Engaging households in sustainable renovation – Exploration of a complementary approach

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Abstract

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One of the major challenges for sustainable resource use lies in the renovation of the existing building stock. Less than 1% of the total building stock in North-West Europe is renewed each year, which means that most gain has to be achieved by renovation of the existing building stock in combination with changes in behaviour by residents, the end-users of the buildings.

Commonly used methods to stimulate and support residents in making adjustments to their homes, are mostly monodirectional. Residents then are passive receivers of information and advice. Previous research shows that active involvement and multidirectional exchange leads to better results.

In line with these findings, the study presented in this paper takes approaches that are used in the field of product development for and with end-users as a starting point. These approaches, such as co-design processes, creativity techniques and vision development to come to novel ideas, appear to have characteristics that are conducive to stimulate people to make changes towards sustainable renovation. The study explored if and in what way these approaches can complement the commonly applied methods.

For this purpose, a number of sessions, called 'Livinggreen Labs', were organised. In the sessions several techniques were applied for a number of themes and with varying types of participants. The sessions were evaluated by the participants, as well as by the organisers.

The findings suggest that the approach tested in this study can provide an attractive complementary way to sensitise people to the possibilities of sustainable renovation and sustainable lifestyles. The sessions showed high involvement of the participants. Peer-learning and exchanging perspectives between people with different backgrounds were highly appreciated. The approach seemed to be most useful for vision forming and participatory processes in local urban development programs as opposed to best practice knowledge transfer. In order to more purposefully compare these different methods in the future, the former might be called "emerging knowledge transfer".

Because of the specific context of the project in which the study is executed, further investigation is required to assess whether and how the results apply in different contexts. Furthermore, detailed insight is to be developed in what ways the use of techniques from the design field, together with existing methods, yield the best long-term effects on sustainable renovation activities by residents, i.e., achieve real impact.

1 Introduction

One of the major challenges for sustainable resource use lies in the renovation of the existing building stock. To take the energy domain as an example, in Europe in the year 2004, energy consumption in households constituted 37% of the total energy consumption, of which 63% was residential (Poel et al. 2007). By the year 2030, this figure is expected to have risen significantly (Pérez-Lombard et al. 2008). Most of the consumed energy has been generated by the use of fossil fuels. The dwindling availability of fossil fuels prompts serious reductions in overall energy use. With an annual replacement rate of 0,25 % or lower in e.g. The Netherlands, France and UK then it would take hundreds of years to replace buildings (Thomsen and Van der Flier, 2009). Renovation of the existing buildings is thus imperative to make the housing stock more energy efficient. Since energy legislation have been introduced around the end of the seventies, beginning of the eighties, to set standards for energy consumption in buildings, much of the existing building stock from before that time has sub-standard energy consumption levels, compared to what is possible today.

Renovation[1] (also sometimes called retrofitting) of residential buildings is necessary, in order to lower resource usage of households. Households should therefore be motivated to adopt resource efficient and environmentally friendly products and services. In addition to the implementation of these technologies, it is crucial that the behaviour of the household also supports efficient and smarter use of resources.

User behaviour is a significant determinant of the environmental impact of a building, see e.g. Van Raaij and Verhallen (1983) and Dietz et al.(2009). And to consolidate the potential gains of energy-saving or –producing buildings, it is imperative that consumer behaviour changes as well (Haas et al. 1998). Haas et al. state that there is a 15-30% rebound-effect, i.e., people act less consciously regarding energy use because they think the measures they took are sufficient. Practices, technology and products are available on the market, to reduce energy consumption, both of and in the house. For these to have positive effects, residents need to be persuaded to change their behaviour and implement and adopt these technologies and products[2].

Reducing consumption of energy is one of the aspects of renovation measures and often the main goal because there major environmental and economic gain. Other aspects also play a role, such as other resources are used in the house and how to deal with those in the most environmentally friendly way (e.g. water and materials used), but also making the building future proof, and how to deal with the historical characteristics of the building.

The Livinggreen.eu project, co-financed by the EU Interreg 4B programme addresses various aspects of renovating buildings. Firstly, sustainable renovations are demonstrated in a number of restoration projects of cultural heritage buildings. Secondly methods are employed and developed to stimulate adoption of sustainable technologies as well as behavioural changes. For this second goal, the sustainability centres that were connected to the project partners were the main beneficiaries. In two cases these centres are at the moment run by the municipality, in the other cases external organisations do the management of these centres, but keep strong links to their municipality. Because these centres have households and other end-users of buildings as clients, the methods had a strong link with influencing the knowledge and behaviour of end-users of buildings.

This article focuses on the latter goal, more specifically on one of these methods to engage end-users in sustainable renovation in a broad sense: adoption of new technologies and change in behaviour. The goal of this method, referred to as Livinggreen Labs, was to explore in what ways the use of design techniques can provide an alternative or complement to commonly used methods.

The structure of this article is as follows: Section 2 presents a literature review of characteristics of commonly used methods and evaluation of those by scholars. Furthermore methods from the design discipline and their relation to behavioural changes are discussed resulting in a list of potential building blocks for the Livinggreen Lab methods. The research approach for this development process is presented in section 3. The resulting method and how it developed is discussed in section 4. The sections 5 to 7 present and evaluate the actual results and recommendations.

[1] Many terms exist that have a similar meaning: retrofitting, refurbishing etc. All words have their own nuance, but we will not engage in that discussion. Renovation will therefore be used throughout the text of this article.
[2] In the course of this article, the term end-users occurs many times. Unless stated otherwise, this refers to residents, i.e., people living in houses. Vice versa: where we use residents, they should be considered end-users.

2 Potential for design approaches to stimulate behavioural changes

2.1 Views on traditional approaches and clues for other approaches

Programmes to stimulate people towards more sustainable behaviours have been subject of study for several decades. A traditionally used approach is to use information campaigns. These tend to 'push' information, based on the assumption that by solving an information deficit with consumers suffices to move them towards different behaviour. This approach has however been criticised. Relying on basic knowledge dissemination will in all likelihood not have a substantial effect on behaviour, since behaviour change can be inhibited by more than knowledge deficit (e.g. Barr, 2003; Lorenzoni, 2007).

Research suggests even that traditional campaigns can invoke lethargy, cause a feeling of disempowerment (Howell, 2012), or spread feelings of apathy and helplessness (Kaplan 2000). Kaplan (2000) states even that people tend to avoid contexts in which they consider themselves helpless.

To engage people in making systemic changes to deal with environmental problems, different communication approaches are required (Ockwell, Whitmarsh and O'Neill 2009). Knowledge increase should always be combined with other strategies that also address other social structural factors that influence behavioural change (Gardner & Stern, 1996, Verplanken and Wood, 2006, Breukers, 2011)).

Building on the critique on traditional campaigns for stimulating people to make changes, there are several clues on what may benefit the approaches to engaging people and households in this area.

Positive framing was found to cause more supportive attitudes of climate change mitigation than negative ones (Spence and Pidgeon, 2010). Morton, Rabinovich, Marshall and Bretschneider (2011) found that positive framing resulted in stronger intentions to act. Feelings of efficacy - that the action would be successful - supported these intentions. In the same line, thinking about positive solutions in a future situation, tends to empower people to take action (Boulding and Boulding, 1995, as cited by Carlsson, Kanyama et al, 2008).

Another option is the communication of meaningful information, i.e. information that enables to take action, e.g. by proposing alternatives that are applicable to one's personal situation. (Lewis et al, 2010) discusses this in the context of drunk driving, but it seems more generally applicable, Meaningful information should provide a guide on how to implement new behaviour. This suggests that increasing knowledge in itself can be effective as a step towards action and behaviour change, as long as it is applicable to the personal situation of the recipient, i.e., if it is contextualized and socially embedded (Guy and Shove, 2007). This also means that interventions are to take place at moments that people are susceptible to them. An uptake of measures can be expected by combining interventions with events like changing homes and replacing old equipment (Stieß and Dunkelberg, 2012) or when other changes in people's daily environment disrupt their daily habits (Verplanken and Wood, 2006). Purposeful campaigns around such a specific opportunity, like changing homes, have been successful in Germany (Stieß and Birzle-Harder 2010).

Additionally, social norms (i.e. socially shared believes about what one should or should not do) seem to be effective as a tool to convince people to take action and making these explicit can spur behavioural change (e.g. Martin, 2012, Cialdini 1993 and McKenzie-Mohr, 1999). Also has interaction among people shown to influence behaviour. Communication with peers about new products or behaviours supports the decision making process (Rogers, 2003). Furthermore, by communicating with other people, one realizes not to be the only one considering or making changes (Heiskanen 2010) and may overcome feelings of lethargy. Interventions that stimulate interaction can make use of these mechanisms, as is proposed by for example Gardner and Stern (1996) and Heiskanen (2010). Participatory approaches where people are actively involved in the development of interventions and measures, thus in the ways they may be enabled to change behaviour, are suggested as powerful directions to stimulate behavioural change and empower environmental citizenship (Ockwell et al., 2009; Frey and Stutzer, 2006, Gardner and Stern, 1996, Heiskanen 2010).

The views that were discussed here, all originate from social sciences research. Interestingly, there seem to be methods and tools that are used in the design discipline that also address these issues. The following section will discuss these insights from the design discipline.

2.2 Inspiration from the design field

From the field of design it can be taken that the use of (elements of) co-design can make a valuable contribution in the light of the much needed positive approach of people. The definition of co-design is taken from Sanders & Stappers (2008). Co design is the 'collective creativity as it is applied across the whole span of a design process' (Sanders & Stappers 2008). Co-design, where designers and principals involve end-users has yielded positive results as early as 10 years ago (Westerlund et al, 2003). and its success, in terms of more usable products for end-users is considered to have been adequately proven **(**Gulari and Börü, 2011)**.** The concept of co-design dates back to the 1970's, when it was known as participatory design (Sanders & Stappers 2008). Often encountered in design literature, and widely practised, is co-creation. Although the terms are used interchangeably, they do indicate different meanings. Co-creation refers to any *act* of collective creativity, rather than to the *process* as a whole.

In the field of design, co-design is used to enter the ideas and experiences of users in design processes, coming to products better fitting both to producers and end-users. This process is primarily aimed at the process of product development, and therefore indirectly to an increase in sales of products (or services). In a recent study, done by Kuijer and De Jong (2011) an interesting observation has been made. As a side-effect of their co-design research project, focusing on developing new practices of bathing to reduce water consumption, they note that the participants in the co-creation sessions came away with altered views on their water use. Kuijer & De Jong argue that through a design process focussing on practices, making use of users and their experiences, both users and designers get a better insight in what those practices are and what they mean. They further suggest that by understanding practices, the true value of design in the context of behavioural change is shown. Also, results of Nair et al (2010) regarding these highly participative processes lead them to conclude that the process may be even more important than the product: thanks to the interaction with peers and between experts (i.e. groups of people from different backgrounds), participants had a much better understanding of the social norms that influence their behaviour, and thus they can also start to challenge them. The actual product results were then almost irrelevant compared with this 'side' effect.

These analyses provide some support for the conclusion that this way of creating these new insights may have value in behavioural change campaigns. Using co-design and participative, co-creation techniques can create more involvement from the people that participate in such sessions. From the above it may even be carefully expected that that new insights gained during such sessions may positively influence people during their daily routines. In particular when the goal is less to transfer and apply existing knowledge, but rather to get new insights on which new solutions to design (be it on urban, block or home level), organizing such participation seems very useful. The question that this paper seeks to answer is whether a approach, inspired by co-design can indeed contribute to sustainable behavioural change.

2.3 Conclusion literature overview

From the literature review it can be derived that it makes sense to develop a method that combines the lessons learned from traditional, environmental campaigns and with activities that are consistent with a process of co-design, in order to better achieve sustainable behavioural change.

From the views on traditional campaigns we learned that just transferring information is widely accepted as an insufficient method and may even disempower people. The following clues for an improved approach are suggested by analysis from literature:

- Use positive framing to support the perception of the possibility of action; negative framing will mostly result in paralyzing fear.
- Provide meaningful information, based on which a person can take action and which is offered at moments that one is susceptible to the information.
- Make use of the power that social norms have in influencing decision making
- Interaction about the changes under consideration can support people in decisions to adopt measures or behaviour.
- Participatory approaches that are solution and action oriented can empower people to take action.

Additionally, from the co-design process we take that:

- diversity of participants adds to the likelihood of more creative and new solutions;
- a main reason to involve end users (like home owners) as part of such groups to develop new ideas is that they can complement experts and are the ones who in the end need to adapt behaviour;
- possibly through the *process* of co-design – independent of the exact contents and results - people become aware of their own behaviour and show willingness to change.

3 Research approach

The possibilities of using a co-design approach to engage people in sustainable renovation were tested in the Livinggreen project. Based on the analysis as shared in section 2, co-design techniques and tools were used to create a method, called 'Livinggreen Labs'. The Livinggreen Labs were co-organised with partners in the project who are running the Sustainability Centres. In the sessions multiple approaches of engaging the target groups were tested within several relevant themes and with varying types of participants. The sessions were evaluated by the participants, as well as by the members of the partnership.

The project had defined 5 themes, each to be addressed in a Livinggreen Lab: energy, water, materials, architectonic values, climate resilience. Additionally the goal was to work together at least once with a project partner that was running a sustainability centre, to co-organise a Lab.

Data to analyse this 'Livinggreen Lab method' has been gathered in three ways. Firstly during the design, implementation and adjustment of the method itself over time. The method was adjusted based on experience of each lab. Additionally, the context of each Sustainability Centre was to be taken into account, as will be described more elaborately in section 4. Secondly, by participants evaluating the Livinggreen Labs by means of a questionnaire to provide insight in the appreciation of the method as well as their ability and intentions to act. As the theme and format of the Livinggreen Labs changed over time (see section 4 also for more details on this aspect), the evaluation of the labs was adjusted as well. And finally, the persons of the co-organising partners (the sustainability centres) who were involved in the organisation of the Livinggreen Lab, were asked to reflect on the applicability and usefulness of the approach for their purposes.

4 Development of a diverse sensitising methodology

As mentioned in section 2.3, starting points for the initial format of the Livinggreen Labs are the findings from the literature review. The initial set-up aimed for double dividend: inspire product- and service design and sensitise participants about the topic at hand. These starting points were translated into the following principles for the Livinggreen Labs:

- Involve end-users in the design process, in order to better integrate their demands and wishes in the products and services.
- Stimulate active participation in the sessions, to reinforce learning effects
- Choose topics that the participants can relate to as design challenges. Either from the outset or during the process.
- Use a solution and action oriented approach
- Bring together a diverse group of participants from different backgrounds (residents, companies, municipalities, renovation and sustainability experts etc.) to foster creative and new solutions as well as exchange, let alone transfer of knowledge.

The format of the Livinggreen Labs changed over time, due to lessons learned from the executed Labs as well as under influence of the different themes and the different settings in which they were to take place. The specific techniques and tools used therefore differed. The common element in the method is the design approach, which remained a central part of the Livinggreen Lab. Below the more detailed evolution of the design of the Livinggreen Labs is described.

At first the format of a creative problem solving session to tackle a specific design problem of the co-organising partner and persons from different backgrounds were targeted for participation, including residents and companies. Lab 1 used this approach for the redevelopment of an area in the city of

Ludwigsburg. Lab 2 focused on designing products and services for households, the main target group of the hosting partner. In both Labs concepts for products and services were proposed and peer-learning occurred. Most benefit of the two Labs was found in the way to engage the participants - creative and design approach, stimulating exchange among people with different backgrounds - and its effects on skills and knowledge. Therefore, it was decided to shift the approach towards skills and knowledge exchange as a main goal. Another factor contributing to this shift was that the following themes had no direct relation to products and services for households.

Lab 3 was to become part of a fair organised by the hosting partner and was therefore set up as a festival stand, aimed to create awareness about materials use and re-use in buildings. Exchange of information among participants could however not be achieved with this set-up. The following Labs therefore returned to the workshop format like in Lab 1 and 2, but with focus on skill development and knowledge exchange among participants. Livinggreen Lab 4, 5 and 6 thus continued to use design exercises to encourage knowledge exchange and skill development. Though, as illustrated in table 1, different techniques were used due to the differences across themes and hosting partners.

Reflecting on this evolution, two types of Livinggreen Labs can be discerned: (1) aimed at product and service concepts as an outcome (Lab 1 and 2), (2) Aimed at creating awareness and skill/knowledge development Lab 3 – 6).

The key characteristics, general set-up and main results of each Lab are shown in Table 1.

Table 1: Overview of the Livinggreen Labs

	Key characteristics	**Process and activities**	**Main results**
1	**Theme:** Energy in the built environment **Hosting partner:** City of Ludwigsburg (municipality) **Participants:** Industrial designers, urban planners, municipality civil servants, expert **Goals:** (1) inspiring future development of the Weststadt, for the municipality and project developer, (2) let participants learn from each other	- Sensitizing assignment before workshop - Introduction to design assignment - Tour through area - Personas development - Formulation of vision for the Weststadt area - Elaboration of vision in urban planning and products and services - Presentation on posters to audience of opening of the Sustainability Centre. - Elaboration and documentation of concepts by designers attending the Lab.	Selection of visions for the area, elaborated into products, services and public space designs. Ideas focused on how to make energy efficiency and sustainable energy production an intrinsic and visual part of the Weststad.
2	**Theme:** Water use in households **Hosting partner:** Ecohouse Antwerp (sustainability centre) **Participants:** Industrial designers, volunteers of the Sustainability Centre **Goals:** (1) Design of product concepts to support water efficiency in households, (2) Participants learn from each others' knowledge, skills and viewpoints	- Introduction to design assignment through a movie - Reflection on existing products and design concepts. - Formulation of design challenge in two parallel groups - Idea generation through creativity techniques - Definition of requirements for idea selection - Selection of ideas and elaboration to concepts - Presentation to jury - Elaboration and documentation of concepts by the participating industrial designers	Design proposals: Concept designs for products in the bathroom and toilet using water differently by introducing new practices Proposal for shift in the water treatment system reducing the volumes of water, includes concept designs of products and services for households
3	**Theme:** Material use for sustainable renovation **Hosting partner:** National Trust Morden Hall Park (Sustainability centre) **Participants:** Households **Goal:** Sensitization of public about material use and re-use	Festival stand set-up as a pathway with four steps: - Welcome, inviting people to explore the lifecycle of building materials with a game. - Inspirational examples of materials re-use - 'Actions': a) gather information about sustainable building, b) make something out of used materials giving them new value, c) gather information about sustainable lifestyles - Make a commitment to an aspect of sustainable renovation and/or behaviour.	Design of a festival stand Commitments by visitors for a step towards sustainable living.
4	**Theme:** Energy renovation, materials and techniques to use **Hosting partner:** National Trust Morden Hall Park (Sustainability centre) **Participants:** Residents, experts (as advisors) **Goals:** (1) inspiring (energy) renovation of the resident's home, (2) participants learn from each other (knowledge,	- Mapping of values for the home in the future by each participant individually - Discussion of value maps - Drawing vision of ideal future home (e.g. net energy producer) - Roadmap drawing from present to future situation - Tour: exhibition on sustainable living and renovation - Refinement of roadmap - Group discussion about the roadmaps and other	Visions on the future home per participant and a roadmap to reach that situation. Booklets with value map, future vision and roadmap, reminding the participants that renovation can be implemented step-by-step.

	experience, skills, viewpoints)	topics that came up about sustainable living.	
5	**Theme:** Dealing with heritage in sustainable renovation **Hosting partner:** City of Lille (municipality) **Participants:** Residents, architects, users of the building under consideration **Goals:** (1) knowledge exchange & skill development, (2) participants learn from each others' knowledge, skills and viewpoints, (3) Design ideas for a particular building	- Introduction of goal of workshop - Tour through building that is to be renovated. - During the tour participants place notes on parts of the building they liked and disliked. - Discussion of the notes - Lecture on architectonic values and assessing them - Lecture with examples of sustainable renovations preserving architectonic values - Detailed group assessments of parts of the building - Groups: Renovation design of their part of the building - Presentation of designs to the whole group and discussion of the designs - Elaboration of designs for documentation	Four design proposals for renovation of the building, taking architectonic values into account and at the same time making the building more resource efficient.
6	**Theme:** Building climate resilient built environment by strengthening local social networks. **Hosting partner:** The White Rose Foundation (sustainability centre) **Participants:** Members of a diversity of local organisations **Goals:** (1) skill development for building social networks that are able to (2) adapt to changing circumstances in local context, (3) develop network strength	- Sensitizing assignment and inventory questions before workshop about views on resilience, activities and network contacts - Presentation and discussion of combined of responses - Formulation of joint vision of a resilient Delft - Discussion in two groups challenging participants to embed their network, activities, and capacities in the vision on resilient Delft - Filling in Resilience Development Plan - Defining opportunities and actions for the near future concerning contacts and activities	Overview of actors and activities Ideas for further improvement and synergy among actors and activities. Network of organisations that know each other better Some commitments of participants for particular activities and contacts. Strong willingness to continue with concrete projects

5 Livinggreen Lab evaluation

5.1 Evaluation objectives

The main objectives for this evaluation were to evaluate if the Lab method has positively contributed to more active attitude among the participants concerning sustainability and eco-renovation, meaning (a) an increase of knowledge and (b) an intention to act, compared to the situation before participation in a Lab and compared to the other methods that are used within the Livinggreen.eu partnership.

For this evaluation we have used the results from questionnaires and interviews. The questionnaires were filled out by the participants after every lab, the interviews were done with the co-organising partners per lab.

In order to compare the Lab-approach to the other methods that are used within the partnership, we have used results from the questionnaires that were conducted for all the activities and events that were organised by the Livinggreen partnership with a total of 250 respondents. The activities or events that were part of this questionnaire were: exhibitions, guided tours, specialist consultations, fairs and workshops[3]. The objective of comparison with other methods is not to make statements about right and wrong methods but rather gain insights in the situations and conditions that govern the success of different types of methods.

5.2 Approach for the evaluation with the participants

From the total of 6 Livinggreen Labs only 4 labs have been taken fully into account in this study, lab 1, 2, 4 and 5. For Lab 3 no relevant evaluation was possible, because the attendance rate was too low. At the time of this writing not all results of Lab 6 were analysed yet, first insights have been included.

At the end of every lab the participants were asked to fill out a questionnaire. These questionnaires were composed of a default list of questions relevant for the Livinggreen partnership and a number of questions that were tailored to the research objectives.

[3] More information on these activities and events can be found on the project website www.livinggreen.eu

The results are presented in two parts, combining the labs that were executed and evaluated in a similar way and have therefore yielded comparable results. The evaluation of Lab 1 and 2 has been mainly qualitative, the evaluations of Lab 4, 5, and 6 had a more quantitative approach.

For Lab 1, 2, and 6 the questions for the evaluation were aimed at what the participants had learned and what they found valuable about the lab, both for themselves as for the general interest. Labs 4 and 5 have been evaluated in a similar way as the non-Livinggreen lab activities. The results of Lab 4 and 5 are compared with these combined results of the questionnaires of the Livinggreen partnership.

***Table 2**: About the participants and the organising partners*

	lab 1: energy	lab 2: water	lab 3: materials	lab 4: materials	Lab 5: heritage	Lab 6: resilience	Total
tot. no. respondents	7	8	0	11	14	9	50
tot. no. participants	14	8	10	11	18	17	78
Hosting partner was municipality	x				x		2
Hosting partner was knowledge centre		x	x	x		x	4

5.3 Results for Lab 1 and 2: focus on product and service development

5.3.1 Contribution to more user-centred solutions for eco-renovation

On the question what the relevance of the lab for the City of Ludwigsburg was, all participants of Lab 1, both civil servants from the city and the students, answered that the lab had generated new ideas for the development of the considered area. One of the civil servants mentioned: *"The results where a bit abstract, but that's also good, because then you can think about proposals you have never thought of before, and there for you can get an innovative concept"*.
Reservations were made about the fact it could have been even more useful if there had been more information available, to get deeper into the matter. Also, one of the participants mentioned the importance of the presentation of the results, which strongly influences the attractiveness of the results.
With regard to the relevance of the lab for sustainable renovation the opinions of the respondents from Lab 2 were divided about the applicability of the technology. Some were very positive about the application and sense of realism, others were more pessimistic *"because of little access to state-of-the-art concerning technology"*.

5.3.2 Value of the Livinggreen lab as method

Regarding the question what was the value of the lab for the participants, all of the respondents for Lab 1 indicated in one way or another that the creative and open-minded atmosphere as a result of the differentiated groups and used creativity techniques, made it a very interesting and useful experience.
The participants indicated to have learned from each other, and that it was useful *"to see how people with another profession solve problems of developing a city quarter"*. One of the participants, a civil servant for the city of Ludwigsburg, noted: *"(...) the lab-method could be used in similar cases and for other questions I'm dealing with."*
For Lab 2, one of the participants remarked to have *"gained additional awareness, more thought on water use"*. Also one participant mentioned the added value of the lab to be *"innovative"*.

The answers of the participants to Lab 1 to the question what they had learned from the experience can be divided in two categories: learning a skill and gaining knowledge.
The participants who learned a skill mentioned for example to have learned how to brainstorm, work together in groups, or learn from each other. The participants that gained knowledge indicated for example to have learned about architecture, the use of old buildings or city planning.
Especially the civil servants indicated the added value of looking at a problem with 'outsiders', because they can think more freely, which leads to more innovative thinking. They learned *"a new way*

you can deal with planning tasks to get new (creative and innovative) impulses, without the common restrictions." And *"it was great to get input and ideas from people who don't think a lot about financing, planning, legal conditions, or other rules"*. A reservation was made that it is important to *"have results that are not just a vision, but also an action plan"*. One of the participants saw potential in this new learned skill: *"In my opinion, with a bit of training in proper brainstorming the city could have such workshops on their own, with inhabitants"*.
For Lab 2 the answers of the participants to the question what they had learned from the experience can also be divided in two categories: learning a skill and gaining knowledge.
One participant indicated to have gained knowledge about *"facts and figures about water systems / use in households"*. Others learned a skill, for example *"good design and thinking in a bigger context"* and *"brainstorming together and forming ideas, widening my own view"*.

5.4 Results for Lab 4, 5, 6: focus on awareness and knowledge and skill development

5.4.1 Effect on knowledge of eco-renovation and the Lab-theme

The results in table 3 show that most of the participants to the labs rate their knowledge on eco-renovation beforehand as 'good', while most of the participants of the other Livinggreen activities rate it 'basic'.

The degree of increase of knowledge (table 4) among the participants doesn't show clear differences between the methods, although on average the control group scores a bit higher.

What was learned in the labs can be divided in three categories: (1) gained knowledge, (2) skill and (3) awareness.

Three people indicated to have gained knowledge on eco-renovation materials, like for example *"new insulation materials, new solar panel, new toilet + sink, new double glazed units"* or *"that cork is expensive but needs much less man craft to install as insulation material"*. Six people indicated to have learned a skill, especially the ability to divide a big problem into smaller, bite size pieces: *"importance of identifying discrete manageable steps"*.
Three people also mentioned an increase of awareness: *"need to think more deeply about total carbon footprint of all measures"* and *"the many ways in which we can improve on our present living imprint"*.
There seems to be no connection between the kind of knowledge that was gained and the perceived amount of increase in knowledge.

Because of the theme (see table 2 summary description of the labs), the questions with regard to Lab 6 were not directly related to eco-renovation, but on theme-specific topics. All respondents indicated a slight or higher increase in knowledge on resilience and their local network, being the core components of the social resilience.

***Table 3**: Knowledge on eco-renovation beforehand*

	Lab 4	Lab 5	Lab 6	Other LG activities
Thorough	0%	0%	11%	4%
Good	55%	50%	44%	33%
Basic	45%	36%	44%	52%
None	0%	14%	0%	11%

***Table 4**: Increase of knowledge on eco-renovation*

	Lab 4	Lab 5	Lab 6	Other LG activities
A lot	27%	29%	N/A	30%
Some	46%	0%	N/A	45%
A little	18%	50%	N/A	23%
None	9%	21%	N/A	2%

5.4.2 Effect on the intention to act

5.4.2.1 Autonomous evaluation of the labs

When asked if the workshop had inspired them to take further steps for the renovation of their home, all participants to Lab 4 indicated to be inspired to do so. The answers can be divided in three categories: (1) inspiration to take practical measures for sustainable renovation, (2) inspiration to change lifestyle, or (3) a spur to act on old intentions.
Of Lab 4, five people indicated to intend to take practical renovation measures like *"insulate my solid brick walls"*, or *"I am considering a shower heat-exchanger"*. Three people indicated to be inspired to change their lifestyle, like *"some steps for self-sustaining: producing food"*. Two people indicated to already have intended to take eco-renovation but to have been inspired again to act on those intentions.

Of Lab 5, one person indicated to be very much inspired to continue the renovation of their home, three people were inspired a little bit, four people were inspired a lot. Three people weren't inspired. Three people didn't answer the question. To these participants the question was also asked which part of the lab inspired them the most to take a next step in the sustainable renovation of their home. The participants to Lab 5 rated the first visit and the design session as most inspiring. Next to that, the participants indicated that they liked the interaction with the professionals best. One of the participants remarked that the method that was introduced during the workshop helped him to structure his approach to his renovation, so that he could optimize the choices between the preservation of the architectonic value and his budget: *"(…) there is a kind of methodology of about evaluating (…) we split between different categories, and before I was like maybe going in every direction without any organization. (…)"*

In Lab 6 almost all participants indicated to want to get together in a similar setting to continue the process that has been started in the Lab. In addition to that, during the workshop some participants have expressed a specific intention to act on a step towards resilience as defined during the lab.

5.4.2.2 Evaluation in comparison with other methods

For lab 4 and 5 the participants were asked how often they measured their energy consumption, e.g. read electricity, gas or water meter. The results show (see table 5) that the participants of Lab 4 read their meters more often than the participants of Lab 5 and the control group of the other Livinggreen activities. This implies a higher than average awareness of their use of resources.
After the workshop the participants were asked if they would measure their resource use more frequently as a result of the workshop (see table 6), again the participants of Lab 4 showed the most conscious attitude through more than halve of the participants answering yes. Lab 5 also showed a considerable amount of participants that intended to measure their resource use more regularly, the participants to the other Livinggreen activities showed least intention to do this.

To gain an insight into the extent to which the participants already displayed environmentally conscious behaviour, we presented them a list of examples of this kind of behaviour and asked them if they already did this). The results show again that the participants of Lab 4 have already adopted an environmentally conscious lifestyle and the participants to the other Livinggreen activities do also. On average, 60,6% the participants of Lab 4 indicated to already did the environmentally conscious action. For the participants of the other Livinggreen activities this was 56,6%.

Lab 4 focused on both energy consumption and this reflects in the results. Clearly more participants of Lab 4 than of the other Livinggreen activities, indicate to be inspired a lot to 'save energy at home' (45,5% for Lab 4 and 37,7% for the other activities), to 'use a smart meter to measure energy use' (36,4% for Lab 4 and 26,6% for the other activities) and to 'install renewable energy equipment at home' (45,5% for Lab 4 and 32,3% for the other activities). Lab 5 focused on the architectonic values of buildings, we see this in the results because participants indicate not to be inspired by the workshop for a specific kind of environmentally conscious behaviour.

***Table 5**: How often do you measure your energy consumption e.g. read electricity, gas or water meter?*

	Lab 4	Lab 5	Other
Weekly	27,3%	0,0%	7,2%
Monthly	18,2%	0,0%	19,6%

Quarterly	18,2%	7,1%	20,9%
Annually	9,1%	50,0%	26,8%
Never	9,1%	35,7%	25,5%
N/A	18,2%	7,1%	0,0%

***Table 6**: As a result of today's visit or event, will you measure your energy consumption (e.g. read electricity, gas or water meter) more regularly?*

	Lab 4	Lab 5	Other
yes	54,5%	45,5%	33,7%
no	27,3%	36,4%	22,6%
maybe	18,2%	36,4%	43,7%
N/A	0,0%	9,1%	0,0%

5.5 Summary of the results - evaluation with the participants

From the results of the evaluation of Lab 1 and 2 we have learned that the creative and open minded atmosphere and differentiated groups, contributed to the conception of inspiring and innovative ideas. Breaking point for the further use of the ideas seems to be the elaboration of the initial ideas, both in content and technical sense as for the importance of a good presentation of the results.
The participants indicate to have learned a certain way of free thinking and to have gained specific knowledge on eco-renovation.

From the evaluation of Labs 4 and 5 we have learned that the Lab method does not yield clearly different results on the increase of knowledge, although on average the control group scores a bit higher. The participants of the Labs however clearly indicate to be more inspired and inclined to act within the specific focus field of the Lab.

From the evaluation of Lab 6 it can be concluded that the collection of participants from different backgrounds was inspiring and the setting of the Lab useful to create a network of actors. Notably, a condition that several respondents mentioned would increase their intention to act, was the focus on a concrete project to work on together. This is consistent with the findings from literature that people are stimulated more if results are actionable and directly applicable to their own situation and behaviour.

5.6 Evaluation with the hosting partners

5.6.1 Evaluation process

Interviews were taken with 5 hosting partners, two of which are municipalities and three of which are sustainability centres.

When asked what the benefits of the Lab had been for their organisation, almost all partners indicate that their lab has enabled them to get in contact with, and/or receive input on a specific subject from a different target group than they usually reach. By the two municipality partners, the input from the participants on the treated subject, the outcome from the labs, was appreciated and marked as useful for future policy development. Two of the knowledge centre partners indicated that the method was an interesting way of working, but did not see a direct useful application for the results of the labs. The third knowledge centre indicated that the Lab was a new way to get in contact with their target group and create a community.
Four out of five partners answered that it was worth the effort to organize a lab because the outcome was interesting and unexpected. One of the municipalities indicated to want to use the method again for other topics.

All partners answered to have learned that diverse groups lead to more, creative and also different ideas to the question what they had learned from the Livinggreen Lab. Which part of the labs was considered most useful by the partners varied strongly for the different labs. This is partly due to the difference between the labs. A common denominator is that the most creative and interactive parts

were marked as being the most useful. Also the closing of Lab 6, in which social norms were used to stimulate willingness to act, because the participants were asked to make a public statement about their intention to act, was considered very useful.

When asked which of the other methods that they have used in their centre for knowledge transfer to the target group of home owners they consider most useful, personalized advice is regarded the most successful by all respondents. Exhibitions and guided tours are rated second most useful. After that the very direct knowledge transfer methods like lectures and information sheet.
The partners were asked to indicate in which way the methods used in the Livinggreen Lab differs from their own methods. Most partners indicated Livinggreen Labs are not aimed to give concrete personalized advice but are aimed at vision forming. One partner mentioned that they already use creative techniques, but in a different way so that it does address their goals as a sustainability centre. Another partner also stated that they use creativity techniques (encouraging interaction), but does see the Lab as a possible addition.

Every partner mentioned that the lab method would be most effective in situations that call for some form of idea and vision forming. When asked for additional observations regarding the Labs, almost all partners mention it to be a very interesting participatory technique. One partner also mentions the added value of the learning experience for the participants.

5.6.2 Summary of the results – evaluation with hosting partners

From these results we have learned that there is a difference in appreciation of the method by partners that are municipalities and that are not. Municipalities see benefits from this kind of feedback collection and are happy to be connected to students/laymen. The other partners thought it was an interesting way of working, but they could not directly apply the results of the labs because they don't have the means to do so.
In comparison to the other by the partners commonly used methods, the Lab method was marked as not very suited for knowledge transfer. For knowledge transfer methods like personalized advice, exhibitions and lectures are rated better. The Lab method was rated rather effective specifically for vision forming and as a very effective participatory technique.

6 Discussion

The execution and analysis of the evaluation leads to a number of interesting points for discussion.

For example, meta-analysis by Osbaldiston and Scott (2012) revealed that the choice of engagement methods should be proportional with the possible size of the effect, i.e., high effect actions in terms of behaviour change can justify high-effort engagement and low effort low effect, but any other combination seems to miss the mark. Obviously, since this was an experimental project in terms of testing methods, we would always need to take into account the learning curve that will take place for any future editions.

With this statement in mind, it is relevant to ask whether the effort to use the engagement method as described in this article, is a valuable addition to other methods to engage the audience. This question leads to an interestingly diffuse answer. On the one hand participants do value these creative and participative methods as (another) valuable tool to transfer knowledge. On the other hand the hosting partners see more value in its use as a method to involve people in developing a vision, i.e. stimulating environmental citizenship on a higher level than the one of direct personal benefit. It is however important to make a choice. A method that attempts to achieve all possible goals (knowledge transfer, active involvement, and creative contributions) is likely to achieve none and therefore extra effort will not lead to better results.

Based on these evaluations one can wonder whether it makes sense to relate both these effects to the same type of knowledge transfer. A distinction can be made between transfer through (existing) best practices or through emerging knowledge. The knowledge that is usually referred to as best practice information is the one that seems to be most valued by the hosting partners. The type of insights that refer to knowledge generated with the participants could be called emerging knowledge. The latter appears what the participants appreciated in the Livinggreen Labs.

In general, given the nature of the project some care needs to be taken in drawing strong conclusions from the evaluations. It is clear that all Labs had a host of variables: the contents (themes), the organising partners with their own focal points, goals to achieve with the Lab, strengths and corresponding methods, and finally the different techniques that were actually used in the individual labs. Because all these aspects varied per lab and no variable was really fixed, it is quite difficult to allocate specific results to any of these variables. This is supported by the fact that while all partners evaluated the lab in a positive way, they all had different reasons and arguments for this. Still, by combining the different evaluation results and observations, we can arrive at reasonable conclusions, as will become apparent in section 7.

The fact that a few different methods and techniques within these methods have been tested did serve a purpose, This can best be explained by returning to the research of Osbaldiston and Scott (2012). They suggest that for desired behaviour change to take effect a combination of engagement methods is required, including triggers on why, how and when to take actions as well as to include a form of "social modelling". It seems that a process where people discuss sustainability themes with peers and others,– as happens in the Livinggreen Labs -, these conditions (practical tips and getting insights in social norms) is then preferable. This result is in line with findings from Gardner and Stern (1996) and Heiskanen (2010) This provides an extra justification to try out different methods where such situations are created.

From the co-design principles we take that possibly through the *process* of co-design – independent of the exact contents and results - people become aware of their own behaviour and show willingness to change. This as well has been seen in the group dynamics in several Labs. This observation supports the literature on this topic.

Most of the participants in a Lab did not have a design background, except for about half of the participants in Lab 2. The design approach, most explicitly present in Lab 1 and 2, were regarded as a new way to deal with the topics of the Labs. This was considered refreshing and inspiring, which seems to set an example of the inclusion of designers in similar future editions.

During the development of the Lab-method, the focus on products and services as end result was let go, but became a vehicle for knowledge transfer and later for skill development. The interaction between participants in the Lab, in line with the findings by Nair et al. (2010), was far more influential. The work in groups of diverse participants was greatly appreciated by most participants and partners, amongst others for sharing knowledge and experience. Whether it has resulted actual changes to the participant's behaviour remains to be seen.

7 Conclusions

The following conclusions are supported by the research findings:

- While participants valued the (varying) concept of a Livinggreen Lab useful as knowledge transfer method, it seems to achieve higher added value when one wants to involve citizens in a process of idea or vision formulation. If this is not the purpose, the creative and participative techniques may only have limited added value, relative to the extra effort and specialised skills that it takes.

- The project results validate the assumption that in the area of contributing to *new* developments (as opposed to learning something known) participative and creative techniques have a natural advantage over more traditional push methods. These are also valuable, but more for the transfer of known knowledge. Most of the other methods that were used in the Livinggreen project focused on that, and for that purpose they were considered positive by participants, especially if the methods contained personalised aspects like one on one advice. To be able to compare the methods better it may be useful for future purposes to not place knowledge transfer opposite to idea and vision forming, but reposition the difference as *best practice knowledge* and *emerging knowledge* transfer respectively.

- Independent of the exact terms, it is an absolute must to inform participants accurately about the purpose of a session, especially in terms of their direct personal benefit. Having expectations regarding direct personal benefit (like 1 on 1 advice) while the purpose is actually more on a societal level (like vision formulation for local area development) or more general

skill development, will have a negative effect on the satisfaction and effectiveness of the setting as a whole and reflect badly on the techniques used.

- Possibly most importantly: while the use of participative techniques has been widely advocated before, this project used a design approach to this topic. The main results relevant for this design angle therefore seem to be twofold. Firstly, the extensive testing of different techniques from the design field and introducing the concept of involving participants from diverse backgrounds was new to many people attending the labs. Secondly, the observation that the (combinations of) techniques used in the labs created a new type of dynamics, where the results contained new insights that could be transferred to the actor who had the power to use these results. Diverse examples of this actor were a municipality (Energy), end-users with new skills (Heritage) or different local actors needing to work together as a network (Resilience). An important condition for this effect, i.e., an empowered actor using new insights for next steps, to take place is the presence of this actor during the lab.

With these conclusions in place, where does this leave us for next steps? We see the following areas for further development:

- to gain more insights into 'what works', it is necessary to 'fix some variables'. E.g., repeat the labs with the same organisation and vary the specific techniques, or fix the theme and techniques but vary the organising partner etc. When this is done in a structured and controlled way can stronger conclusions be drawn about the effectiveness of (combinations) techniques and situations where this effectiveness is maximised.

- Since this option would take considerable resources, another possibility for further exploration is to upscale the experiments: using a higher number of participants. I.e., repeat the same process with one or two enthusiastic organizing partners but using more groups of participants.

- In future research on knowledge and skill development, it is recommended to pull formulation of new ideas and visions into the realm of knowledge transfer by calling methods that are aimed to achieve this “emerging knowledge transfer” techniques or methods. In this way they can be more consciously assessed in comparison with other knowledge transfer methods.

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