available, an approach that should be promoted amongst other European social housing companies.

"We have a team dealing with these topics, we can help vulnerable tenants and we support customers to do assessment of their incomes, to check that they receive everything they are entitled to, to inform them of any benefit that they could apply to and help them manage their budget. Prior to offer a property to somebody, we do an affordability check, so we will never offer a property to customers who can't afford to rent that property, in the process of customers applying for a rent, we will make an interview about their situation, we will go through how much money they receive, incomes or benefits and then how much the bills are going to be in the rent. We do an income expenditures analysis to check that the customers can afford the properties, how much the bills are going to be in the rent, how much electricity and gas it is going to cost them, and we do an income expenditures analysis to check that the customer can afford the property. If not, at the end of the analysis they will be refused the property, and this applies to any property we propose" (Local Manager – 2016).

As an employee of PFP mentioned during our interviews, renovations in Padiham were important to allow many tenants to access to a decent comfort standard and to suffer less from the very real consequences of energy poverty. The category of tenants staying at home, must on average heat their dwelling 8 hours more than an active tenant. Two categories of tenants are more susceptible to stay at home during the day: the unemployed parents especially the housewives and the retired tenants who are present inside their dwellings during the day and the evening. This category of tenants is characterized by a low difference of usage patterns between the weekdays and the weekends. By contrary in families, the weekends are characterized by a stronger presence at home with both the companion/husband-wife and the children present at home with a multi-use of multiple appliances.

Before the renovations some families during the weekdays and week-ends couldn't afford to heat all day long and we have noticed 2 situations in 2016 where housewives were setting the minimum of heat during the day, until the return of their child in the afternoon, when they would release the heat from the storage heater just when their children come back from school or activities.

B: "There is a switch, I put power 6 on the radiator, with the vent off during the night and then 4/5 on the vent (at 4pm). When I open the vent, all the heat leaves so I wait when my son comes back from school to open the vent at 4pm, before I have been at home all day long. The radiator only releases heat until 5:30pm when it should release heat until 8pm at least (with power 6)"

4.8.4 Reminder: Vulnerable tenants chose a payment meter more expensive but controllable

For a majority of households in our sample, tenants experiment energy restrictions and even fuel poverty. This situation encourages many tenants to keep a pre-payment system (top-up meter where tenants put money in advance in their meter (GBP 5/10/20 at a time for example) then they adapt their consumption depending on their budget and their capacity to top-up again in the next days or the week later. The pre-payment meter is indeed sometimes the only solution to get a contract with an energy supplier for vulnerable households due to low credit ratings. The problem of this system is that the energy cost with pre-payment meter is higher than on direct debit and post-payment system.

In 2016: "Probably about 2/3rds of tenants are on pre-payment meters to help them manage their budget. The advantage of pre-payment is that tenants can manage their budget better, some tenants cannot pay by direct debit because they have a bad credit history". Local Manager, 2016

4.8.5 Reminder: the « day by day economy »

It is important to understand that in the UK pilot site, many tenants live in a "day by day economy" and the budget allocated to electricity is established every 2/3 days or every week. This is the reason why **the pre-payment meter presents a sort of "security"** for tenants as they can't exceed their budget: the meter is paid before the consumption of electricity or gas, so they are sure to control that they won't be in debt later. Pre-payment meter is the more common system to pay electricity in our sample (2/3 of tenants in Padiham according to the Local Manager).

Unfortunately, the pre-payment meter contracts are more expensive than direct debit contracts, but many tenants prefer to keep this system because:

- ⇒ They feel that they can really control their energy budget;
- ⇒ They consume only what they can really afford to spend;
- ⇒ They avoid any "surprise" of excessive extra cost that they can't control like with a direct debit contract:

"The key is not to pay for what you have consumed but to consume for what you can afford and accept to pay" (Household O).

The pre-payment meter symbolizes for tenants an efficient energy cost controlling tool with, in a context where no other tools are given to customers to really control their consumption and to fix budget limits. The other reason behind this preference of "pre-payment meter" is that many tenants have difficulties to handle an important amount of money and a budget, and to anticipate their equipment uses several days in advance in an optimized way, such as by using low energy tariff during the night (Economy 7).

F: "We have a top-up system, with a meter outside: you check the amount of money and you put some money with a key. It's my husband who is handling the top-up system. We pay £50 a week when it's really cold".

B: "Now on pre-payment meter I pay around £30 a week and in winter £56 a week, it's expensive. The tariff I pay is higher with the top-up system, but I don't want the bills with direct debit, I'm paying for what I'm using and I can anticipate, I have the choice to consume less but it's a problem (the top-up system) if I have to pay so much to have it" (extra cost).

The interviews in 2016 concluded that the more vulnerable a household is, the more regular is the rhythm of pre-payment meter top-up payments:

- ⇒ from a top-up 3 to 4 times a month (every week approximately);
- ⇒ to an average top-up every 2/3 days to a daily check for the most deprived households.

Tenants who changed for direct debit are more satisfied with their energy bills than before with their pre-payment meter system:

- ⇒ 3 households of the 4 households who consider that their energy cost is acceptable, have a direct debit system either by monthly or bi-weekly direct debit and they consider that they benefit economically from this system compared to the pre-payment system; but the cost to access to this service of direct debit can be too expensive according to some tenants on pre-payment meter.

- ⇒ Some tenants with bad debt history cannot access a direct debit contract from any energy supplier.

J: "I have a pre-payment meter. My supplier asked £80 to have a direct debit, just to have this service so I said no. I would prefer the direct meter but it's too expensive to just access the service".

The risk of over consumption after renovations for tenants in pre-payment meter is real, a support of budget management skills and energy efficiency is needed for these tenants in any deep-renovation projects to avoid over-consumption post-renovations.

4.8.6 After renovations

Five tenants have already experienced a noticeable difference in their energy expenditure thanks to the renovations, with an estimated saving between 30% to 50% of the previous energy expenses. It would be interesting to check if this observation is confirmed by tenants during a second winter 2019/2020. If confirmed during a second winter period, this additional benefit of renovations on energy budgets of tenants would be another very positive outcome for the DREEAM approach in Padiham.

The objective of tenants to spend 30% to 50% less in energy expenditures after the renovations seem to be achieved for several tenants interviewed in 2019.

> **L: "Before I put £10 a week for electricity and £10 a week for gas and it was lasting 6-7 days, now these £20 last more time around 3 days more at the same period of the year and I haven't changed my use of the radiators this winter, and the radiators haven't been changed in my property, just the boiler so there is a difference"**
>
> **W: "Before I used the additional radiators everywhere even with the other heating on, I had to heat constantly but not anymore! It's the reason why I was paying £40 per week for electricity, now with the new radiators I pay around £35 per week if I put 21° and about £30 per week if I put 19°.**
>
> **A: "I was putting £60 a week, now I put £25 a week during winter. Even if the winter was a bit less cold than the previous winter, it is lower even compared the other previous years. We try to save any money, before I would be struggling to even buy food, I had to be very careful, now we spend less for the heating. We were struggling before to pay £60 a week for the electricity".**

Some energy champions who manage their energy very well have confirmed a difference in their bills since the end of renovations during sunny days in particular but not much during rainy days (thanks to the PV). On sunny days the difference is around 20% to 30% according to one "energy champion" tenant compared to his daily electricity budget. This tenant is an Energy Champion with an app to track his real-metered consumption so the accuracy of his estimation is very high and we had the opportunity to check his billing history during the post-renovation interviews to check the accuracy of his description.

> **P: "I have always been taught to respect money, I know the value of money so I am careful, it's common sense, I prefer to spend the money on other things than on energy. I know how to use Economy 7, I am very careful. I gained 30 pence a day when it's sunny but you don't gain any much in days that are rainy like this today. The numbers on the PV meter jumped quite high when it's a better weather. You still have people who top-up their meter when it goes down, but I use an app, it sends notifications, I can check my consumption every day. I check at least 3 times**

per week. I compared the different energy providers and I took the cheapest, I do it to compare providers every 6 months."

Several tenants who are checking very precisely their energy consumption recorded a difference in their energy bills after the renovations, and according to some of them the saving are probably linked to the PV but they are not yet sure. A lot of tenants are very interested to know more about the real production of PV and the benefit for them.

W: "I check on the app how much I use for radiators, the app tells me the global consumption of one day and my money balance. Every night I go to bed it says £13.48 Pounds, when I woke up it says £13.02 and it is how I judge how I am doing in a day, now I spend £14 of electricity in a week when I don't use the radiators, it is brilliant ! It must be linked to the PV!

"It does feel warmer and it is a lot cheaper now with the new renovations, I get to spend £50 a week before and now I spend £25 a week. I have to put only 14° on radiator and it's okay! I don't even need to put radiators upstairs" (ITW7).

Five tenants have not yet noticed an important difference in their energy bills but they express the need to check with one more year and a second winter period to determine the real impact of renovations on their energy budget.

S: I pay £140 per month for electricity. I haven't had a difference in my budget yet but I wait for 12 months to check if there is a difference"

4.9 Conclusions: comparison of tenants' expectations in 2016 and social impact of renovations in 2019

In 2016: the key expectations of tenants for the renovations was the replacement of the storage heaters by radiators with a direct and precise heating control, the improvement of the dwellings' insulation and the limitation of humidity and damp. These expectations have been met with the renovations carried by PFP in the DREEAM project. The Social Evaluation has confirmed already the multiple direct and indirect benefits of renovations on tenants' life quality, energy uses, energy budget and health listed below.

1. **Replacing the storage heaters by another type of equipment with fine variations and direct control has been done.** Tenants like the new storage heaters and find them very efficient. Though most tenants still need some information to use these new heaters in the most energy efficient way and to understand all the different setting and options of timers to save energy.

⇒ Before in 2016 the key complaint was related to storage heaters according to the local manager and tenants: "**The storage heaters don't work very well, some storage heaters don't give enough heat (…) in the past few years, the major issue was the storage heaters" (Local Manager, 2016).**

⇒ In 2019, the new storage heaters are with the windows and insulation, one of the key elements of satisfaction of tenants, a "life changing" installation that allows tenants to live without feeling cold inside in winter.

2. **Spend less money for energy especially for the heating and the hot water was a key expectation in 2016**

⇒ 11 households of 15 interviewed believe that their energy costs were too high (10 of them have all electricity and only 2 households with a mix electricity and gas).

⇒ Expectations of savings were very high and illustrated the economic vulnerability of many tenants in the UK pilot site: many tenants ideally wanted to spend 30% to 50% less in electricity in winter

⇒ In 2019, we have already noticed 5 households of 8 households visited with an estimation of 30% to 50% saving in energy expenses the winter after the end of DREEAM renovations.

3. **Limit the air draughts created by the gap under the 2 entrance doors and improve the draughts around the windows**

   ⇒ 11 households had a problem with air draughts linked to these 2 aspects (doors gap and windows ventilation system)

   ⇒ In 2019, all the tenants interviewed expressed their high satisfaction for the new windows and the ventilation system. There is only 1 tenant expressing a dissatisfaction about the ventilation system that transfers heat or cold from the space under her roof, and one tenant still has problem with draught under the entrance door.

   ⇒ **New actions possible:** An additional technical checking of both these issues could allow to determine if the insulation under the roof of the first tenant was efficiently applied, and if other tenants still have problems of gaps and air draughts under their entrance doors that decreases the energy efficiency of DREEAM renovations.

4. **Limit the condensation and the presence of damp**

   ⇒ 8 households experienced important condensation in or around the windows and 7 households had damp in 2016.

   ⇒ In 2019: this problem of condensation is solved thanks to the renovations and only one tenant interviewed has resistant damp in the dwelling. Overall, the renovations have changed considerably the perception of coldness and humidity in the dwellings, two problems intertwined and that when combined have detrimental effects on the life quality of tenants. Renovations have solved both the perception of coldness and humidity.

   ⇒ **New action possible:** technical visit to identify the reason why mould is resistant in some dwellings.

5. **Improve the thermal comfort especially in 8 households with cold to freezing perception in winter**

⇒ Especially since in most of these households, some tenants stayed at home all day in 2016, the poor thermal comfort in their home had various negative effects (budget, well-being, psychology, health). The situation for many of these tenants was really difficult in winter.

⇒ In 2019, the life inside these 8 households has literally changed for the best. These tenants express their high satisfaction, and gratitude for the difference that renovations have brought into their life, these tenants now feel at home inside their dwellings, they are not afraid of winters anymore neither are they worried about not being able to pay for the heating and to choose between heating and other necessities such as eating. Some of the tenants in these 8 households have also noticed an important change in their bills with saving ranging from 30% to 50% of their electricity bill in

winter before the renovations compared to electricity bills during the winter 2018/2019 that followed the end of renovations.

In PFP pilot site of Padiham, we have an example of successfully designed renovations that have changed the life of all tenants, and in particular the life quality of tenants in energy poverty.

Other lessons learned for future replication with the case study of DREEAM renovations in PFP pilot site:

- The Social Evaluation visit inside the home of tenants could allow to saving money on renovations by selecting only the most useful equipment to install such as radiators, thanks to the life experience of tenants who know where to install or not heating spots:

> **P: "I only use the radiator in the living-room and in the bedroom, they put a storage heater in the hallway but it's useless, I don't use it so they could have saved money. I spoke to people at number 5 and they only use the heater in the living-room".**

The human side of renovations is important for the life quality of tenants during renovations, PFP approach in this matter is exemplary and should be communicated outside the project:

⇒ Tenants express a high level of satisfaction with the work done by the renovations' companies and workers.

⇒ Only one little complaint has been collected during our Social Evaluation post-renovations about the workers who have forgotten to replace a library shelf in one dwelling.

⇒ Except for this complaint, none of the tenants interviewed have expressed complaints about the noise, the attitude of workers, the lack of information, the disturbances or materials – this is clearly an important difference with the experience of tenants with renovations in Berlin and Treviso pilot sites where tenants expressed a lot of complaints about the work process of workers and the lack of information received about the renovations.

⇒ Tenants in PFP pilot site have been constantly informed about the evolution of renovations by the local social worker Latif Patel, PFP staff and the liaison agent of the renovation company.

> **"It is important not to impose the works on tenants. Renovations will not work without tenants buy in. PFP will communicate in a way that shows tenants the options - advocating the best option - and gets tenants buy in for the best option » (Local Manager – 2016)**

⇒ The checking of work quality has been continuous during renovations by the company in charge of operations with a clear attention to details such as avoiding mess, piles of materials, destruction of gardens, and dirt. This work ethic has had a direct positive impact on the life of tenants that has been disturbed as little as possible.

⇒ Based on this positive experience, we recommend that before renovations, the building owners follow a detailed Tenants Experience & Satisfaction check list to control that sub-contractors are performing the requested tasks to check that tenant's life not disturbed and to inform them all along the process.

⇒ The PFP team was also very careful to give the right amount of information to tenants about the evolution of renovations and to exchange with them directly regularly, and with constantly the possibility to ask questions and received quick answers;

⇒ At last, PFP organized on open day with a demonstration dwelling at the end of the renovations to welcome all the tenants of the pilot site and to explain to them the different equipment installed, the right way to use them, the impact of renovations on energy efficiency. A dozen employees of PFP and the renovation contractor were available during this entire day to meet tenants and answer their questions. This approach of an "Open Demonstration" day organized by PFP should be replicated in future renovation projects as tenants were very satisfied to be invited for this event, and many of them showed up to meet and greet the workers team, PFP team and ask questions on the new equipment.

5 BERLIN PILOT SITE

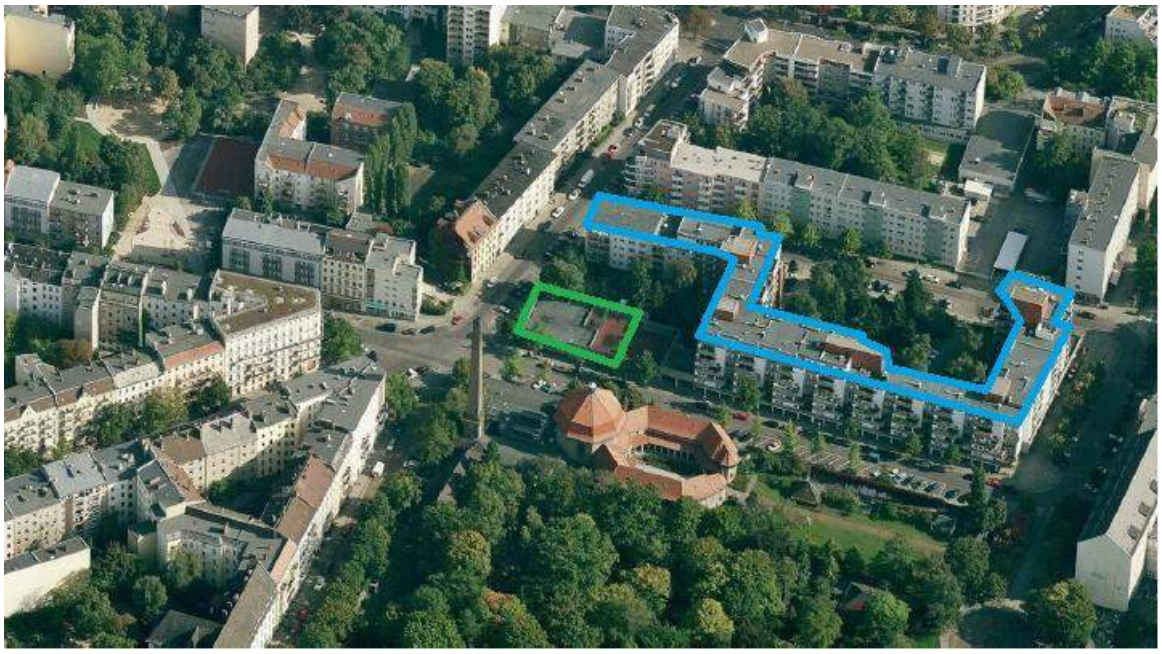


Figure 5 - Aerial view with New building and Existing building

5.1 The heterogenic expectations of tenants before renovations

Before renovations, the perceptions of tenants about the next renovations were very diverse with three common expectations: that the renovations would not cost extra money for residents, that renovations would create energy saving benefitting residents directly, and lastly that tenants receive information about the costs, the PV, and renovations.

Some tenants were not happy about the prospect of having a new building in front of their apartment and some tenants were very enthusiast about renovations, overall the perceptions were very contrasting between positive and negative opinions about future renovations.

Impact of renovations on nature and trees: tenants would like alternatives to cutting

We noticed also that several tenants were unsatisfied about the future impact of renovations on gardens and trees, as some trees would be cut down to build the new block and some of the gardens would be destroyed by the works. We recommend in the future to adopt replacement solutions instead of cutting down trees such as tree extraction and re-implantation in other part of the district. This technology is operational and could be very well perceived by tenants who are attached emotionally to the gardens and trees. Some companies now provide machines to extract the trees alive and to replant them successfully in other area in the context of renovations or urban development instead of cutting them. The positive impacts of such an action are various: social (tenants are very attached to gardens, century old trees, flower bushes, etc.), environmental (trees protect biodiversity as they are natural habitat for pollinators), climate-change fighting (trees keep a lower temperature and avoid heat islands in summer, instead they provide natural

shadow and fresher temperatures), health (trees have direct impact on the well-being, stress and mental health of humans).

C2: "I can't imagine that the advantages through costly engineering for 1892 and for flat users nearly compensate the disadvantages of the renovations. A brochure for all flat users about the new engineering work will be helpful. With exception of the typical symptoms of old equipment problems in the settlement, it is a comfortable living, with warm water district heating, big terrace, outside there is much green".

B3: "I am not so happy that we will have a new building here because they will cut the tree, so I will have a building instead of a tree in front of my window, I would have preferred to keep this tree, now if they replant it, it will take so many years to have big trees…we could have exchanged to find another solution".

A6: "It is good to have new windows but with the renovations, the increase of the collective costs would not be something good, we hope there will be no increase".

B4: "It is positive these renovations, very!"

C2: "We would need information on the PV, on how much cost we will win every day. I don't know about the PV, the time to get money back is very long, there is a problem with selling electricity, and the share of costs. Germany has so much power that we give energy to other countries. PV are expensive, it is an advantage for the environment, there is a problem with the costs of PV, there was no intervention of the settlement committee in the decision, it could have been different".

C2: "Through the repair work I hope we can improve to save energy. Energy saving is an important theme with other residents for private and common uses".

5.2 Berlin tenants were already involved in energy saving before renovations

Tenants identified as energy champions were already very careful with energy uses before renovations but they were very interested to receive even more pragmatic information adapted to everyday life. They wanted to receive information about efficiency scale between A++ ,B, C equipment, energy plug meter, self-energy checking table, Energy efficiency Label explanations as existing EU energy labels are difficult to understand, (energy champions are tenants who know very well how much they use energy and energy tariffs, production, distribution).

5.3 Key incentives to make energy saving are economic, environmental and educational

The main actions to save energy was the purchase of LED lamps, the restriction of shower use, chasing waste such as switching off unnecessary lights and the use of eco-programmes, purchasing only equipment ranked A and above such as A++. Some tenants avoided taking showers every day to save water. Some tenants expressed before the renovations that the electricity cost is high in Germany: “30 cents per kWh” and this context increased their interest to receive effective tips to use less energy.

Tenants in the Berlin pilot site were frequent changers of their energy providers: they changed energy suppliers to combat the effect of energy costs increases. The loyalty to a specific energy supplier seemed non-existent in the Berlin pilot site compared to Italy pilot site. In general, Berlin tenants illustrated the change of relations between consumers and their former “historical energy provider”. We haven’t met one tenant that expressed any kind of loyalty to one particular energy provider before renovations, the price and the environmental impact of energy provider were the main incentives for Berlin tenants to choose their energy provider. Some tenants had difficulties to know what their margins to make saving were after the renovations, as they were quite careful already, so they needed detailed propositions to identify opportunities to save energy and water. Some active tenants discussed often with each other in community meetings. They had the idea of installing automatic thermostat timing as a good solution to reduce the energy uses in the buildings before renovations.

5.4 Key factors limiting the interest of tenants for energy efficiency before renovations

We have identified key factors that lowered the interest or capacity of tenants to make energy saving renovations that we have integrated in our engagement programme:

Energy efficiency technology are not always user-friendly such as the LED light spectrum

- ⇒ LED lamps are uncomfortable for some tenants: the light spectrum gives a bad feeling of vibration, or headaches to some tenants, the type of light colours is unpleasant compared to older lamps.

- ⇒ LED lamps are too expensive and even if they cost less to run, some tenants don’t want to put that much money into the purchase of lamps. Besides, it is sometimes difficult for some tenants to understand clearly the economic and environmental benefit of LED lights compared to traditional lamps as they lack a clear table comparing the electricity consumption and

environmental impact of different types of lamps. Some tenants are interested to receive more specific information on that topic.

Self-named "low energy consumers" didn't know what they could do to make more saving without compromising their life quality

⇒ Tenants who considered themselves low consumer of energy found it very difficult to identify margins of saving in their everyday uses and needed personalized advice or coaching to determine feasible options.

Estimated bills increased the lack of interest and knowledge of some tenants for energy consumption

⇒ Tenants who had opted for estimated bills are billed monthly on the same estimated amount of energy and received an adjustment once a year to pay or get a refund between their energy estimation and their real energy consumption. This particular category of tenants had more difficulties identifying the impact of their behavior on their energy consumption and costs and tended to have the impression that their consumption does not change, neither the energy tariff supporting a low level of interest for the electricity consumption.

The lack of clear calculations and information between energy efficiency scales A, B, C, D and EU energy efficiency label had negative impact on the interest of tenants to replace old equipment by more efficient one

⇒ Some tenants had very old equipment that still worked well but was expensive to run so they kept this equipment because they didn't know how much exactly they could gain with new equipment with better energy efficiency ranking.

5.5 Energy champions tenants already used electricity metering device

Before renovations, some of the energy champions used an Excel spreadsheet to compare the real consumption of equipment to the theoretical consumption written on the label of the equipment before renovations. These tenants adopted energy saving habits according to their calculations. The knowledge of these energy champions tenants was very valuable, and their willingness to be helpful to other tenants was already very high before renovations.

> **A5: "I am a little energy consumer. I take one bath per week and use very little water. I have low energy lamps everywhere. But I use the radiator a lot, I need to be in the warmth and I have an old washing machine, electric plaques, microwave, coffee machine, toaster…making saving is not really a matter for me because I am already careful, I use a measuring device to check the difference of consumption between the devices, I do this because I am interested in electricity consumption".**

Both energy champions and other tenants were interested to help and to be helped to exchange more on energy before renovations, such as through the idea proposed by the sociologist of "Environment community". Several tenants had ideas to improve energy use in their buildings before renovations and would have liked to be consulted more before renovations and the major decisions on the renovations. Some of the tenants expressing this were members of the settlement committee and they would have appreciated that the decision would have been done after more consultations or a co-design process.

The approach of interviews before and after renovations, in completion of the technical work is considered very positive by tenants in Berlin pilot site, and innovative compared to traditional renovations where tenants are not consulted. Some of the active members of the settlement committee would have liked that the committee was consulted more before major decisions on renovations and to involve more tenants through interviews and exchanges. Various tenants would like to have interviews and a co-design process replicated in the future.

This new approach to interview tenants is also positively perceived by one tenant working in the housing sector who considers that architects and engineers should integrate interviews in the entire process, they should ask tenants their opinions as proposed by the sociologist because tenants know well the problems and opportunities of renovations, and the improvements needed in the buildings, so tenants could bring information that are very valuable for the decision making.

For some other tenants, consulting them before renovations is important because it could avoid taking technical decisions that are not appreciated by tenants and to realize mistakes too late when the technical interventions are completed, and tenants are unhappy.

5.6 Reminder: Incentives to adopt energy saving behaviors before renovations

5.6.1 Economic incentive: adopting energy saving behaviors…to save money

C2: "I try to reduce the use of lights, I have no carbon filament light lamps but LED lamps. I use first hot water from the tap then I use power electricity. We use dishwasher rather than washing dishes by hand to use less water. Making saving is first a question of costs. In my life I worked in a company with high level on environment questions, and as responsible for environmental and quality (ISO 9000)".

A2: "It is my habit to consume like this, to be careful with the money. When I was young, we were using heat very carefully, it was not for the environment but for the money! It was to save money. I used to have a non-nuclear energy provider, but I changed to a provider using nuclear power, I will check and probably change again in the future, I compare them. I don't have LED because it's too expensive and the light vibrates. I don't like that type of light. I have a remote control to stop several equipment at the same time I don't like LED lights because it's a cold light, I don't like it, I don't like the concept of an on off and on and off ray of light. I only have LED light in the kitchen. For energy-saving sometimes I use the timer in the washing machine for the radiator, if I leave the house for a long time I only put

19° on the radiator but I know it's not good to shut down radiators completely. I have been told that it was bad because all walls become too cold, and then it requires a lot of time and energy to heat up the apartment again if we shut down radiators completely, and I have checked and experienced that it was right. On average I put between 21 to 22° on the different radiators".

B2: "We are careful, we use the shower only 3 times per week for each person, we have only LED lamps, it is less consuming, there is no problem of mercury with LED and it is not slow to light enough. My dish-washer and washing machine have eco-buttons but I don't use them because it takes too long, the cycles are too long. I prefer to only use the button that I know".

B3: "I use eco-button on the new dishwasher, we have five LED lights, we hear about energy saving in the media, we pay 92 Euros per month, but we expect to pay less soon as our son has moved out. 92 Euros is too much but for 3 persons it was ok. I often unplug the TV when I don't use it because I know it consumes electricity, I would advise this tip to the other tenants to make saving. We close the radiators when we leave the apartment".

B4: "I reduce the temperature of washing-machine from 60° to 40° to consumer fewer energy. I also use Eco button on the dishwasher, and I only use the dishwasher when it is full. I have changed my old lamps with LED, it looks nicer now with LED light, I like it when LED light look like old bulb, like you can see here, it is a bit old, like a real bulb. I can feel the difference between cold and warm light, and LED allow to have more options and to change the colour of the light".

C1: "All my lights are LED, because it uses less electricity, LED are more efficient, also I like the cold white light, and the price of LED lamps is ok. My girlfriend doesn't close the water while she brushes her teethes and I tell her to be careful. I de-plug everything when I leave and I shut down all the lights, I am interested with WIFI radiator so when I leave during a long time, it shuts down and turn on automatically, it would be better because when I leave and close the radiators, when I come back it is too cold, so when I leave for a short time, I leave the radiator on. The calibration of radiators is not good, it only starts at 3PM, not before".

C2: "I have LED because it is cheaper, and it needs less power. I have automatic switches in several rooms and an equipment to measure the voltage. I am not sure though about the difference between A, B, C, D, I would buy an equipment ranked A but I don't know how much energy or money of difference there is, I am not sure if it is economical the difference between A, B, C, D. C2. It is very important to save energy because the cost goes higher and higher so it's a good initiative. It is a lot of money energy consumption and with 0,25€ per kilowatt hour it makes a real difference to make saving!"

C3: “I use the eco-programme of the washing-machine and dish-washer, I have a mix of old lamps and LED. LED are expensive but the consumption is lower than the low energy efficiency lamps. I try to not consume too much energy, I only boil water for 1 cup of tea, I have been raised to switch off the lights when I don’t use them, so I try to be careful.”

A1:“I have watched a documentary and I have put LED everywhere. I am always chasing my children to tell them to consume less. I am absolutely aware about how to save energy and I'm a bit of a role model for my children about energy, water and money. Yes, they are always margins of saving to find for example with the kettle and the vacuum cleaner”.

A3: “We don't let the light on and we are careful with electricity, we don't let any appliances on standby, we use the dishwasher on economic programme and also the washing machine. I don't see how I could consume less. I have learned thanks to my mother to be careful during my childhood. She showed me how to make saving, later I will show to my child how to do and to stop wasting or stop using water or electricity when it's too much It is both for the environment and to save money”.

5.6.2 Educational incentive: adopting energy saving behaviors to show the right example and for future generations

A1 (energy champion): “I review the consumption of the family regularly, and compare the energy providers, we try to control our consumption, we don’t let the lights on, we have all lamps with LED, our fridge and TV are A+, we have induction in the kitchen, all our equipment are A and A++, we don’t have any BCDE equipment. We are often knocking on door of the bathroom to say our children to not stay that long under the shower. Being careful with saving energy is important to educate children and for the environment. We have to think about our grandchildren, not only about us, there are other generations coming after us”.

5.6.3 Moral incentive: the individual responsibility of everyday consumption

A1: “We have to be careful about our impact on environment individually, we have to try day by day, I am a man, but I think like women that we have to do one thing at a time to have a good impact. We are wondering sometimes « how we can do better?”

5.6.4 Environment incentive: the adoption of green energy supplier

> **B4: "I choose an eco-supplier because I want to be able to answer to my children "what have you done for the environment", that I have done that, to choose an eco-supplier, I pay a little bit more and I spend this money well".**

The inversion of education: some children and grand-children taught their parents and grand-parents to make energy and water savings to protect the environment in the Berlin pilot site:

> **B2: "My grand-children taught me to make savings for water, energy, for the environment, me I had the habit to not waste already but I think it's good that my grand-children teach me how to save more. On average we pay 67€ per month for electricity".**

5.7 Perceptions of energy costs before renovations

5.7.1 A general feeling of rising prices of energy and a growing interest for energy saving advises

> **C2: "Prices of energy are rising higher than other costs. The best way to save is to change the power company, I did it last year, now I pay only 70% of my previous bill. I can't understand that we have to pay additional money for environmental energy. Germany has too much energy and give it away for nothing".**
>
> **A5: "I consume 1000 kW per year, it is an average of 35€ per month. I changed energy provider before, but they went bankrupt, so I went back to a big energy supplier instead. I believe that the cost of electricity increases and that it is due to lobbyism".**
>
> **B1: "We use the dish-washer and washing-machine 2 to 3 times per week. We take 2 showers per day per person and we are careful to not waste energy and water. Electricity bills are too high. It is fine for us because I am very careful, and I manage to stay around 3000 kW per year. In Germany, electricity is expensive…30 cents per kWh. I have changed electricity provider to minimize the impact on my bill of the increase in electricity cost in Germany".**
>
> **B2: "I can't really compare with other people, but I noticed a massive increase of electricity cost, due to the taxes, the EEG reallocation change with green energy, the share of costs for renewable energy".**

5.7.2 Energy champions tenants were interested to receive better tailored information on energy

> **A1: "I would be interested to receive information on the difference between A+, A++, A+++. I am very engaged in saving electricity, I search on forums how to save energy, how to reduce the costs, with my provider I can check that my yearly consumption stayed the same but the cost increased, the cost of electricity is increasing so we try to save energy, we tried to use a restrictor in the shower, we always have timers on the radiators".**

5.7.3 Identifying margins of opportunities to make energy saving is often quite difficult for tenants

> **A3: "I don't know where we can make saving….we don't waste anything and what we consume we need it! We have low energy lamps, we use very little water, I don't know what we can do better, maybe you can give us solutions but I don't know myself".**

Tenants with estimated bills had more difficulties to understand the link between their energy uses, consumption and costs compared to tenants with bills from metered consumption.

> **A6: "Four times a week, I am cooking at lunch and it is when I use the equipment the most. In the evening I don't cook, we only eat a bread toast and we look at the TV but we eat very few in the evening. We don't make much saving with our old equipment, we have a 25 years old dishwasher that I use 2 times per week, it is old and not A+ category. I use the washing machine two times per week. Our fridge is new, but I am not sure if it's A category, I have to check. We only use the shower three times per week. We have electronic bills with estimation, and we have a refund each year with our real consumption. We have no problem with the cost of electricity, it is not expensive, I don't really see an increase, it is always the same, but I don't know because we have estimated bills and my husband manages the electricity".**

5.8 Thermal comfort perceptions before and after renovations

5.8.1 Synthesis: the thermal comfort and life quality were already good before renovations

⇒ Thermal comfort and insulation were already good before the renovations according to most tenants.

⇒ A majority of tenants interviewed had no negative experience of humidity and black spots before renovations.

⇒ Some tenants experienced air leaks around their windows and loss of heat in winter due to the bad condition of windows before renovations.

⇒ Key expectations for renovations were focused on changing the windows to avoid air leaks but not to get a better isolation or more warmth, the thermal comfort of tenants was already good to very good before DREEAM renovations

5.8.2 Before renovations

Before renovations, tenants expressed that apartments had good isolation and a comfortable inside temperature:

C2: "We make a seldom use (of radiators) in main bedrooms, dining rooms, bath, kitchen or radiators. We only use radiators in the living room we need more heat while sitting, watching TV, in free time without movement. There is good isolation and no use of additional heating. I know the system, I never got instructions for the heating, I think it would be helpful to have instructions. During holidays time, I reduce the heat setting on minimal".

A2: "It is warm in every room. It is less warm in the kitchen and hobby bedroom. I set 2 in bathroom, 5 in bedroom, 2-3 in the living room".

A2: "The temperature inside is good. I open all the radiators during the eating period. I put them on thermostat 4 and 5 in the kitchen and living-room. I don't need any additional radiator. The inside temperature is good. It is hot, I like it, I feel very comfortable in this apartment. I think it can be 30 degrees sometimes, that is good".

B2: "We settle thermostat 3 in general in the living-room, computer room, bathroom. The heating is off in the corridor, kitchen, and bedroom and the temperature inside is good. It is a little bit warmer in the bedroom and computer room. There is no air current, no air leaks. The dwelling is warm".

B3: "During the day it is 23° in the living-room, during the night we turn-off the radiators to 18°, we have thermometer in the living-room, so we check. An expert told me that I should warm a minimum during the night and that we should not have more than 5° degrees of difference between day and night to not loose energy".

B4: "I put between 2-3 in the kitchen, in the living-room, and I put 5 in the office room, and the bathroom, but the regulator position is too far so it is difficult to turn down or turn off the radiator, so I leave it like this. I don't know the exact temperatures in the various rooms, but the temperature is ok, or I take a blanket. But this apartment is way better than my previous apartment".

C1: "I leave all the radiators on when I am home, the temperature inside is ok but along the window wall it is not isolated at all, there are metal plaques and a cold feeling but no air leaks, but it is cold. If I could, I would isolate more and put jalousie. The lockers for the doors are not safe enough I think, I arrived by middle of October, but I like it here, people are friendly and talk a bit".

C2: "In summer it is around 25° to 30°, I use a fan…in winter, the whole day, the heaters are on and we regulate by opening the windows".

C3: "The floor is cold because it is empty downstairs, but it is a bit a luxury problem, the apartment is comfortable, it is warm in the bedroom, kitchen, bedroom. But tenants living on top of empty spaces are colder in their apartment compared to other tenants"

B1: "In winter, there is a feeling of cold from the floor as the shop under our apartment is empty. We have between 18 to 21,5 degrees in the different rooms of the apartment".

5.8.3 After renovations

There is not much difference in thermal comfort before and after renovations, but some tenants notice that it takes less time to warm the rooms and to reach a comfort temperature level compared to before the renovations. Some other tenants feel that the warmth is more homogenic between the rooms, and they can reach higher inside temperature compared to before.

> **C2: "I use radiators in the main bedroom, 2nd bedroom, dining room, bathroom, there is no difference, and still a seldom use of heating or no use of heating at all. In the living room, I don't use the heating, the room is always up to 22 degrees thanks to a good isolation. After renovations, better windows isolation needs less temperature compensation, it needs less time to warm up and longer to cool down after a cold night with new isolation".**
>
> **A3: "I always put 3 in the living-room and during the night the other radiators are closed, at setting 4 it warms in a very short time".**
>
> **B1: "I put 20 degrees on the thermostat everywhere in the apartment, I use boost function when it's really cold. Now it feels a bit warmer inside due to the shop under my apartment that is now used and there is a big difference with when there was nothing under the apartment. It was colder before when there was no flower shop, it was colder and humid".**

The new thermostats are more precise and allow tenants to set their comfort level more finely. Tenants can reach a temperature that is considered hot…and even sometimes too hot during the winter period since the renovations:

> **A5: "I put levels 3 to 4 all the time on all the radiators. I need a little bit more warmth as I get older and the new thermostats now allow to settle the temperature more precisely".**
>
> **A6: "I put setting 4 in living-room, bedrooms, and 3 in bedroom. Radiators are open all the time during heating period from October to March. We don't need additional radiators. There is one bedroom that is cold on the north side. We have a difference in temperature feeling, I don't like when it's hot but my husband is freezing because he has medical problem, it is too hot for me inside, it's 23,8 degrees in the living-room now. But we don't complain, we feel comfortable in the apartment, we lived here 40 years, we never had problems because the temperature is good by setting 4 in the living-room, bathroom, bedroom and 3 in one bedroom. We could not live well with only 20 or 21 degrees so it is good that we can have more around 22/23 degrees inside".**

Two exceptions in the sample with cold perception feeling: one tenant feels particularly cold in her renovated living-room and even took pictures with a thermographic camera to identify the origin of this cold perception:

> **A3:" It is too cold and too much cold air so I have put some tissue in the ventilation holes. It is too cool in the living room, the bedroom, in the third bedroom. There is no humidity problem. Radiators are on all the time between two or three sitting except in the bathroom. It is very cold in the living room, I have made several thermographic pictures and you can see how cold it is on the floor and on the side wall and in the angle. I put the radiators in the living room at a maximum because of the cold but except that there is only a little bit air current in one of the bedroom and cold air ventilation in the bathroom"**

Another tenant feels cold in his apartment, in the student apartment situated on the ground floor.

> **C1: "In the student apartment, nothing has changed the life quality is the same, and there is no change for energy bills. The isolation is not so good in the kitchen due to the aluminum panel closed to the windows, it reflects the cold, the apartment is around 10 degrees when the radiator is off, it is cold in winter, the feeling is cold, when it is winter time, it is only if I stay inside the apartment for several hours that I can heat enough the apartment to stay in the kitchen. When I am out, I set level 1 on radiator. The windows are cold in the kitchen, it is cold".**

5.9 Ventilation before and after renovations

5.9.1 Before renovations

Before the renovations, some tenants reported problems with the ventilation system, that was too loud, and created a cold feeling inside the apartment. Various tenants interviewed had put shutters in their ventilation holes to avoid losing warmth which is considered as a typical mis-use of equipment that has a negative impact both on energy performance and on health. We see a clear distinction in the perception and use of ventilation between energy champions who use ventilation appropriately and several other tenants who closed the ventilation holes in different ways.

Energy Champions:

> **C2: "In winter time we open the windows only for air circulation often for a short time. We don't reduce the heating while opening the windows, we don't have humidity equipment".**
>
> **B1: "I am a kind of safety officer in the building, and I know that some tenants have closed their ventilation with tissue or else. But I have no problem with my ventilation".**
>
> **A6: "We have to aerate all the apartment every morning during 15 mins, and also when we cook".**
>
> **B4: "Every tenant receives a booklet on how to ventilate well with ventilation".**

Though several tenants closed the ventilation by different ways and don't ventilate enough their apartment and complain about the ventilation system.

> **A2: "The ventilation system is very loud so in the bathroom I have put tissue inside the ventilation system to lower that sound".**

B3: "We have closed all the ventilation holes with stuff, and I believe some other neighbours did too, we do it because the air that comes in is too cold! And there is also a problem of pressure with the ventilation, if we close the kitchen door when the ventilation is on, it will suck the air and you will hear a "pop" when we open the kitchen door. There is a strong feeling of air current due to the ventilation so we have put shutters on the ventilation holes in the bathroom, in the kitchen, it is cold and due to the air suction, it is loud the ventilation, and even louder in the kitchen from 6pm to 10pm. Someone told us that is was sucking too much air, an engineer told us that it was just at the limit of too much suction, he has changed the control level. Our neighbour downstairs hear the ventilation block, and we also hear it too a lot".

C1: "I have changed the ventilation, there is a little manual saying which button I can change. I did it because before the ventilation was on all the time, and it was very, very cold in the bathroom, so due to this I have changed the timer by opening the ventilation electric system. Now it only begins 2 minutes after I enter the bathroom until 15 minutes maximum after I leave the bathroom. It is what I need for the ventilation in the bathroom, I don't need more ventilation and the ventilation on all the time. I monitored how long the ventilation takes to dry the room and it is good like this now".

C3: "There is a bit or air leaks along the kitchen window. Now in the bathroom with the new ventilation there is a smell from the other apartments. Due to the ventilation, the dirt is gone but the smell from another apartment comes to my apartment".

A2: "It's noisy, there is a background sound. Before the renovations, the collective ventilation was closed at 10pm and opened at 7am, it was relieving when the sound was stopping. It is only one ventilation hole and I can hear everywhere until the entrance. My neighbour also put tissue in the ventilation hole".

A3: "In the toilet, it is loud and chilly with the ventilation"

Two tenants even changed the setting on the electric system inside the ventilation block to modify the hours of operation because it was making them feel too cold in their apartments. In the student apartment, the ventilation system in the bathroom was initially working all the time so one tenant decided to change the settings by dismantling the ventilation system, to only have ventilation few minutes when using the bathroom. We have noticed in other apartments that some tenants keep on trying to shut the ventilation holes with various systems. One tenant has installed a Plexiglas panel to stop the air from the windows venting, some tenants are really not happy with air velocity and cold air draughts. Information on the positive impact of ventilation would be needed for tenants in the Berlin pilot site.

A4: For the ventilation I have hacked a little bit the system, I have changed the programing of the ventilation, with the help of the installer, so the ventilation is not running all the time but only a short time after that I have used the bathroom. I was a bit surprised because there

is no ventilation at all in the kitchen and there is no ventilation in the bedroom but there is one ventilation in the bathroom".

C1: "The ventilation works during too long, if I stay more than 5 mins in the bathroom it then continues to run during 20 minutes. I changed the ventilation, before it was running all the time and it was cold so I changed the setting. The ventilation uses a lot of energy, it should be less loud, and less chilly, I think it should be another device or type of ventilation".

B1: "Sometimes there are air draughts with the ventilation, I changed the ventilation on the window to make it less open. I have put a Plexiglas on the windows ventilation, on the windows vent to shut down the ventilation because there was air leak".

5.9.2 After renovations

Air circulation has been improved with new windows and air leaks through windows have disappeared for the various tenants we have visited. Tenants are very satisfied with the new windows and the integrated ventilation opening on the new windows.

C2: "Through the forced ventilation in some windows, we never have humid windows, it is much better than air circulation with vent ventilation windows. For years we had enough air circulation due to leaking windows! In wintertime we had to seal all the windows. now the new windows and doors are very tight, air circulation is only possible by the forced slots, it is a very comfortable situation. Ventilation in kitchen and bath are very satisfying, there is no trouble with unpleasant smell, noise or humidity".

A5: "There is a good circulation of air with a ventilation in the kitchen and it feels good".

5.10 Humidity perception before and after renovations

5.10.1 Before renovations

Before renovations, there was no humidity and black spots, or mould for most of the tenants interviewed except for two tenants with superficial presence of mould.

A1: "There is no humidity, no black spots, no holes or water leakage before renovations, more warmth would be better, to have a more homogenous and better temperature inside and to spend less in heating. we have 5 temperatures level on the radiators. I try to put 20 degrees maximum on average, but it can get a bit cold. There is a cold spot on the east side wall: last year it was colder than this year (2018) because before the ground floor beneath

was not inhabited by the group of elderly tenants so the ground floor was colder and ours too".

C2: "Some weeks ago, there was much humidity on our walls, it was to the leaking floor outside the terrace, we dried the walls and now we have no problems anymore".

B4: "I have black spots in my shower, and in one of the bedroom around the windows".

A2: "There is no humidity, no water leaks".

A5: "There is no air leaks and I monitor the humidity that is never higher than 67% so it is good".

A6: "We have no humidity".

B3: "There is no problem of humidity".

5.10.2 After renovations

The same tenants interviewed have confirmed that there is no humidity in their apartment either after the renovations in 2019 – except for one tenant:

A3: "There is humidity in the bathroom, it is too humid, the ventilation in the bathroom does not suck the air as in the toilets".

C1: "There is no humidity or air leaks in the dwelling".

5.11 Air leaks & windows before and after renovations

5.11.1 Before renovations

Before renovations, various tenants interviewed had problems with air leaks and heat loss due to the age of the windows and their low isolation performance.

A2: "There are air leaks and bad isolation in hobby bedroom, and opposite bedroom around the windows".

A1: "There is no heat loss around the windows frame".

A6: "Windows are not closing properly and the stores move when there is wind, so there is an important air leak around the window between the living-room and the balcony".

B3: "All windows have air draught".

B4: "The windows are not closing so well, on my balcony there is a real gap, there is cold air entering through the windows in the bedroom, the balcony, in the living room. The windows are not isolated so well but there are no big air draughts inside the apartment, but around the windows".

5.11.2 After renovations

All the tenants interviewed are satisfied with the new windows, air leaks have disappeared and several tenants expressed how they appreciate the quality of the windows, the sound insulation thanks to the windows and the new possibility to open the windows in two positions: either half open or completely open.

A2: "The new windows have stabilized the temperature. The roof is better insulated than before. It is better now with no more air leaks like before but the wall on the hobby room side remains cold, just the wall".

A5: "The windows have improved the feeling inside, it feels warmer and the sound from the street is less loud. You can hear the difference, it is very silent now. The windows are really good. There are no air leaks".

C2: "We had a warm winter so we can't really say but it warms quicker now and the isolation is very good now. Two years ago we had water on the roof and ceiling and they have put big isolation on the ceiling. Now the windows are very good when the previous windows were very old more than 40 years old".

C2: "Now there is no more condensation in winter thanks to the little flap on the window, before we had problems with humidity with the walls but now it's okay there is no more humidity problem".

A4: "There was a problem of air leak but now it is okay with the new windows. With the new windows I would very much like to have jalousies. So I can't be seen from the street as I live on the ground floor".

C3: "Now with the little vent even at minimum, it keeps air circulating all the time. You feel that is circulates but I don't need it as I ventilate every day. Windows are very nice, the old ones had no problems though. The new windows you can open them in two positions".

C1: "There is no more air leaks and humidity".

A2: “It is good the new windows’ mechanism, I feel more comfortable in the living-room without air leaks”.

B1: “The new windows are very good”.

5.12 Perception of new elevators after renovations

5.12.1 Positive perception

C2: “The situation with old elevators was not quite satisfying. Nearly daily we had problems; the reason was often the partition wall to expand the room. Now the new elevators are bigger, the brightness is much better and the reliability is very high. The light is automated through moving censors which is a good idea”.

A3: “The new elevator is good expect that it stopped working and it took one day to fix it”.

B1: “The elevator is good”.

5.12.2 Negative perception

A2:” The new elevator often stops working and it takes lots of time to fix it. It was quicker to fix the old elevator when there was a problem”.

5.13 Concept of new students and seniors’ flats: a positive experience

C2: it is a very good concept. Two limits though: students are friendly but after they have studied, they will leave us, and seniors are not able to take part to collective life”.

5.14 Perceptions about PV after renovations: tenants expect more information about the value for residents

Tenants are interested by the installation of PV, some are sceptical, but most of tenants interviewed would like to receive information after renovations about the real production capacity of these PV and the concrete value for the community and tenants:

C2: “The installation of solar modules is a good ecological and image action with green energy but there is no advantage for residents (up to 4 cents/kwh). The photovoltaic is good

for 1892, for the economic thinking but I don't see any advantage for the tenants, it is sold directly to the grid, it is not for us. I would be interested to receive more information on the photovoltaic panels and how it benefits to tenants, I think we should know how much energy is obtained and how the energy is used in the building".

A2: "Green architecture is mostly positive, one of my friends lives in a green building and he uses less energy, it is good for the environment. We exchange a lot together on energy, tips, technology".

A5: "I am interested in this technology of PV but I don't think that it will be enough the PV installed to warm my entire apartment. I don't know how it will work. I know that it is installed for the community, for the lights and the use of electricity in the building but I know that the production is limited due to the little size of the roof".

B4: "The solar panels will allow a monetization only 20 years after their installation…So I am not so interested, I think the bills in the building from 1892 are very transparent, the heating bills are very transparent, I don't need more information".

C3: "We didn't need these renovations. I see no difference with the new thermostat and the photovoltaic on the roof. I know that the big part will go to the grid and a little part will go to the lights".

C1: "I didn't know about the PV installation, it would be nice to have a visit on the roof to discover the installation for tenants and also to know more about the electric production of PV. It would be good to help tenants to understand the way PV work and how the PV production is used, I think it can be efficient. I haven't received information about PV, for me it is positive as long as it benefits to the tenants".

5.15 Experience of climate change on thermal comfort in summer

A5: "In winter it was normal to have one meter of snow in the street in December and January in Berlin, it was always snowing when I was a child. I am 71 years old now and each year we feel a difference compared to the previous year, there is a real difference in temperatures in winter and it gets really warmer in summer. When I was a child it was warm in summer but now the sun can be very strong as early as May each year. I live on the south side of the building and I get a lot of sun".

The issue of thermal comfort in summer starts to be noticed by some tenants in the Berlin Pilot site:

> **B1: "In summer it's 3 degrees more in my apartment, I have experienced a real change since 1979 when I started to live in this apartment, I have noticed that there are more days up to 30 degrees in summer compared to before, it can be a problem for elderly people like some tenants living at the last floors who suffer from the heat here in summer…and the biggest change is in winter, it is really warmer".**

5.16 Remaining expectations and other remarks about renovations

> **C2: "We expect the finalization of the long process of reparations. Regulation of the new key system, I wonder why it is not possible to keep the old system, it would require less keys. Rebuilding the garden and playground for kids if possible in 2019. Receive information and observe a reduction in the energy cost with the new isolation and air circulation. Solar energy on the roof is a good ecological point, it is good for image and of course for environmental purpose but it is not price-advantage for tenants. We have a good sense of solidarity, even though the participation in neighbour activities are decreasing. For the future, I am sure that 1892 sets good base for environmental thinking, environmental image and will be a good example".**
>
> **C3: "The fuse board is bigger now after the renovations".**
>
> **A2: "There is a difference between entrance doors and the ground of 10 centimetres.**
>
> **A2: "Why are there no lights outside the building? Before there was a little light to see the key hole, now you need to enter to have a censor seeing you to have the light! But it's very dark outside…"**
>
> **A3: "The new lobby is ok, the glass door is ok but the problem is the height difference between the ground and the entrance step".**

1. Italy Pilot sit

5.17 ATER Treviso

ATER Treviso is the Territorial Agency for Social Housing with public body status, having legal personality, self-organizational, self-financial and self-accounting. In order to meet the needs of the least well-off, ATER Treviso manages the building heritage for social housing within the territory of Treviso. It also works closely with various municipalities of the Province as well as with the Veneto Region through the network of ATER Veneto (ARAV). ATER Treviso manages about 6,000 lodgings to be leased for residential purposes[6].

Following the international financial crisis, from November 2016 Veneto Region is carrying out a reform process in Veneto social housing public companies, that has started with the Regional Law n.13 of 28th June 2013. This reform process is progressively reducing the funding for social housing (retrofitting and new constructions) and getting ATER Treviso under the control of Veneto Region.

ATER Treviso is leading building renovations experiments for the group ATER

Currently ATER Treviso is the 1st actor to give the kind of feedbacks the company will get from the DREEAM project for all the group ATER in Italia. ATER Treviso is a sort of the pilot site of all ATER Italy with various experimental projects. The information gathered during the various projects of ATER Treviso will also be very useful for other social housing companies in Italy as they don't have this kind of data.

[6] Official ATER presentation (http://dreeam.eu/partners/)

5.18 Technical characteristics of the pilot dwellings

The new pilot site is composed of 2 buildings called Tower A & Tower B. The 2 buildings have a similar structure, orientation, size and dwelling layouts. Both buildings have 6 residential floors and 3 dwellings per floor. Shortly, the 2nd pilot site was characterized by poor windows and important air leaks through the windows structure and wood block curtain.

Figure 6: Aerial view of the 1st and 2nd pilot sites in Treviso

Figure 7: 2nd Pilot site with Tower A

Figure 8: 2nd Pilot site with Tower B

5.19 Reminder: Socio-economic context

The 2nd pilot site is not a segregated area and the economic vulnerability is similar between the 1st pilot site and the 2nd pilot site according to the local building manager with a mix of working and non-working tenants.

> **"It's not a segregated area, it's a quite nice district like the 1st pilot site" (Local building manager – 2017).**

According to the local manager, the levels of incomes between the 2 pilot sites are quite similar with various socio-economic profiles, from vulnerable households who experience periodic fuel poverty to middle class categories with less concerns regarding their energy budget. There are no criminal issues and Anti-Social Behaviour (ASB) in the 2nd pilot site.

> **"We have no crime problem in the pilot site. We have anti-social behavior/crime situation in the 3rd Tower though" (Local building manager – 2017).**

The community feeling is very strong

The collective feeling inside the pilot buildings A & B is a "village atmosphere" according to both tenants and the building manager. The previous pilot site and the new pilot buildings are situated in the exact similar area and they share the same collective recreational areas and garden, so this explains the great similarity of inhabitant perception between the 2 pilot sites. Many of the tenants living in the building A especially, have moved into their dwellings when the buildings were built, so there is a strong link with the area and the site for many tenants. The A tower is more friendly, communicative with fewer changes of tenants in the past according to the local manager compared to Tower B with a highest turn-over.

> **"The tenants have changed a lot, there was different reasons for this turn-over but it was not a choice from ATER. So, the community feeling is less strong in the Tower B in this context" (Local building manager – 2017).**

A population of elderly people

According to the building manager, both the 2 towers have old people living inside and they live there since the towers were built in 1976. Most of tenants in the new pilot site are elderly people. There are fewer young families with children. In our sample we have tried to select a minimum of 50% of elderly tenants and a good proportion of other household structures involving families and singles with children in order to have a good picture of the diversity of households described by the local building manager.

5.20 Technical characteristics before renovations

Key technical issues in the pilot site according to the building manager before renovations:

⇒ The door of the elevator doesn't allow people with a handicap to enter the elevator because the door is too small (not by law but for the current model of wheelchair). People with a handicap must move into another building;

⇒ The 2nd problem is the high mobility of people that creates social problem because lots of new families are foreigners who don't necessarily know well the rules to have a good experience together with the other tenants. There are lots of problems with cultural differences, and especially elderly tenants don't like this difference.

⇒ The high costs of individual heating and water consumption for tenants

⇒ The new pilot site has different rules than from the 1st pilot site. The tenants have their own boilers for hot water & heating so the building manager knows very little about the energy issues of individual tenants because energy usage is not linked to ATER. The building manager does know however that the cost of winter heating and hot water is very high and tenants keep very low temperatures inside their homes.

⇒ Tenants complain a lot about the cost of the natural gas for winter heating. Some tenants keep around 15° degrees because the heating is too expensive and some elderly tenants have health issues due to this situation. In this context, tenants are very happy to have these renovations.

⇒ Tenants also complained about the cost of the water. The similar situation has been observed in the 1st pilot site where tenants were complaining a lot about the cost of the water.

"The water bill is global for each building and tenants complain a lot about the cost of water per cubic meter and the increase of the water cost in the last years, lots of tenants don't pay these bills, they can't pay. Tenants have very low income and they are often not able to pay. They try to spend as less water as possible but still they have difficulty to pay the costs of the water" (Local building manager – 2017).

The role of ATER and the municipality to help tenants who can't pay the bills

If tenants don't pay their bill for hot water and heating, ATER must pay it for them. In some situations where households have a very low income, the municipality gives a little amount of money to ATER to help pay these bills, but a lot of tenants don't pay with no consequences on their supply, they still have access to heat and hot water. ATER has no information about socio-economic statistics related to tenants, so ATER can't know if tenants who don't pay are in economic difficulty or if they don't want to pay. Generally, some

disrespectful people consider that to pay their bills is not a good thing, it's a behavioral problem according to the local managers.

> **"The average is that in each building 6 households don't pay and the other pay their bills" (Local building manager – 2017).**

The charges linked to the rent integrate:

- ⇒ The volume of water consumed;
- ⇒ The electricity consumption in the collective spaces (tenants pay the maintenance of elevator, power for the elevator, power for water supply pumps and electricity in the stairs);
- ⇒ The maintenance for the dirty water system;
- ⇒ The gardening.

The local manager takes care of the administration and the reallocation of these charges to the different households. The tenants expressed their satisfaction regarding the work done by the current local managers for their excellent transparency, information and calculation of the collective building charges. They would be happy though that the electricity bills related to the consumption in the collective spaces could be less expensive.

5.21 Previous experiences of renovations & expectations with DREEAM project

Tenants had experience of important renovations but this is the first big renovation that the tenants experienced with the DREEAM project. In the A tower, the elevator has been renovated and is adapted to handicapped persons but in the B tower the elevator is not renovated yet. The buildings were originally built in the 1976 and they remained more or less in the same conditions, except they had an important structural consolidation of the external walls in the early 1990s.

Expectations of tenants for renovations

According to the building manager, tenants were very happy about the future DREEAM renovations and they were very collaborative with the DREEAM partners.

The tenants were not very expert about renovations according to the local manager but the more important requests/ expectations that she receives were:

- ⇒ Windows replacement to limit the air draughts;
- ⇒ Wall insulation refurbishment.

5.22 Reminder: Social structure of households in the pilot site

Compared to the rest of the ATER stocks, the 2nd DREEAM pilot site is representative in terms of:

- Site and dwellings size. The 2nd site is not particular and ATER manages larger and smaller sites in terms of the number of properties covered;
- In terms of households' diversity and family types with a good mix between families, elderly tenants, tenants with work & tenants without work with an important proportion though of retired and elderly tenants.

Synthesis & archetypes of the 18 households interviewed

In the beginning of 2017, Savills organized an interview with ATER project manager and the local building manager of the Tower A & B to establish the social context and the key characteristics of the tenants living in the new pilot site. Based on this interview, SinCeO2 and SAVILLS have listed the technical and social archetypes of the households to select in our qualitative inquiry.

On the 18 households of the Tower A and the 18 households of the Tower B, according to the description given by the local manager, our sample has been composed with the variety of following household structures to be well representative:

⇒ Couple of elderly people without children

⇒ Younger couples with a young child

⇒ Couples with elderly children

⇒ Few people living alone

5.23 Reminder: Patterns of presence inside the dwellings before and after renovations

In our guideline used during the interviews with tenants, we have integrated indicators related to the wake-up time and the periods of the day where tenants are at home and when they use the most their various domestic appliances, and their heating system, in order to build 2 additional relevant social indicators to our sociological evaluation strategy before renovations. These 2 indicators allow us to establish the daily cycles of energy consumption inside the dwellings, and the situations of high heat demand & thermal comfort priority for tenants who stay at home most of the day (such as retired tenants or unemployed tenants). These 2 indicators also allow us to determine also opportunities for energy load models with peak-demand, off-peak demand periods, time-related consumption habits and opportunities of Demand Respond scenarios.

The Italian households of the 2nd pilot site have 2 peaks of energy consumption that are similar before and after renovations:

Peak 1 between 05:30 and 07:00 in the morning according to the wake-up hours described during interviews and the linked habits: shower & breakfast preparation. There are 7 households between 04:30 to 0:600. There are 8 households between 06:30 and 07:00. Only 3 households wake-up after 07:30 to 08:30. After 08:30/09:00 the housewives and retired tenants start to open the windows and to clean the apartment until the middle of the morning and use both domestic hot water and electric appliances for 1 to 2 hours.

An almost continuous presence inside the dwelling during the day

Presence at home: 77% of households (14 households on 18) have at least 1 person who is present in the dwelling during daily hours. In only 4 households, the dwelling is not occupied all day long. The continuous users of dwellings are retired tenants, unemployed and stay-at home tenants such as housewives or unemployed children.

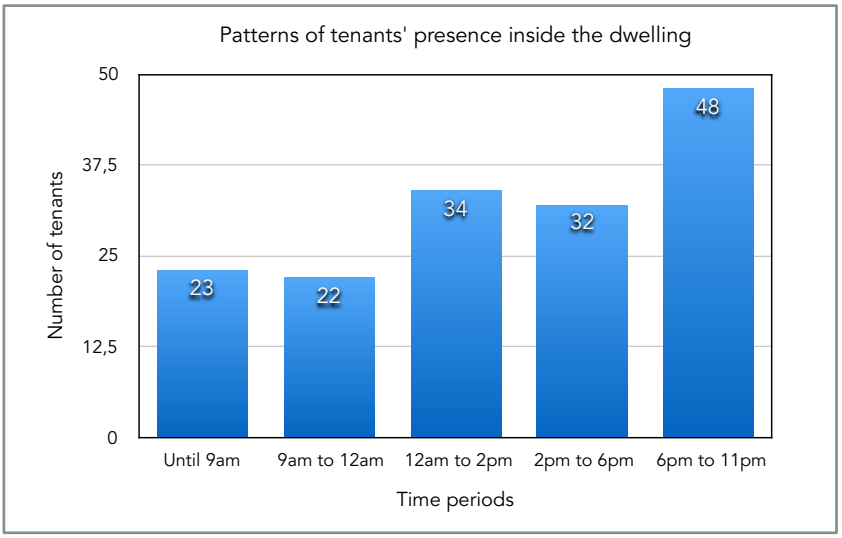


Figure 9: number of tenants at home during hours' period

Precision: the difference between the total of tenants living in the pilot buildings and superior total number of tenants counted in the time period from 6pm to 11pm is due to the fact that the tenants interviewed have included the 2 relatives who stay for dinner almost each day at their home.

5.24 Peak and off-peak periods of energy consumpion before and after renovations

There are 3 peak demand periods with multi-occupancy and multi-energy uses inside home: lunch, afternoon and dinner. During the morning, the presence of tenants inside the dwellings until 9am is very atomized with various wake-up hours from 04:30 to 08:30 and not a concentration of “morning routines” during the same 1 or 2 hours. The energy consumption is dispersed from 04.30 to 09:00 in the morning in the 2nd pilot site. The same patterns were observed before and after renovations.

5.25 Thermal comfort before renovations

5.25.1 A similar thermal comfort feeling between the different floors of apartments

The interviews with tenants show that there is a less important difference of thermal comfort between the different floors compared to the 1st pilot site where “sandwich apartments” (apartments sitting between two heated apartments) benefited from a better inside temperature compared to the other floors, especially the 1st and last floors that were particularly cold. In the 2nd pilot site, the tenants experience a very similar and homogenous type thermal comfort between the different dwellings and floors.

5.25.2 An important difference of thermal comfort perception between west-south and north-east

There is an important difference of thermal comfort in the dwellings divided between the cold rooms situated on the north-east side and the warm rooms situated on the south-west side. The mapping of the interview results shows that the cold rooms are mostly concentrated in 1 particular area in the 2 buildings: the north-east orientation. The more comfortable rooms are concentrated on the south-west side. The north side can become colder due to air leaks and local wind called “tramontane”.

5.25.3 A difference of thermal comfort between the different orientated spaces

From the 1st to the 6th floor, 18 households, (100%), experience a lower thermal comfort in the bedrooms situated on the north side with both colder temperature a more important humidity feeling compared to the other rooms. These rooms also have a larger presence of mould in our sample.

The living-room was comfortable but the dwelling in general is quite cool and requests extra heating to reach a perception of “comfort”.

For 16 households of 18 (88%) of households, the living-room was comfortable and warm, and was often the warmer room in the apartment, except for 2 households who don’t like the global thermal comfort in their apartment including in the living-room (the general temperature is too low for them to call it “comfortable”, the apartment was considered as globally “cool” but liveable though it is not comfortable);

11 households of the 14 households who own a cooling device, used the “heating option” of this equipment to increase the global thermal comfort in the apartment in winter. This is a good indicator that the thermal comfort of the apartment using only the collective heating system was not enough for 77% of

the group of households who own an AC system and use the "heat option" to reach a "comfortable" feeling.

For 5 households of 18 (27%) of households, the bathroom was cold but we can state that the bathroom was cold for 10 households in total, as 10 households (55% of tenants) need to use an extra electric radiator to heat the bathroom before the use of showers. For a majority of households, the kitchen was at the right temperature and for 8 households (44%) this room is even considered as "warm", "comfortable", "it feels good". The more heated rooms are living-room and the 3 bedrooms on the north and west sides.

5.25.4 Uses of radiator before renovations

The 18 households used all the radiators in winter and set the temperature on the general thermostat that regulates the heating of all the different radiators. Only 5 households don't use the radiators in the kitchen and in the entrance, and shut them down to avoid too much heat consumption.

> **"We spent a lot of money to keep the warmth, to keep 20° in the rooms, we have to keep the radiators open 12 hours per day. They put 21/22° the maximum possible but the real temperature in the living room is about 20° and in the bedrooms it is 16°. We can put more temperature than 22° but they don't need to" (K)**
>
> **"All day long, we put 20/21° on the thermostat, they can't have more temperature, it's not comfortable (…) The tenant has to put pull-over, it's cold, he would like to have more heat" (H)**

Many households have adopted saving habits to avoid excessive heat consumption before renovations

10 households of 18 have adopted rigorous daily habits to start and stop using the radiators at specific hours. This habit is directly correlated to the objective of tenants to avoid heat waste and an important collective bill. Also many tenants have adopted the habit to shut down the radiators on the general thermostat when they leave the apartment or to lower the temperature to a minimum when they leave their dwelling.

> **All radiators except kitchen and the entrance, they open from 12am to 3pm, and from 5 to 8pm (D)**
>
> **They set 20° manually when they need/around 3 hours per day: (E)**
>
> **She opens at 6am until 8am then at 12am to 2pm and again from 5pm until 8/9pm.She doesn't like very hot temperatures: (I)**
>
> **Each day from 5 to 11pm only during winter season, at 18°/19°. She feels good this way: (J)**
>
> **She opens the radiators only when she is at home, she puts 22°, when she leaves, she closes the radiators on the general thermostat: (L)**
>
> **21°on the thermostat, she opens at 7am until 12am when she opens the windows, then she puts again at 2pm until 10pm (N)**
>
> **She opens the radiators at 6:30 to 8:3Oam then from 5pm to 7pm. Each day and radiators except kitchen and entrance (O)**

They put 18°, it starts for 3 hours a day, but they use air conditioning like a heating pump. From 8pm to 11pm (P)

All the radiators used, from 4pm to 10pm. 20° set point (Q)

All radiators from 5pm to 8:30 (R)

5.25.5 Thermal comfort after renovations

Tenants are satisfied with the thermal comfort after renovations with an important reduction of the cold feeling perceived before renovations. We have noticed already some situations of rebound effect with over-consumption of heat post-renovations.

A1: "I put 5 on radiators everywhere in winter from 5pm to 7am and from 4pm to 11pm. Nobody explained to me how to use the valve on the radiator. At 5 setting and up it is too warm but I like it with very hot temperature, I prefer to put 5 even if I know it's too warm".

B1: "There is a good comfort now, everything is ok. I put 3 to 5. But my new boiler makes explosion sound, it is frightening when the old one was silent".

B2: "I feel good in every room, I suffered a lot during the last summer when they stopped the renovations work as is was very warm. It is too early to know for the heating, they stopped the work in April 2019 so it's too early to know if the renovations worked for the life quality in winter".

B3: "There is a good feeling of warmth everywhere. I feel less cold now after they finished the renovations in April.

Various tenants "manipulate" the thermostat system to get as much warmth as they can with the boiler for their apartment.

A1:"I put 21 degrees on the thermostat in the entrance but thanks to renovations the temperature is never below 21 degrees, but the boiler does not start below 21 degrees, so I put 23 degrees on the thermostat to make the boiler starting…other tenants do it too…it is to feel warm inside".

A2: "I feel uncomfortable only at 20° so I put 23° on the thermostat to put the boiler on, under 23° the boiler does not start. For the valves I have to put 5 to have a good temperature. The technician told me to put 3 only but it is not enough to be comfortable, and he gave us a little card with the description of the new boiler. I have a simple thermostat, not a time-thermostat like other tenants".

Some tenants have started to notice a difference in their bills after the renovations:

A1: "I have made saving after the renovations for the heating, before I paid 500€ for an entire winter with the heating and this winter I paid 250€ for the winter and in not cold winters in previous years I paid 400€ per winter so there is a real difference even if it was a winter a bit warmer than usual. I didn't change my consumption and it's warm inside".

A2: "In the last two bills I saved money"

5.26 Humidity before and after renovations

5.26.1 Humidity before renovation

- 10 households experienced an high humidity levels in their dwelling and even water infiltration on the terraces or in some walls
- The households with high humidity levels were n° C, D, F, G, H, K, L, N, P, R
- Though no tenants use a "dehumidifier" in winter to dry the air.
- 8 households didn't experienced any humidity feeling

"Yes it's humid, especially in the bedrooms" (G)

"Yes, a lot of humidity on all windows each morning, condensation" (F)

"Yes, on the walls, because in summer they open all day long, it's very good ventilation, but in winter the humidity is important. Long time ago they had more mould but they use painting to avoid mould. There is probably condensation near the bow windows, bad sensation of humidity in the little bedroom" (H)

"A lot in the bedrooms and in the rest of the apartment" (K)

"Feeling of humidity everywhere and water infiltration on the ceiling of her bedroom (West side)" (L)

"Lots of humidity in the north/east bedroom" (N)

"Humidity in the bedroom" (P)

5.26.2 Humidity after renovation

The humidity has reduced or disappeared after the renovations, a very positive point compared to the situation before renovations when tenants experienced a high level of humidity in their dwelling and in consequence, suffered even more from the cold.

> **"There is no humidity" (A1 – 2019)**
>
> **B1: "I observed that the work in the building stopped in April 2019 so it is too early now to know if there are still problems of humidity, now there is no humidity but the company didn't finished the work here".**
>
> **B2: "There is no humidity"**
>
> **B3: "There is no humidity because I use the new ventilation against humidity. Last month they finished the work and I use the ventilation every day, I can show you (the tenant explains us perfectly the different setting of the remote control for the ventilation). I know how it works. There is less humidity now, the ventilation it works! I have tested it with my nephew and the vacuuming system works very well, in few minutes there was no more smoke!"**

5.27 Mould before and after renovations

5.27.1 Mould before renovations

There was a presence of mould in 13 households: B, F, G, H, I, J, K, L, N, O, P, Q, R Including 2 Households experience a big problem with mould: K, N

> **"The bedroom in the East side has mould in the corner, on the angles but not like in the other apartments where there is more mould, the other tenants complain about the mould issue" (B)**
>
> **"There is water infiltration on the terrace of the living room, mould on the angles and between the ceiling and the wall, lots of mould" (N)**

At the contrary, 5 households never have any mould presence, including 3 households had mould several years before but they have started to use anti-mould painting and they ventilate a lot so they have no more problem today:

> **No mould but they open very frequently, and they use painting products against mould. 10 years ago they had more mould but after aerating, putting anti-mould painting it's fine" (A)**
>
> **"Long time ago there was mould in the corner of the north bedroom, but probably the work on external wall in the 80s caused that problem, but they use a special product against damp and they ventilate very often so the mould has disappeared. They ventilate each day all the different rooms" (D)**
>
> **"No but in the past they had mould but long time ago, not anymore" (M)**

5.27.2 Mould after renovations

A1: "There was mould before but not anymore"

A2: Renovations have been finalized in October 2018 so I expect the old mould to come back soon. The black is still there, we have cleaned the mould and then it was ok, but I wait one or two years to see if comes back or not".

B1: "There is no mould"

B2: "There is no mould"

5.28 Air leaks before and after renovations

5.28.1 Air leaks before renovations

14 households had important air leaks everywhere around the windows. The origin of the problem is the poor insulation levels of the windows with large gaps between the metallic window doors and the wall. The curtain blocks are also a problem as the air enters into the dwelling through holes in the blocks. Tenants have a daily experience of high air velocities and the worst air leaks are situated in the rooms that are the more exposed to the local air current and regional wind (tramontane).

"Air leaks everywhere especially around the metallic block and the ribbons (all the windows)"(A)

"Yes especially in the living-room with bad windows and strong wind. The curtains used to move due to the air leaks"(B)

"There is a lot of air leaks, it decreases the feeling of warmth, it doesn't feel hermetic with air currents inside, it is not terrible but it is less comfortable than without air leaks"(C)

"Lots of air leaks in all the apartment especially around the windows"(I)

"Everywhere, it creates a lot of cold, there are "terrible air leaks" (K)

Only 4 households didn't experience air leaks before renovations and 3 of these households have installed double windows, which has resolved greatly the issue of air leaks.

"They have double windows now so it's better, they have not too much air leaks because they have installed themselves double windows" (E)

"Lot of air leaks, now they have less because they have put double windows, it was expensive" (F)

"Air leaks everywhere. They have put double windows except on the windows doors. They have strong air current from the door windows where it's not double glaze" (G)

5.28.2 Air leaks after renovations

A1:"The external block with the external curtain is not isolable so there are cold and air leaks that enter in the apartment. The electric circuit was too old so it was impossible to install an electric external curtain and they kept the old one. There are air leaks only around the blocks, but it is much better now after the renovations".

B1: "There are no more air leaks"

B2: "I have very few air leaks, now it wonderful compared to the old windows, there are no more air leaks with the new windows".

B3: "There are no air leaks anymore"

5.29 Ventilation before and after renovations

5.29.1 Ventilation before renovations

- 0 households declare they don't open windows often or not each day
- 18 households declare that they open windows their dwellings each day
- On these 18 households, 4 households declare that they don't stop their radiators while they ventilate the different rooms in the apartment.

Each day, all the tenants ventilate their apartment from 10 mins to 1 hour on average, and some tenants who are used to leaving the windows a bit open all day long. So even in winter, each morning all the dwellings are ventilated completely by habit, to lower the humidity feeling and for the air quality.

In winter from 09:00 to 10:00 on average, most of the dwellings are ventilated and become colder during a specific and similar time lapse. Like in the 1st pilot site, there is a common habit amongst tenants who stay at home during the day to clean the apartment in the morning, and the ventilation of different rooms is part of this daily routine. Tenants also like to leave all the windows open during the summer and to create natural ventilation in their apartment.

5.29.2 Ventilation after renovations: a new mechanic system

Part of the renovations in the Italy pilot site, involved the installation in each dwelling of a mechanical ventilation system controlled by the tenants with a remote screen installed in their entrance. Several tenants interviewed are very happy to have this new ventilation system and declared that it is very good at reducing humidity and removing cooking smells without heat loss. Some tenants are not satisfied with this new ventilation system.

One minor complaint is about the use of the remote screen to manage the ventilation mechanism: some tenants are not well informed about the various options and think the system is a bit complicated.

Positive perception:

> **A1:"I like the new ventilation, it works well especially for the humidity"**

Negative perception:

> **A2: "I don't use the ventilation because it's colder after that I use it. And the system sucks in little flies inside my apartment, it happens in another apartment too that flies come in with the ventilation system. I started to use it during last winter but it's really too cold, I understand the difference for air quality and the difference with opening the windows but I use it mostly when I cook, it helps for the smell".**
>
> **B1: "I never used the ventilation! And nobody explained to me how to use it so I don't use it at all! I don't know the way it works and the concept of this ventilation".**
>
> **B2: "I never use the ventilation because it was not well settled by the company. Someone came yesterday and it probably works but I have no confidence about how it works and I am a bit scared to use it. I speak with other tenants and I don't understand how it works, I am waiting for someone who can explain me how it works! The new ventilation is very efficient and extract the air very quickly".**

5.30 Windows before and after renovations

5.30.1 Windows before renovations

Most tenants interviewed in 2017 expressed their expectations of having new windows as their windows were old, with lots or air leaks and heat loss during winter especially because of the external curtain system that was not isolated.

> **"The windows as they are not closing properly, and there are cold leaks around the windows, the radiators should be changed, and the wall insulation should be improved" (B)**
>
> **"The windows are the priority, the boiler is very old and she thinks it is better to change it" (C)**
>
> **They appreciate the future renovations, the windows are the priority, solar panels are positive, it's good because it's innovative and to save energies, both for the cost and for the environment. They have no worries on the renovations, they learn to their children to be careful with energy consumption. For him it's important to transmit values about ecology to children but it's not common in Italy, people think that it's not expensive and they don't care to consume not too much, they don't give the example at school, they speak but don't act, people start to be aware of the climate change, in Treviso area the weather has changed. He comes from the Pouilles area, and in Treviso the winter was 20 years ago with snow, grey sky, now it is high temperature, lots of rain and sunny day, it looks like the winter typical of the Pouilles comes in Treviso now" (E)**

They expect double glazing for the windows. The windows and the opening should be changed as there is a big gap between the wall and window closures (F)

"The panorama, the view here is beautiful. There is life in the area. My expectations are linked to the isolation, all the external insulation, and the windows" (K)

"I love the apartment, the area, the view and the space. Insulation is the priority, because I have water infiltration" (L)

"No opinion about the choice of renovations, I would like to have something that allows me to pay less for energy as simply as it is" (M)

They like the apartment except the windows, they have very high bills for the heating with gas, 2000 euros per year of gas (P)

The windows are expected, she would like vasistas opening (Q)

They like the design of the apartment, the kitchen separated from living room, the big entrance. They are happy to have renovations of the windows" (R)

5.30.2 Windows after renovations

Tenants are mostly very happy with the new windows except some people who dislike the way they open and collide with each other. Due to the size of windows and walls, some tenants have indeed received fixed windows or windows that collide together when opened wide.

A1: "I found them beautiful, but the problem is that some windows they can't be open and are fixed".

A2: "I hate the way they open the new windows, compared to the little two windows I had before, I prefer the esthetic of the new windows but they are not practical"

B2: "I am very happy with the new windows, they are more beautiful and practical than the old ones".

B3: "New windows are good"

5.31 Thermal comfort inside dwellings in summer and climate change

5.31.1 The west/south side rooms were very hot in July and August before renovations

The south-west side of all the apartments become very warm during a period from June to September, and during the summer months of July and August. Though, the tenants in the 2nd pilot site don't experience extreme situations like in the 1st pilot site where the rooms on the south side were becoming "unliveable" in summer for the tenants.

"Its' very hot in the living room and the kitchen but they use a lot the natural ventilation, they can stay inside these rooms though, it's not like in the other building of the 1st pilot site" (D)

The humidity is terrible for tenants and adds to the thermal discomfort in summer. A lot of them use their cooling system to "dry" the air and some tenants have a "dehumidifier" option (they even bought a cooling system device for the purpose of lowering the humidity, not to cool the air). The temperature is getting better with use of the plastic shutters. In summer, many tenants live with the shutters completely closed in the rooms oriented on the south/west side.

> **"All rooms are too hot, especially the kitchen, they use natural ventilation, they close all the shutters and then the temperature is better" (E)**
>
> **"Very hot in all the rooms in summer" (K)**

Due to the climate change, the hot summer period tends to expand these last years according to tenants and this has an important impact on the life quality of elderly tenants.

> **"She can't live without AC, it's way too warm in all the apartment, she uses the AC depending of the weather from July to August and sometimes also in June, all day long, all night long. They live here for 37 years (from 1979) when she was young she was out of the house for long hours instead of now when she stays inside home, she can't go out to take some fresh air like years before, so they feel more the heat for this reason, the elderly people suffer in general from this situation" (N)**
>
> **"Everywhere it's too warm, they are at the last floor and its very warm, they suffer a lot of the big humidity in summer" (Q)**

5.31.2 A situation of fuel poverty in summer

Only a few people have air conditioning systems probably because they are too poor to buy these systems and to pay the high electricity bills linked to the AC, according to the local manager.

> **"The other problem with air conditioning is that ATER asks to people who install an AC system an amount of 50 euros to authorize this installation, people don't want to pay so they don't want to declare that they have it. The list of AC cooling systems owned by tenants was given to SinCeO2.The only possibility is to visit and ask directly. It is impossible to see from the outside, it will be only declarative. We can maybe guess it with bills in summer" (Local manager, 2016).**

In our sample: 14 of 18 households own a cooling system with 1 or 2 split a/c units inside their dwelling (in the corridor and in the living-room or main bedroom) and 4 households don't own a cooling system.

On the 14 households who own a cooling system: 7 households have quite similar electricity bills in winter and summer, and this can be explained because their heating bills in winter are also quite high.

> **In their opinion they have no higher bills in summer, 65 euros per 2 months on average (A)**
>
> **They don't see a big difference between their bills in winter and summer, 60/70 euros per 2 months for the electricity, in summer around 80 euros per 2 months: (F)**

"No, it's more expensive in winter because they use a lot a little electric heater in the shower in winter" (P)

They spend for gas, for 5 months 900 euros in winter, in winter 146 euros for 3 months of electricity, 153 euros for 3 months in summer: (Q)

Seven households have higher electricity bills in the summer months. For certain tenants, this additional cost is really a problem and they must limit their use of the cooling system to a certain number of hours especially during the night, to be able to sleep because the heat is still very high during summer nights.

"Yes it's more expensive, very high compared to no use the AC" (B)

She spends a lot in electricity: 150 euros per 2 months because she has washing machine once a day, and dishwasher once a day, a little bit more expensive in summer with the deshumidificator. She has 3 "must": washing machine, dishwasher and vacuum cleaner, she wants to use them daily and she doesn't want any change in her routine, she would like to save money but not to change her habits: (J)

In summer they spend 100 euros more for 2 months for AC:(K)

"Yes there is a difference: high consumption of natural gas in winter and higher consumption of electricity in summer." (L)

5.31.3 A rising phenomena due to climate change, the "double fuel poverty" in winter and summer

According to several tenants, summer, temperatures have been rising for two decades, and the North of Italy has started to be as warm as during the summer months in the south of Italy a decade ago, and at the same time in the north there is a lot of humidity, much more than in the south.

Tenants in Italy who own a cooling system experience 2 high peaks of consumption nowadays: in winter and in summer. Most of the tenants in our sample who don't own a cooling system haven't chosen to not own such a system, but they simply cannot afford it and it has an impact on their quality of life. Some tenants also experience in summer an increase in the number of showers they take. Some tenants take 2 to 3 showers per day in summer because of the extreme heat, compared to the habit of 1 shower per day in winter. Some tenants can't take that many showers because it is too expensive. The high cost of water and hot water in general that tenants complain about, also increases in summer when they have to take more showers due to the heat and the humidity.

We want to highlight the difficulties experienced already by tenants in Treviso now in 2016-2017. What we call in our analysis the "double fuel poverty" linked to the increasing energy and water consumption in summer in the Italian pilot site, illustrates well the challenges that public housing companies will have to face as climate change progresses in the coming years with rising health risks due to the fuel poverty in summer

and winter like in Spain[7], increasing fuel poverty, the difficulty of tenants to pay their bills and incidentally their rent. Other researchers have observed similar phenomena[8] that will be accentuated in countries already affected like Italy, Spain, Portugal, Greece, and this issue will progressively affect the other countries of Europe.

We integrate in the next two pages a long abstract from a research of EnAct on the European countries where we currently observe the more fuel poverty in summer:

> "According to the report, between 2010 and 2012 the number of households that need to spend a disproportionate amount of their income on electricity and gas bills increased to 16,6% from 12.4% in 2010. In real life, these percentages translate to 7 million people who live in unhealthy conditions of homes that are very cold in the winter and very hot in the summer. A sharp rise in the number of Spaniards living in the risk of energy poverty was revealed in a report published by the Spanish Association of Environmental Sciences (ACA). According to the report, between 2010 and 2012 the number of households that need to spend a disproportionate amount of their income on electricity and gas bills increased to 16,6% from 12.4% in 2010. Coupled with mould and humidity and electricity cuts, due to unpaid bills, energy poverty is a social crisis resulting from rising energy prices (roughly 60% since 2007) and decreasing incomes (…). According to ACA, energy poverty is defined as the inability of a household to meet a minimum amount of energy services that satisfy basic needs, such as maintaining a home temperature of 18-20oC in the winter and 25oC during the summer. Tenants will start to struggle to pay their bills and by incidence their rent not only in winter, but even more in summer. This analysis is shared by many observers including specialists of the EE Fuel poverty network and EnAct, especially after the summer 2016 with very high temperatures in Europe compared to seasonal averages".

The example of Spain with identical situation:

> "Fuel poverty has been linked to countries with cold winters where people cannot either keep their houses adequately warm or pay their energy bills. Nowadays people in countries with hot summers have to expend more than 10% of income to pay their energy bills. There are several factors which lead households to expend such a high amount of money to pay their energy bills, although the most important two are the inadequate systems and poor quality of buildings. This summer (2016) has been very hot in central and southern European countries leading the highest recorded temperatures to be exceeded. Regarding this fact, our coordinator Raúl Castaño-Rosa in collaboration with Marilyn Smith (EnAct) make the following post. Promoting the relation between fuel poverty and energy efficiency in buildings, fuel poverty in hot seasons is the base of this investigation. Day-time highs of 40°C (112°F) are not unusual in Sevilla, Cordoba and other cities in the south of Spain during July and August. But the financial crisis that has plagued the country since 2008 is making scorching days much more unbearable for many more residents. Their situation draws attention to the reality that fuel poverty is

[7] "In 2010, pre-mature deaths attributed to energy poverty exceeded those from car accidents" (Castaño-Rosa, Smith, 2016).

[8] Reference: Where does fuel poverty exist? Summer heat drives fuel poverty in Spain, **September 19,** Castaño-Rosa, Smith, 2016

not only about being 'COLD@HOME', in regions with cold winters and for people living in cooler homes, or only about long-standing root problems such as old, poorly constructed dwellings. Between 2006 and 2012, the rate of Spanish households who couldn't afford adequate heating in winter rose from 6% to 9%; those in arrears on utility bills rose from 4% to 6%. Over the same period, a staggering 25% of households self-reported they could no longer afford to keep comfortably cool in summer. These percentages translate to 7 million people who live in unhealthy conditions, in homes that are very cold in winter and/or very hot in summer. An annual 7 200 deaths can now be attributed to energy poverty in Spain, according to the World Health Organisation. In 2010, pre-mature deaths attributed to energy poverty exceeded those from car accidents. Yet the issue of fuel poverty was largely unrecognised in Spain until the late 2000s, when a report published by the Asociación de Ciencias Ambientales identified improving the energy efficiency of homes as a potential means of stimulating employment (Tirado Herrero et al., 2012)".

6 Green Neighbours: an innovative engagement programme co-designed with tenants

Figure 10 - Co-design session in Italy pilot site with ATER's architect and a tenant.

6.1 Introduction

The second part of the sociological research in the DREEAM project consisted in engaging tenants after the end of renovations through a programme that we have developed in collaboration with tenants and called “Green Neighbours – Co-design eco-actions with citizens”.

Why is it interesting for housing companies to engage tenants after renovations? Mostly to avoid tenants’ mis-use of new equipment installed during renovations and to avoid the rebound effect. Indeed the social dimension plays an important role in the success of renovations in reaching their energy efficiency objectives. It has been studied that behaviours of tenants such as the use of radiators, controls, ventilation or other new equipment installed during renovations can decrease the energy efficiency savings achieved thanks to the renovations. This phenomenon is called the « rebound effect »: for instance tenants will consume more energy after renovations because they received upgraded more efficient radiators and better insulation for example which makes achieving a certain comfort level less expensive.

6.2 Rebound effect

The "rebound effect" is a theory in economics applied nowadays in social sciences to describe take-back effects in various fields including energy consumption. This concept refers in sociological/behavioral sciences to the adaptation of tenants' behaviors after energy efficiency improvements in housing. Tenants experiencing new highly energy efficient dwellings can feel less "guilty" to consume and use more their different electric equipment and radiators than before renovations, or they can start to purchase more equipment with the money they save (Zelem, 2013)[9], which results in the end in a decrease of the energy savings expected from the renovations by building owners.

Tenants don't feel engaged at the end of the renovations done in their building in most projects, they find it too technical, they think that their behavior has little impact on the efficiency of the renovations, so they are not worried about mis-using equipment at an individual level or over-consuming.

This is where our second social experiment started in DREEAM project: developing a programme to inform and engage tenants after the end of renovations so they use well the new equipment and they control better their energy consumption.

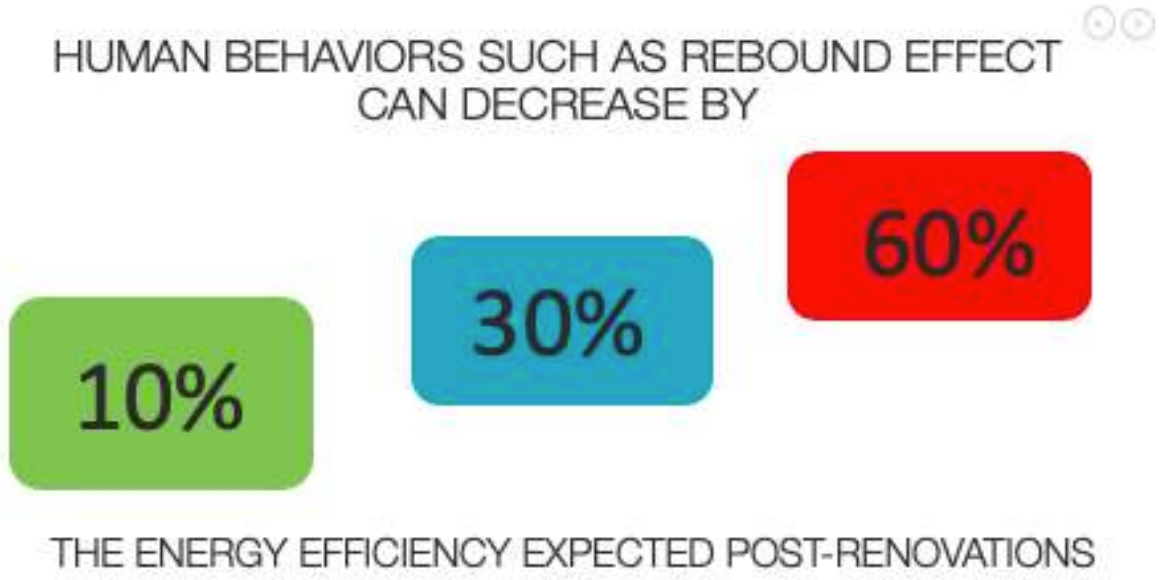


Figure 11 - Rebound effect potential impacts on energy efficiency after renovations

[9] Zelem, University Negawatt, Mèze, 4-5 October 2013

6.2.1 A concrete illustration of rebound effect: the over-heating.

Below you can see an illustration of over-heating after the end of renovations in the pilot site of Padiham. Some tenants can now afford to warm up to 23° thanks to the new insulation and the energy efficiency of the new radiators, so they use the heaters at their maximum capacity around 25°/26°. The inside temperature is too warm, but tenants got used to it progressively. Finally, some tenants seem to live with 24°-25° inside their home in the pilot site of Padiham during winter time after renovations.

Figure 12 - Over-heating illustration in Padiham pilot site with 25° set all day long on the different radiators after renovations

6.2.2 Impact of overheating and rebound effect on energy performance

Example from Padiham pilot site calculated by Sinceo2 with a comparative analysis before renovations (2017) and after renovations (2019)

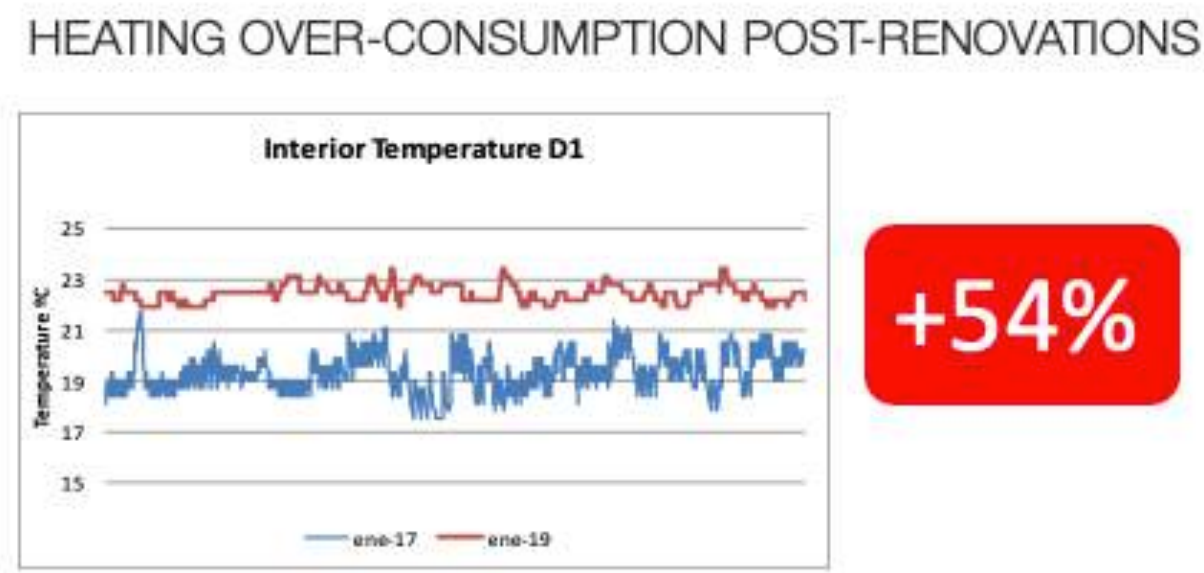


Figure 13 - Rebound effect illustrated with an example from Padiham pilot site with 54% of over-consumption after renovations. The tenant has changed her heating habits (the temperature inside has changed from 19° before renovations in 2017 to 23° degrees after renovations in 2019 due to over-heating).

For the tenant who over-consumes in this apartment who we interviewed, it seemed that the electricity bill is 50% less expensive since the end of renovations thanks to the new insulation and the new efficient radiators installed, which is very positive. As the new radiators allow the tenant to reach a higher indoor temperature, the tenant overheats simply because she can afford to heat that much after renovations, and she appreciates this new comfort.

This tenant experienced an important change in her life thanks to the renovations, before the renovations she experienced energy poverty and in consequence she lived with a continuous cold feeling inside her home because she could not afford to heat more…and now she experiences a new feeling with a home that is very warm even too warm sometimes, a very positive and important change for her life quality. Some tenants will enjoy as much as possible this new heating comfort and might use the radiators excessively.

6.3 Example of misuses of equipment post-renovations in DREEAM project

Figure 14 - Illustration of ventilation's misuse with tenant filling the ventilation hole with different type of items (napkins, tissue, Plexiglas)

In this picture, we see the example of tenants who have filled the hole of a mechanical ventilation system in the Berlin pilot site of DREEAM project because they don't know how this ventilation works. They feel that air coming from the ventilation is too cold and because they haven't been informed about the positive impact of a well working ventilation on their health and on the energy efficiency of the heating in their apartment, a situation that a well-tailored engagement programme post-renovation could participate to improve.

Below we have another illustration of a tenant who has reprogrammed the mechanical ventilation system after renovations, by opening it and making adjustments inside to have it running only during a few minutes rather than during the entire day.

Consultations at home could help to solve this type of problem and to make some technical adjustments to avoid that tenants hijack systems, and potentially break some new equipment or decrease their efficiency.

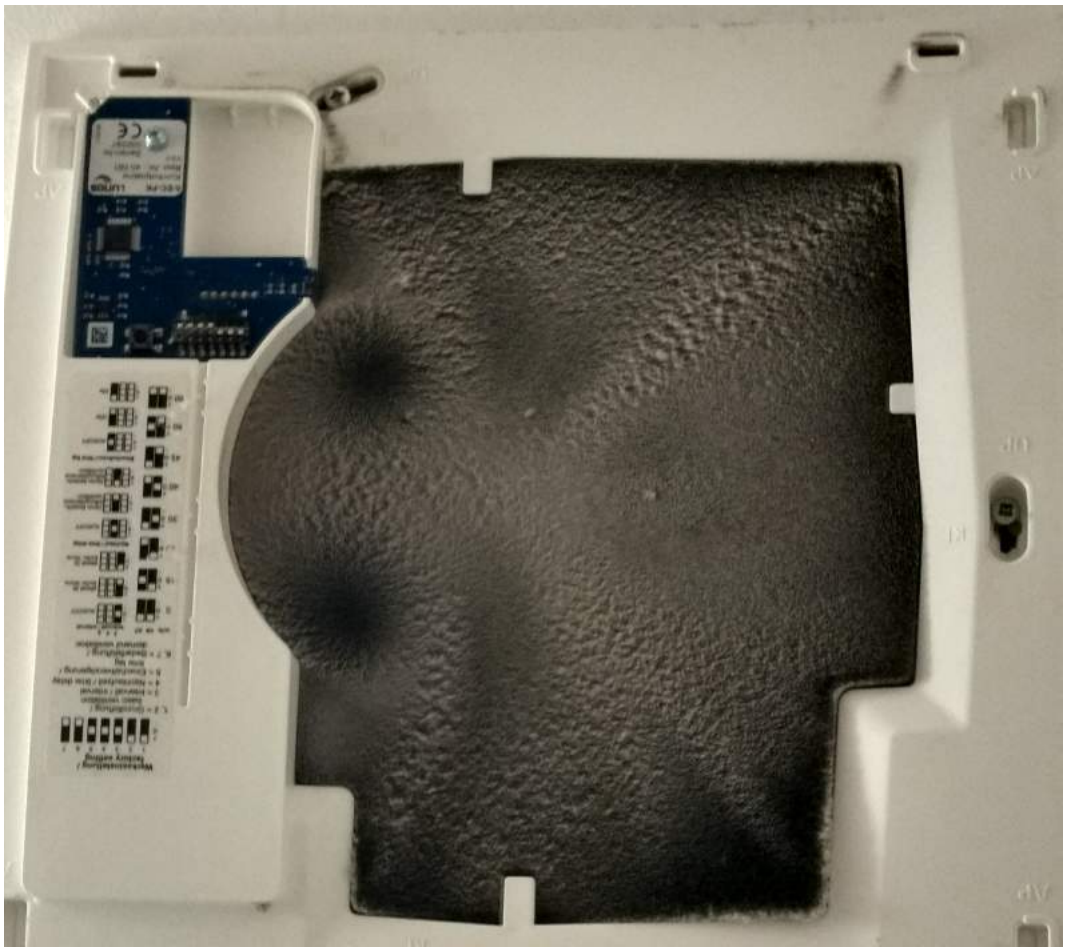


Figure 15 - Illustration of high jacking by a tenant in DREEAM project to reconfigure manually the operation's hours of the ventilation system.

6.4 Engage tenants in energy efficiency behaviors: lessons learned from social innovation

We have observed during our interviews in 2017 and 2018 that most tenants are interested to learn more about energy and water consumption and about energy tips, either because they don't want to waste resources, to save money, or simply they want to be careful about their impact on the environment for the future generations.

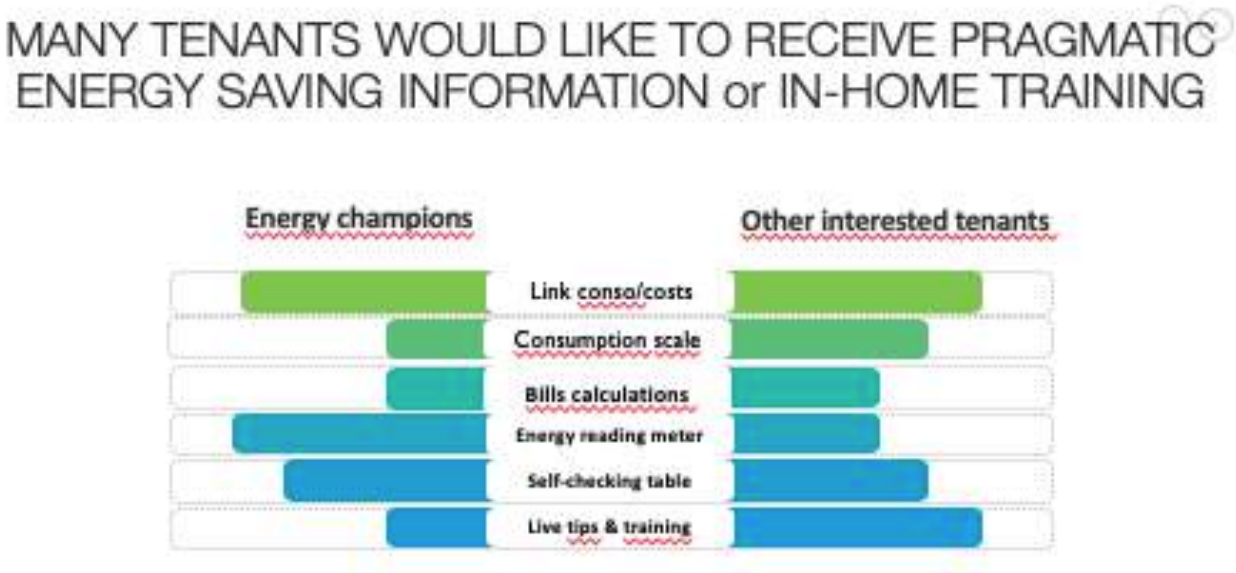


Figure 16 - Key conclusion of our social evaluation on the informative tools expected by tenants

After the social evaluation performed in 2016 and 2017, we have developed educative tools for tenants who participated in the interviews to engage them after the end of renovations. Our work to develop these tools took two years in total between the end of 2017 and 2019.

Our 2 key innovative approaches in this engagement programme:

1) We evaluated qualitatively the impact of renovations on tenants' life conditions from their viewpoint, following a standardized process inspired by social audit methods applied to the field of renovations and urban development.
   This first approach allowed us to answer to the following questions:

   - What citizens and tenants need and what do they think about the technologies selected for renovations?

   - Do the technologies selected for renovations affect positively or negatively their life? The concrete experience of equipment can only be captured by people who live with these renovations everyday such as noise level, vibration, quality of material, heat comfort feeling, technical failure, etc.

2) We developed tools to inform and engage tenants after the end of renovations to fight against energy poverty, rebound effect and to increase energy performance – with a co-design process.

In general, tenants only receive a guide that they don't always read about technologies after the end of renovations or no information at all, and there is a lack of engagement of tenants in renovations programmeme. The consequences of misinformation can be hijacking, misuses of equipment and rebound effect.

In the DREEEAM project, we developed a method to build the level of engagement with tenants by developing and testing a new approach of co-design with tenants.

How did we involve them? With a method developed by Savills' sociologist mixing sociology of consumption, Design Thinking, UX and co-design. Tenants have the answers, they know their apartment and habits very well, most of tenants we interviewed were very interested in the process of co-design and collaborated efficiently with excellent ideas and improvements.

We can learn a lot from meeting tenants and proposing creative and interactive exchanges with them in the format of individual co-design sessions and collective creative meetings. In our approach, concretely we organized 2 series of co-design session in each pilot site in 2018 and 2019 during in-home visits with a group of tenants previously selected and part of the same group of tenants interviewed in the Social Evaluation before and after renovations. We organized these 2 sessions in 2018 and 2019 in the 3 pilot sites. During these sessions, we used different tools such as the energy Quiz to understand better how tenants perceive energy, their knowledge and we tested innovative ways to engage them.

In practice, we spent around 1 hour with each tenant inside their home to co-design solutions to engage them about energy efficiency. We tested different prototypes of the engagement programme directly with tenants, we tested ideas, concepts, suggestions, graphic, illustrations with them and we developed several prototypes until the final prototype of Green Neighbours presented in the following pages.

Picture 5: The tenant and Savills sociologist during the co-design session and the quiz on energy consumption knowledge.

Figure 17 - Co-design with tenants with tactile screens, images and quiz in Dreeam Project

How to design the engagement programme? Our innovative approach was to co-design solutions with tenants by using a quiz, several prototypes of kit and tools that the sociologist co-elaborated with tenants.

Figure 18 - Savills' sociologist during a co-design session with a tenant in Padiham pilot site

Why is it important to co-design solutions with future users? Because user expectations and human experience are crucial knowledge to make a design efficient and adapted to the everyday life of people.

You can see in the picture below the difference between a design done without consulting the real life conditions of people…and the design created by users (User Experience) that could have been done from the beginning if designers or urban planners would have observed residents mobility and if they would have co-designed the walking path with people.

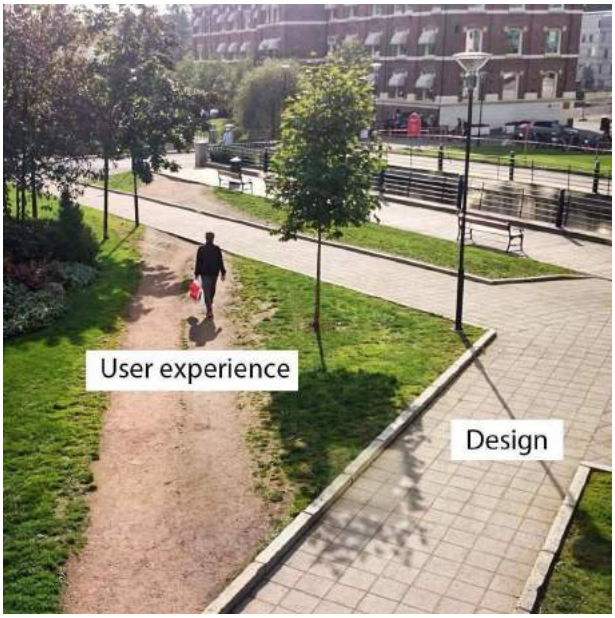


Figure 19 - An example of design not adapted to the uses of local residents

Co-design is a key trend in the development of services and products nowadays and we decided to experiment with this approach in the DREEAM project and to apply it to the field of renovations.

Figure 20 - Co-design session with a tenant and Savills' sociologist for the engagement of tenants with photovoltaic system

The work has been collaborative with tenants thanks to this approach of « co-design » and we can see below an illustration where we use a touch screen to interact with tenants, to test with them various design and questions. Tenants could propose ideas or suggest changes in the prototypes of engagement that we showed to them during these visits. Below we can see the example of the energy efficiency labels quiz, the tenant could contribute to propose a better way to inform tenants on the energy efficiency of devices as the European energy efficiency ranking label A, B, C, D, A+ A+++ is often confusing for tenants.

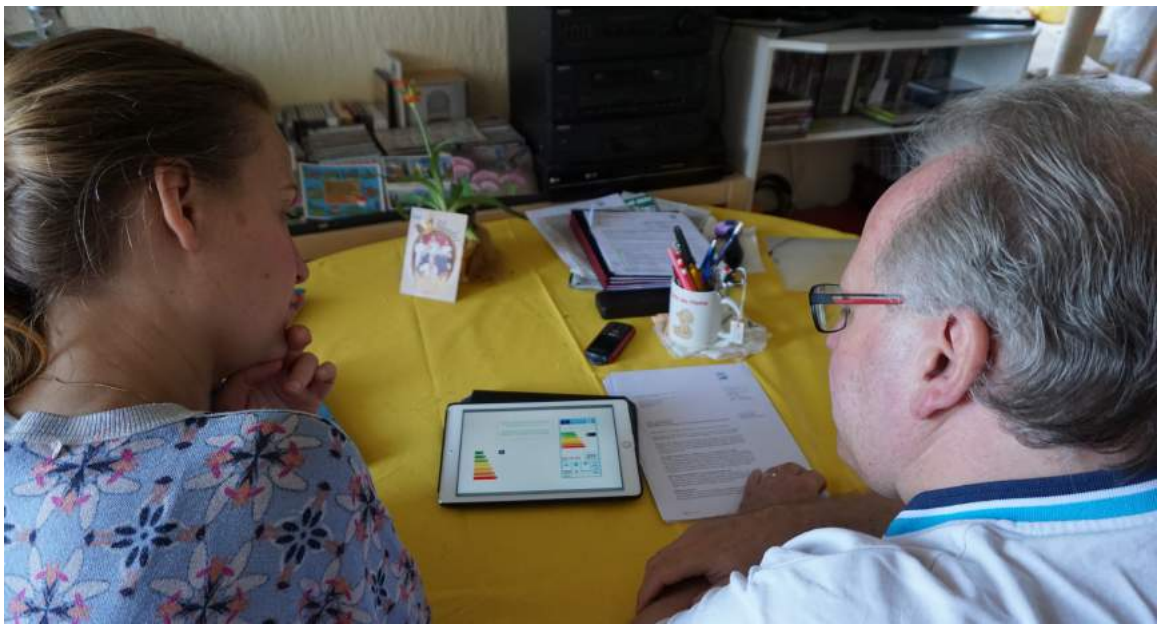


Figure 21 - Co-design session with a tenant of 1892 pilot site on the Energy efficiency label

Figure 22 - Figure 18 - Co-design session with a tenant of 1892 pilot site, the social worker and Savills' sociologist

6.5 Final prototype: Green Neighbours Complete Kit

6.5.1 Sticker for tenants and kit description

Figure 23 - Green Neighbours Kit

The purpose of the educative tools developed in the Green Neighbours kit is to help tenants to make savings with easy items and tips after the renovations, and to help them using new equipment in the most energy efficient way. Before delivering these educative tools to tenants, we train local building managers and social workers on the use of these items and on energy saving tips so they will be able to transfer this knowledge to tenants later.

6.5.2 Pre-requisite: training housing companies' employees to use Green Neighbours Kit

We train these employees to use the Green Neighbours kit tools and to make energy saving, then they will be ready to share these tips to tenants as part of the engagement programme after the end of the DREEAM project.

Figure 24 - Workshop Part 1 to train employees on Green Neighbours kit

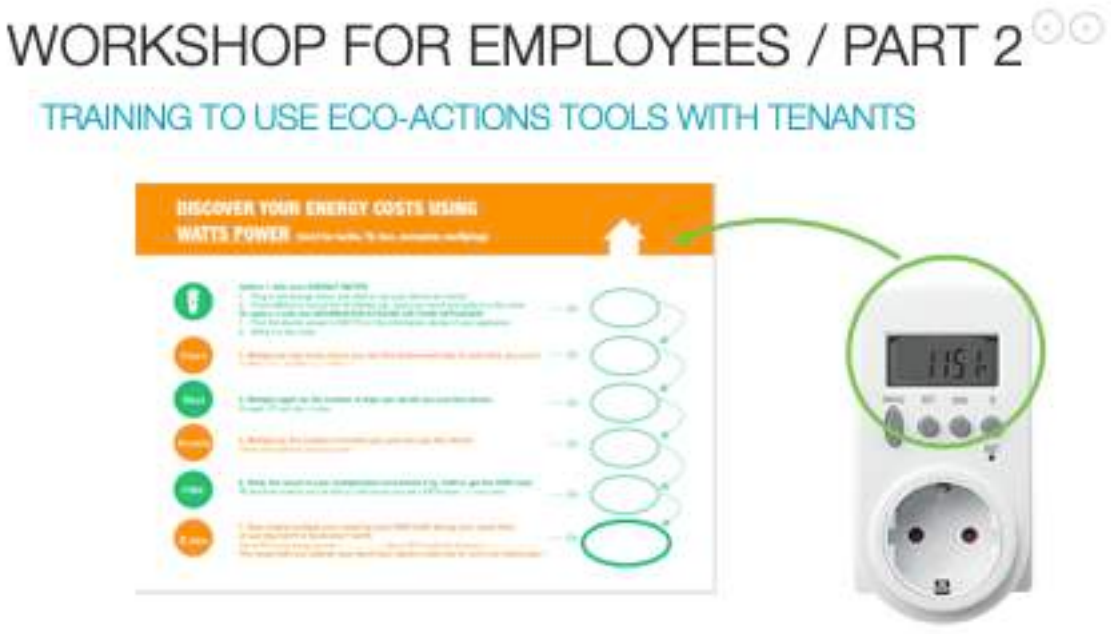


Figure 25 - Workshop part 2 to train employees on Green Neighbours kit

6.5.3 Step 1: Demonstration Tools to engage Green Neighbours ambassadors and social workers

When testing the Green Neighbours Kit in the DREEAM project, we offered a set of items selected to help tenants to make energy and water savings in the three pilot sites. We delivered this box of items to a group of selected tenants in each of the 3 pilot sites with the objective to engage them as "referent" and "green neighbours", so that they could share the information learned with other tenants later after the end of renovations and DREEAM project.

A group of "referent" tenants consists in informing and training in particular a limited group of voluntary tenants who will help housing companies to inform other tenants. These tenants will speak to their neighbours and share the information given to them, and they will help other tenants to understand how the renovations and new equipment will work thanks to the Green Neighbours kit and tools.

The interviews have allowed to identify a group of tenants in each pilot site who would be relevant to help us involving other tenants and we have delivered Green Neighbours tools to these tenants.

The approach of referent tenants worked for housing companies in previous years so we believe this approach is efficient to engage then later a bigger group of tenants. We need first to engage "referent" tenants who are involved in the life the community.

> **"PFP usually works closely with 4 to 5 tenants at the site and get them on board with the renovation works. We have representatives who are able to show to other tenants how to use equipment, it's the better option for that area. I don't think we have particularly champions in Padiham but we had this approach in the past. Champions they've been trained on how to do it, like representative or spoke person. We have positive experience of champions tenants in other pilot sites. Generally, if we have a major change happening, then we will try to get champions tenants on board but we haven't had any need in Padiham, it depends on what has been happening and if there is a need for this" (Local Manager – 2016).**

This approach of "referent tenants" applied to energy and environment has been proposed during interviews to tenants themselves in full transparency and the idea was positively welcomed for a majority of them. This is one of the key lessons of our research activities with tenants. There is a real interest of tenants to get involved in actions such as Green Neighbours and to support the development of collective actions around energy and environment.

The Green Neighbours tools that we have offered to the selected “referent tenants” in each pilot site are:

- The first item of the Green Neighbours tools is an electricity meter with a self-checking table;
- The item 2 is a multiple plug with a central disconnector that prevents the standby energy use of equipment as standby energy use of equipment can be very consuming, some TVs consume more electricity over a year in standby than in use. This is why we offer these standby multi-

plugs to allow tenants to cut the standby on key elements such as TV and save up dozens of Euros;

- We also offer thermometers to help control the heat and to avoid over-consumption of radiators. (Most tenants want to limit their temperature to 21 degrees and agree to not over consume but they simply don't have indoor thermometers to control the inside temperature);

- We also offer a timer under the shower and tips with concrete explanations on the impact of individual behaviours on the collective charges.

6.5.4 Feedbacks of tenants with the tools delivered as part of Green Neighbours kit

The electricity meter device allows tenants to know precisely the electricity consumption of their devices and the cost of electricity to run a cycle.

We have developed a simple guide to help tenants using this device with clear instructions.
As tenants express a low level of knowledge on their energy consumption and a real interest to know better how much their devices use energy, this item is a key tool to empower them on energy efficient behaviors.

An electricity consumption meter is a key element of Green Neighbours Kit to help tenants determining the real running cost of devices compared to their theoretical consumption displayed on the energy efficiency sticker.

Berlin

B1: "We don't waste, we have learned to be careful very early on, we are careful both for the money and environment. I am very careful with energy consumption, I have made a table to compare equipment and costs, for example I have been able to check that I save 60% of electricity use between lamps and LED. Also I have checked the real consumption of equipment, I noticed there is sometimes two times more energy use between the sticker on the equipment and the real consumption, this is why energy meter is interesting, there is a sometimes a real difference between displayed energy consumption on the label sticker and real consumption".

B4: "I don't need a standby multiplug because I already have an energy meter, and it's very useful, I know exactly how much my TV consumes but it's not easy to understand how much an equipment consume and costs".

C1: "It is a good idea these items! The standby consumption it's a lot! I didn't knew".

B1: "I have changed all my lamps with LED, because I have monitored the electricity consumption of all my equipment to not lose any money. For me it's natural because equipment consumes a lot. My computer is always left unplugged"

A1/Italy: "I think it's very interesting the electricity meter and I will test it on all my equipment".

6.5.5 Step 2: Communication tools to inform other tenants in the neighbourhood

Below we present the poster and the sticker developed to promote Green Neighbours in the collective areas of the buildings where tenants live.

The sticker “Green Neighbours” should be delivered in a plasticized version to each tenant engaged as Green Neighbours to display on their windows or doors. This way, the other tenants could ask for help about energy efficiency, eco-actions, environment actions to the Green Neighbours who have been previously trained by social workers, and that they could find in the neighbourhood thanks to this sticker on their doors or windows.

6.5.6 Tenants feedbacks

What tenants say about the final prototype of Green Neighbours kit:

A4: "It is good the idea Green Neighbours, to make collective actions in an egoist time. I would like to be involved as Green Neighbour, and to be involved with other people of the community, I am already involved in ecology".

A2: "It is a good idea! It's great this table".

A3: "It is good! The paper guide is a good idea".

C1: "I think the idea to build a community around energy is a good idea because it can create relation with other people in the neighbourhood".

C1: "I like the idea of ECOBOX and Green Neighbours, it is an interesting initiative, the idea of engaging Green Neighbours. Maybe due to the age of tenants, it might be difficult. We could organize a collective meeting with other Green Neighbours after September. I would be interested to be part of meetings with Green Neighbours, and in advises about electricity consumption. You could also create a group of discussion on Whats app and Facebook and Instagram with Green Neighbours".

A4: "We could create gamification for children in the area, to give power to children as they like to play, like a social game. Raising awareness is the problem. The good way to make the posters for tenants is to make some stickers with the good question: Do you want to save 100 Euros per year? To catch the attention of people. Also, you should use different colors for the different topics. The sentences in posters should be catchy and raise the interest of people like "I saved 100 Euros do you want to save too? Ask me, I am a Green Neighbour, I can help you".

The poster below is a completion to the Green Neighbours sticker. The poster should be displayed in the lobby or collective areas of the neighborhood to inform tenants about the programme Green Neighbours. The template of Green Neighbours should be personalized with pictures of tenants who have previously been accepted to get engaged as Green Neighbours ambassadors.

Do you want to make energy savings and have a positive impact on the environment ?

dreeam
scaling energy renovation

Green Neighbours
Co-design eco-actions with citizens

After renovations...

Discover how to benefit the most from the DREEAM renovations with free tips on energy efficiency and energy savings - developed in collaboration with other local tenants of your community !

Who should I contact ?

Contact your building manager Latif Patel to receive a guide for free and to discover how local Green Neighbours of your community can help you with personalized tips to make energy saving.

Green Neighbours ?

Green Neighbours are volunteers in your community who have received advice on energy savings after the end of DREEAM renovations, and who agreed to share energy tips with other tenants to promote a greener community that benefits to everyone after DREEAM project.

dreeam

Places for People

6.5.7 Step 3: Support Green Neighbours ambassadors to engage other tenants with tools

Tenants needs to better understand their equipment and energy consumption

Most tenants interviewed are very interested to receive advises on energy efficiency. In general, the level of knowledge of tenants about electricity, energy, water consumption is quite low so the task to inform them if crucial.

A2: "I don't think that I consume that much but I don't know how much I consume energy. For the scale of energy consumption between the different equipment, I will say it's really difficult to know, my guess would be that the multi-plug consumes more, but except that I think that all the equipment we can see here consume more or less as much energy but maybe the electric radiator consumes the more, for the other equipment it also depends of the age and the category".

B4: "I am more interested to know how much the heating costs and how the collective costs are calculated. I think that the more consuming equipment are the electric plaques, the fridge, oven, microwave, the lamp… it depends on the category. For the scale of cost, the quiz, I have no idea how much it costs, maybe one bulb of 60 W during 24 hours per day would cost €50 per year I believe. It's not easy to know the difference of consumption between the equipment, I think maybe the most consuming are the oven, electric plaques, the kettle, the dishwasher, washing machine…"

C2: "I think that the equipment consuming the more is the oven, the electric plates for the cooking, the fridge, washing machine, I think in general all the equipment in the kitchen and

after all the cell phone, computers. I think that the question of environment is central so I have chosen a green energy supplier".

C1: "What I think is that the A+ equipment arrived after the improvement of energy efficiency and it's wise, there are two categories of equipment ABCD and A++++. Plugging the electricity meter is interesting, what would be even better is an app because it's simple so maybe for elderly people they can use the energy meter and a notebook, and for younger person they could use an app".

6.5.8 Green Neighbours Quiz

How to raise the interest of tenants in reducing energy and water consumption, taking eco-actions when they say that they already know everything? Though when questioned, the same tenants have very little knowledge about their energy consumption. So how to fill the gap between what tenants think they know and what they actually know about energy consumption?

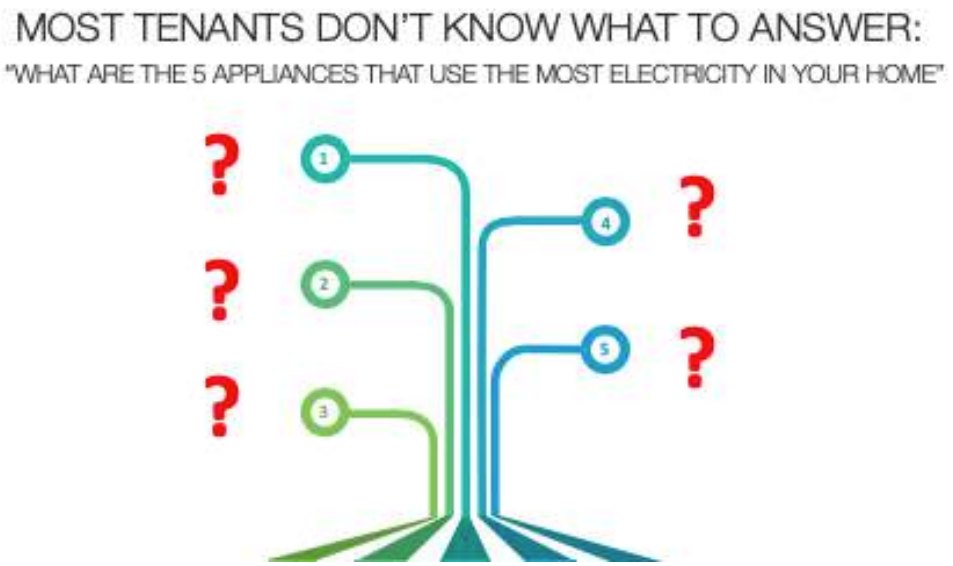


Figure 26 - A key result of our interviews: most tenants don't know how much energy their different equipment use

We have developed quizzes and these are a good tool to check with tenants their level of knowledge on energy consumption and costs in a nice and interactive manner.

We have developed several quizzes on the typical questions that we noticed tenants have the most difficulties to answer. These quizzes allow us to raise the curiosity of tenants at the beginning of co-design sessions and to demonstrate to tenants that there is a lot of information they don't know yet, information that could be particularly helpful for them to better control their energy budget and to make savings. These quizzes are also excellent tools to engage with children when we visit households, children are very positive to answer to quizzes, to test their knowledge, and to learn more about how to manage energy at home.

Figure 27 - Green Neighbours Quiz

6.5.9 Energy efficiency label quiz

Figure 28 - Quiz on European Energy Efficiency Label

We also question tenants on their knowledge about the European energy efficiency label and on their estimation of the most to the least consuming equipment in their home. Testing the usability of European Energy efficiency label to make it more understandable is interesting. European energy efficiency labels support the engagement of tenants for energy efficiency, but they are difficult to understand for most citizens and need some improvements according to tenants.

A2: "I know the tag about the water consumption and the number of kilo, but I absolutely have no clue about the icon in the middle, I have absolutely no clue about the kilowatt hour. I have a (brand name) washing machine, it is good, it has a long life. I changed it three years ago. I bought it second hand and I didn't looked at the consumption to buy this washing machine at all. I pay 58 Euros per month for electricity and I have electric plaques and I think it's okay, I don't need to make that much saving".

B4: "The labels: they present big values but it's not very precise we have the value of the kilowatt hour but the cost can be very different depending on how we use equipment. What would be more interesting in addition to kWh would be to precise how much percentage of saving or loss of energy and money there is between this equipment, in its category compared to the same equipment in another category, so we know how much we save or loose depending of the category we choose".

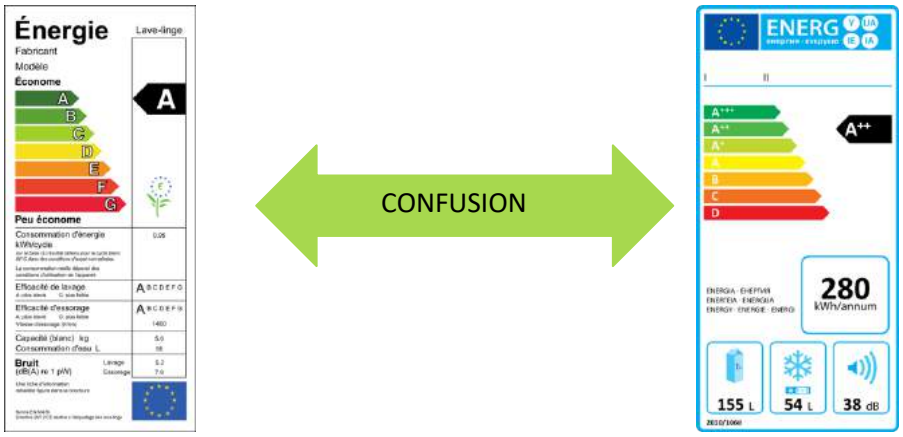
A2: "The difference between ABCD, A++++, A++, A would be good to have it because it's not clear for me at all. My daughter has a new washing machine and the eco- programme works all night long and it's too long! I wouldn't buy such a washing machine because of this and because I don't really know the impact on energy consumption by using eco-programme and A+++ washing machine. Understanding better our consumption, why not, it could be interesting".

A3:"I would be very interested to understand the difference between equipment with category A or A++, it's so complicated, and about how much energy and money I save between 1° when I use the radiator, or when I use one minute less of my shower. I have a normal washing machine and I would like to know more to understand the difference between the different categories of A".

A1:"It would be good to give advises on the difference of equipment performance and running cost between the different labels A+, A, B….to have comparisons on their efficiency, to understand clearly what is the difference between each category because we don't know".

We advise to improve the knowledge of tenants related to the energy efficiency category of their equipment (class A to G), and also their understanding of the difference between the A class from A+ to A+++.

Most of the time, tenants are confused between the different energy efficiency scales and they don't make the difference between A or A+++ fridge for example, they will just describe that they have a device class A *"and maybe more"* but <u>without certainty</u>.



These different quizzes allow to identify very precisely where tenants need more information, what are the most common misconceptions of tenants in one particular neighbourhood. The quiz also helps tenants to ask questions in a more interactive manner.

We adapt the quizzes to local neighbourhood and pilot sites, so for example in Padiham pilot site where tenants have individual photovoltaic panels, we have developed a quiz specifically for PV production to collect the perceptions of tenants about PV, and the information they need to better use their electric equipment with the energy produced by the PV in their home.

6.5.10 Green Neighbours Kit – Item n.4 Self-checking table

We have developed with tenants a self-checking table to use with their electricity meter or with the energy label of equipment, to determine quickly and simply the exact consumption of their different appliances and uses and to estimate the saving that they could be obtained by adopting new behaviours.

Figure 29 – Self-checking table tool

The sociologist proposed during the Stage 2 of the co-design process to create these self-checking tables that work as a reminder about energy consumption that tenants can display in their home on their fridge, they work as simple reminder of key information needed to make energy saving (consumption, costs, saving estimations). Various tenants were very interested by this idea and proposed suggestions to develop this concept into a concrete tool. The final self-checking table is a A5 paper size plasticized document that tenants can use and reuse to write notes, numbers and estimations with a pen adapted to whiteboard or plastic surfaces.

6.5.11 Self-checking table: a tool developed in collaboration between the sociologist, social workers and tenants

W: "It is brilliant, it is a good idea! With the pictures on the side, it is good to see the overall consumption in a year, it's really good".

C2: "If I look at the different possibility of saving when I look at the table, it makes some money, I could save enough for a weekend trip or even more".

A6: "We could make our self-checking with the energy tools that you developed but we need to have another option for the equipment where the label are hidden and for the equipment where we can't access the plug to install a meter".

B4: "I would like a picture where we can see the consumption of each equipment per hour and that the equipment is labelled from red to green to orange, depending on the relation between equipment, and the kilowatt hour consumption And the relation between how much this equipment consumes in KWH and how much this equipment costs to run during an entire hour, I think it should be schematic, simple and it should present the relation between the kilowatt hour consumed and the real cost in Euros.

C4: "The idea of a table to understand, yes it's better because either way we are lost with numbers about the consumption like KWH, but we don't know what it means so the minimum would be a table because we don't understand what it means for example 0.5 kWh…"

1892' Social worker about the self-checking table: "The table it is good to compare equipment, I am not a mathematic person but I like the table, it is clear. Yes I would like to use it in my house of course, I am pretty aware about my consumption but I don't know how much I consume for each equipment. I have a comparison between the electronic bills and usually they are the same. I have removed all lamps, now we only have LED ones. I think LED lights are expensive but they don't use electricity a lot, but for the other equipment I don't really know so it's interesting this table, I think you could put a bigger title up to make it clearer".

C3: "There are already people who come in front of my window to seat and talk, so I would be okay to be an energy referent in the building. I don't know how the electricity is produced and so I think it's a mix of different elements but I am not sure about the kilowatt hour. I have no clue, I'm trying to think and I make a calculation in my head. I don't know really how much I can get (…) You should add a table with illustrations on how much each equipment produces CO2. It would be good to have an idea of how much CO2 is generated by our actions, it's a priority to understand that".

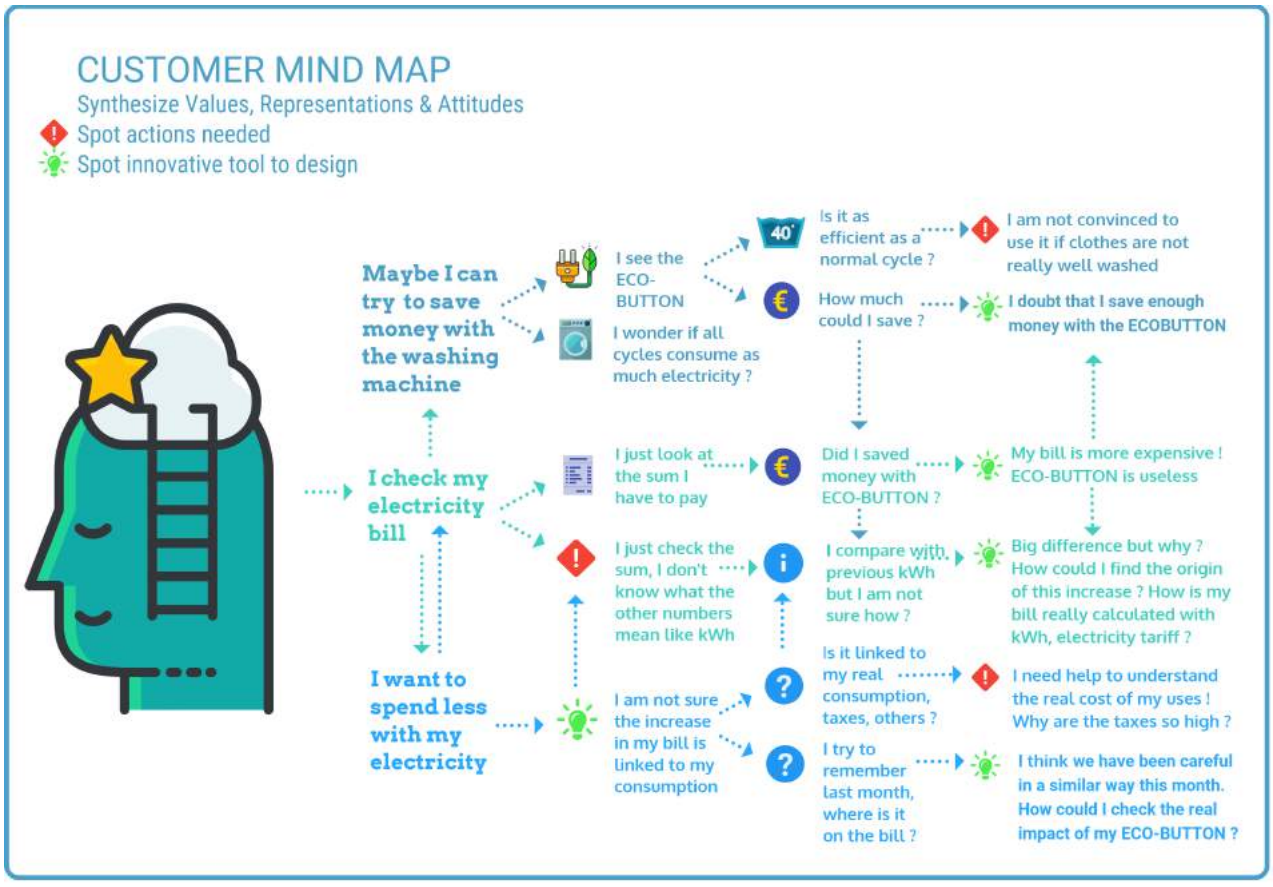
A1: "The table is good and I like that you put illustrations with examples of the equipment".

B2: "I like the table it is simple and easy to use. I would not use the equipment by myself but I would be really interested to receive an audit made inside my home on my equipment especially in the kitchen, but not to do it myself, it is too much work and it's complicated to

install the meter and to learn how to do it but that someone makes the audit for me with the table, yes I am interested".

6.5.12 Test how tenants use their equipment during User Experience evaluation at home

A good tool to elaborate the analysis of tenants' experience is the mind map to synthetize the chain of thoughts that tenants express during interviews and visits at home about their use of specific options or equipment. Understanding and synthetizing the thoughts expressed by tenants can be very helpful then to build the appropriate communication tools to help tenants with tailored tips.



6.6 Perceptions about the social evaluation and co-design

6.6.1 Tenants feel listened and involved with interviews and co-design process

C2: "To find out technical background and interests through neutral interviewer is a good method, positive. I think if interested tenants spent few hours for an interview, the results will make a good basis".

A1:"It is good to ask directly to tenants and to make visual map and visual comparison"

C3: "Architect and engineers should do what you do more, to talk with people, we have so many experts, they should have known what are these problems we talked about before deciding for renovations, they should know the problem with the uses of windows and that the solutions is not made and designed for tenants. As a corporation we should create a trust atmosphere, some tenants are afraid about these renovations especially old people, it is a pity that we spend so much with renovations but not enough about the communication, we are not able to explain the positive impact of renovations and that is why tenants are afraid. Every tenant should be happy, the explanations about renovations for tenants are not as good as they should be".

B3: "It is good to listen to tenants, but I would not take part to Green Neighbours. But I would like to have a quick overview of tips, with short, precise, easy language on renovations and energy tips. We live here for 10 years, but we are not members of the settlement committee, we know some of our neighbours only".

B4: "I think it is very interesting this idea of energy kit with an energy metering plug! We have equipment between A to A+++ but we don't really know what the difference between them is, we would like if you could explain us, we could also look with the energy meter. With the quiz, I think that you discover that you are wrong, I can see I was wrong, it would be fun and dynamic to add a certificate like "energy champions certificate", these ideas of energy kit and quiz, it is good for all of us. I know our energy consumption and it is ok, but I don't know in comparison with other households for example".

B1:"I think the interview is a good idea… you need to ask the same questions after the renovations…to see the difference. It is complex to assess the difference of uses, and what you call rebound effect, you need to identify the difference between increase in energy demand, real use for example of thermostats, increase or decrease of consumption. It would be good that the tenants, we have feedbacks on the interviews after the renovations to see what you have learned with interviews".

B4:"I think it's very interesting to have information on green building, energy consumption…As I shy person, I prefer a flyer to receive information, and individual coaching but not collective meetings, I would prefer individual information, I could go to collective meetings but I would not ask questions. I think it is positive and necessary to meet people before renovations, because you can understand people before renovations instead of realizing too late what people want".

B2: "The interviews were fine, yes it was no problem or annoying, it is ok yes!"

C2: "The interview, yes, it's ok! To take the time, it is good".

C3: "There should be a manual to inform tenants on how to use the new equipment and what to not do. We have to explain how to use the new equipment for example with new windows, we need to explain people how to ventilate more. A good manual would be absolutely brilliant! The solar technology for the warm water, it is too complicated, we would need information to understand the value for tenants…"

P (Energy Champion): "We could have a meeting with other tenants, I will gladly help people with energy as long as they listen".

6.7 Key conclusion: completion of engagement programme's tasks

SAVILLS has successfully performed the 4 steps of the initial "Tenants' engagement programme" plan and performed extra-work with the development of an ambitious co-design programme of energy efficiency informative tools for tenants. The initial tasks forecasted in 2016 by SAVILLS in the deliverable 4.2 have been updated with a deviation in the Step 3 justified by socio-technical difficulties experienced by other partners in the project and that SAVILLS had to adapt to.

Object of the deviation: the initial plan was to co-develop with Open Domo the individual display of monitored electricity consumption for tenants with the data monitored and calculated by SinCeo2.The bankruptcy of OPEN DOMO led the SAVILLS team to adopt another approach adapted to these socio-technical difficulties and to the specificities of tenants' needs in the 3 pilot sites.

- Most of tenants interviewed in the UK experience fuel poverty and use a pre-payment meter and their energy budget is extremely tight. Most of these tenants check their pre-payment meter every day or every 2 days and must be careful about each Pound they spend for their domestic use of energy. The accuracy of the numbers displayed on their pre-payment meter is one of the key elements that helps them to maintain their budget and their financial security.

- The SAVILLS team considered that with the multiple technical difficulties experienced by SinCeo2 and Open Domo, then by DEXMA to secure the collection and display of electricity consumption in the various dwellings monitored in the UK pilot site, it was not rigorous and socially acceptable to take the risk to display errors or inaccurate individual electricity consumption information to vulnerable households, already struggling to manage their energy budget. SAVILLS team do not consider it acceptable to potentially confuse tenants in energy poverty in the UK pilot site with an online platform displaying potentially wrong numbers about their electricity, gas consumption. For this reason, we did consider that an individual online platform for monitored tenants should be part of the engagement programme for tenants in DREEAM project;

- Most of tenants interviewed in Italy and in Germany are up to 50 years old, some of them are retired and these tenants are not the ideal target group to develop a dedicated online platform displaying their daily energy consumption. Most of the tenants we have interviewed in Italy and in Germany are not interested by an App or any online services except two tenants that are good energy budget managers (Energy Champions) but who are not representative of the expectations of the other tenants interviewed.

- Most of the tenants interviewed would be interested to get information on energy efficiency post-renovations and on energy management but with in-home visits, with little devices such as the electricity meter, with direct face-to-face advises and with little easy tips written in simple language and with user-friendly design adapted to their daily uses;

- **Conclusion:** the impact of the replacement of the online access to monitored energy consumption by a co-design programme is positive, pragmatic and socially acceptable in the context of the pilot sites involved in the DREEAM project.

- The co-design programme to develop energy efficiency informative tools with tenants has received very positive engagement and feedbacks from tenants in the 3 pilot sites.

- Our objective to develop this co-design programme with an incremental development process has been respected: our objective of 3 steps and 3 prototypes has been achieved. Our ambitious co-design programme has lead us to develop 3 original prototypes of social services: prototype 1 of ECOBOX and prototype 2 of GREEN NEIGHBOURS information & training concept until the final prototype of Green Neighbours kit.

- The sociologist of SAVILLS has developed informative and training tools in 3 steps following the MIT Design Thinking Process and the best practices stated in the UCD ISO Norm.

- We have delivered the Green Neighbours tools to a dozen of tenants in each pilot site. We reached our objective to get the confirmation of the social workers and five tenants to become Green Neighbours ambassadors, after the end of DREEAM project in the German and UK pilot sites. This is a positive achievement that should allow housing companies to engage later more tenants with the help of these Green Neighbours ambassadors.

- In Italy due to the difficult context of late renovations, several tenants are interested to become Green Neighbours but they advised us to wait a few months before starting the Green Neighbours campaign as a lot of tenants are still annoyed with the delay with renovations.

- It will be decided in October 2019 if housing companies are interested to continue experimenting the GREEN NEIGHBOURS KIT especially the communication tools for the other tenants (stickers, posters, self-check tables) and to test engaging more tenants during the winter 2019/2020.

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