PROJECT 'THE4BEES – TRANSNATIONAL HOLISTIC ECOSYSTEM 4 BETTER ENERGY EFFICIENCY THROUGH SOCIAL INNOVATION'

WORK PACKAGE NO. 2: AWARENESS RAISING ON ENERGY EFFICIENCY AND CARBON FOOTPRINT

KNOWLEDGE BASE ON EFFICIENT BEHAVIOURS

DELIVERABLE 2.2.1

FINAL

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THE4BEES PROJECT

THE4BEES builds on the hypothesis: Energy is consumed by people rather than by buildings. Although most of the strategies to achieve energy efficiency in buildings focus on technical mitigation measures, to reach the ambitious goals on Low Carbon set by EU and Alpine Strategy (EUSALP), both structural and soft approaches shall be considered complementarily across the Alpine Space.

THE4BEES focuses on the behavioural changes of users in public buildings needed to achieve reduction of energy consumption. Such changes will be originated by the use of innovative ICT applications developed by a transnational ecosystem. Those applications will be used by the target groups in the demonstration sites (schools, houses, factories) to encourage behavioural changes for energy efficiency and carbon footprint reduction.

PROJECT PARTNERS

THE4BEES brings together 14 partners representing regional public authorities, sectoral agencies, business support organisation, interest groups including NGOs and research institutes, from 6 European countries and involvement of 27 observers. It's a European project, from Interreg Alpine Space programme.

Partners:

- CSI-Piemonte (IT, project leader)
- Regione Piemonte (IT)
- Regione Lombardia (IT)
- CSP- INNOVAZIONE NELLE ICT (IT)
- CNR-IEIIT (IT)
- Aler Lombarda (IT)
- RSA - Research Studios Austria Forschungsgesellschaft mbH (AT)
- E-Zavod/E-institute Ptuj (SL)
- KSSENA-Zavod Energetska Agencija za Savinjsko (SL)
- HEIA Fribourg (CH)
- Association Hespul (FR)
- RAEE-Rhônalpénergie-Environnement (FR)
- BWCON (DE)
- IREES GmbH (DE)

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A • INTRODUCTION

The EU Interreg Alpine Space project THE4BEES aims at reducing greenhouse gas (GHG) emissions and energy consumption in buildings through more efficient behaviour. This should be reached by innovative awareness raising actions and through the support of ICT tools jointly designed by users, decision makers and actors of innovation.

THE4BEES builds on the hypothesis: Energy is consumed by people rather than by buildings.

However, most of the strategies to achieve energy efficiency in buildings focus on technical mitigation measures. In order to reach the ambitious goals on Low Carbon set by the EU and Alpine Strategy (AS), both structural and soft approaches shall be considered in a complementary way across the Alpine Space area. THE4BEES focuses on the behavioural changes of users in public and private buildings needed to achieve a reduction of energy consumption. In order to address the behaviour of the people intervention strategies have to be used. Innovative ICT applications are developed and used by the target groups in the demonstration sites:

- Students, teachers and facility managers in high schools in France, Austria, Slovenia and Italy
- Residents and facility managers of social housing in Italy
- Workers and facility managers in office buildings in Switzerland and Germany
- Students and other tourists as well as managers in alpine huts in Italy

Awareness is the basis of behavioural change, thus awareness raising is the core of the overall project concept. This work package has the objective to consolidate and grow knowledge on the relationships of behavioural changes, energy efficiency, carbon emissions and the benefit of ICT, consistently with Art.12 of the Energy Efficiency Directive.

In the first report, past and running projects whose results could be capitalized by THE4BEES were presented and analysed (Roser et al. 2016). Within this report the theoretical background of behavioural change and different types of interventions to increase energy efficiency and hence lower carbon emission are introduced. The results are summarized in recommendations for ICT development. In addition, the focus is on the four main target groups (students, private households, workers and tourists) and seven pilots, which are described and linked to the knowledge base. Households often are willing to behave in an energy efficient way, but concrete actions are not taken to the greatest extent possible. For organisations, often a ‘strategic’ decision has to be made by decisions-makers. In the end it is the behaviour of students, workers, tourists and residents that will create the impact.

A premise to change behaviour is that people have control over interior conditions, such as equipment for heating, cooling or lighting (Langevin et al. 2012); however, this option is not given regarding every energy using device in the pilots of the project. In addition, it has to be taken into account that the level of satisfaction might not meet the economic and/or energy performance levels (Keyvanfar et al. 2014).

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B • THEORETICAL BACKGROUND

Regarding behavioural change with respect to sustainable consumption, such as energy conservation, a variety of aspects has to be considered. Thus, as a basic introduction some definitions, terms and principles from a psychological perspective will be given.

Definitions

Definition of sustainable consumption. Sustainable consumption has various definitions. The 1995 Oslo Round Table on Sustainable Production and Consumption gave more clarity to the term and shows the complexity of the topic[1]: 'Sustainable consumption is an umbrella term that brings together a number of key issues, such as meeting needs, enhancing quality of life, improving efficiency, minimising waste, taking a lifecycle perspective and taking into account the equity dimension; integrating these component parts in the central question of how to provide the same or better services to meet the basic requirements of life and the aspiration of improvement, for both current and future generations, while continually reducing environmental damage and the risk to human health.' 'Another crucial aspect of sustainable development is its collective nature. Many problems relating to sustainability (...) are cumulative so that individual sustainable behaviours can contribute to sustainable development only if many people perform them.' (Hanss and Böhm 2010: 49). Findings show the importance of social aspects such as perceived collective efficacy.

Sustainable consumption aims at meeting the basic requirements of life for us and for those who will come after us. In order to reach this aim, actions are needed. Sustainable consumption can comprise different actions such as reflection of needs, information seeking, decision for investments or the use of appliances or resources (e.g. energy) as well as recycling (Homburg and Matthies 2010). Therefore, a single explanation model does not exist and single actions or behaviours have to be considered in their specific context, because several aspects of sustainability have to be taken into account.

Motivation. Motivation is a theoretical construct used in order to explain behaviour (see e. g. Schacter et al. 2016). It represents the reasons for people's actions, goals, norms, desires, beliefs, attitudes and needs. Motivation can also be defined as one's 'direction to behaviour' or what causes a person wanting to repeat a specific behaviour and vice versa. A motive is what prompts the person to act in a certain way, or at least to develop an inclination for specific behaviour such as energy conservation.

Extrinsic motivation and intrinsic motivation are two opposing ways to motivate people. Intrinsic motivation means, for example, that for an individual a specific behaviour is of high importance in terms of a personal norm. The motivation lies in the behaviour itself, it is experienced as interesting and enjoyable (Deci et al. 2017: 21). Based on extrinsic motivation in contrast, a specific behaviour (turn off the light) as such is separated from the goal (energy conservation) by external factors: 'Carrots (rewards or accolades) and sticks (punishment or threats) are the classic extrinsic motivations' (Deci and Ryan 2012: 88).

[1] http://www.iisd.ca/consume/oslo004.html

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Persons with high intrinsic motivation might feel corrupted by external incentives and the motivation might decrease. However, extrinsic motivated behaviour driven by financial incentives or awards may give the opportunity to make experiences with unknown actions or options for behaviour. By making good experiences and having good feelings with this new behaviour, the extrinsic motivation can turn into an intrinsic one. Hence, also extrinsic motivation can play a role in interventions. However, in contrast to intrinsic motivation, the extrinsic motivation often has only a short-term impact (Flury-Keubler and Gutscher 2001: 126).

Habits and routines. *Habits* can be described behavioural scripts that are learned by regularly repeating the same behaviour under the same circumstances (Klöckner and Matthies 2004). These circumstances can be seen as situational cues triggering the habitual behaviour. *Routines* are under control of habitual scripts and are conducted without being conscious of what is happening. They can be described as repeated everyday actions. Maréchal and Holzemer (2015: 229f) argue that habits are more than 'dead routines' as individuals are able 'to make judgement about the habits upon which he or she acts.'

Habits and routines, on the one hand, are useful in everyday-life to enable free capacities for other tasks that require attention; on the other hand, habits and routines are strongly anchored in the brain and linked to specific cues. Well known or well trained actions are also linked to good feelings and emotional aspects. These are, to some extent, resistant to unknown behaviour, which might come along with uncertainty or loss of comfort. Therefore, generating new behaviour is more likely to be successful than to change the old one. In particular, awareness is a precondition for changing behaviour. Activities of day-to-day life are often linked to the use of systems of provision (e.g. the heating system of a building) or technical appliances (e.g. the regulation device for room temperature), which facilitate organisation and routines of activities. Thus, these supply systems and devices define to a certain extent the maintenance and change of daily habits (Birzle-Harder et al. 2013: 12).

Rebound effect. Gains in energy efficiency that lead to less consumption are partially offset by the so called rebound effect. Very often a discrepancy between the decrease in energy consumption expected from technical efficiency improvements and the actual total energy consumption can be observed. A rebound effect is therefore defined as the increasing consumption of resources fostered by an increase of productivity in related fields (Santarius 2012). It can be differentiated as direct and indirect rebound effect. *Direct rebound effects* are linked to the same field of action. Azevedo et al. (2013) give the following example for a direct rebound effect: '... when consumers switch from incandescent light bulbs to compact fluorescents, they may leave their lights on for more hours than they did previously because of lower lighting operation costs' (p. 5). Indirect rebound effects are directed to other fields of action for example saving carbon emissions by switching off the light leads to higher water consumption for showering as savings from light 'excuse' longer showering.

From a psychological perspective the rebound effect is an often discussed issue regarding energy-related behaviour. To date, the rebound effect in the field of energy consumption is not sufficiently researched. Nevertheless, in intervention strategies possible rebound effects should be taken into account and should be based on multiple strategies which are applicable to minimize saving deficits, as pointed out by Friedrichsmeier and Matthies (2015). Intervention campaigns should foster intrinsic motivation as well as pro-environmental norms and attitudes.

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Spillover effects. On a general level, the spillover effect describes the process of a transfer in terms of activities or experiences, having an impact on other (non-related) contexts. Regarding energy-related behaviour, a positive spillover effect means that one pro-environmental behaviour leads to another. That might occur when energy efficient behaviour, as a result from an intervention in the office, is transferred to the energy-related behaviour at home.

However, studies show that the spillover effect is not self-evident (Thøgersen and Crompton 2009). Littleford et al. (2014) found no evidence for spillover effects between the settings (office and home) and explained this with different characteristics of these two settings. Behaviour is context-driven. Thus, Thøgersen (2012) points out that it is important to take into account the specific features of the target behaviours (e.g. different equipments involved). In order to support a positive spillover effect, Thøgersen (2012: 23) formulates several factors for higher chances of a spillover effect based on a literature review:

- Make clear the interrelationships between different pro-environmental behaviours
- Be clear about the environmental reasons for behaviour change
- Causal clarity: focus exclusively on the environmental benefits of a behaviour
- Spillover from pro-environmental behaviours, which have already reached a high degree of social normalisation

The extended Model of Normative Decision-Making

Knowledge about environmental issues does not lead necessarily to environmental friendly behaviour. Studies often show a variety of reasons for the gap between knowledge and action (Frederiks et al. 2015; Zainudin et al. 2017) and several models have been developed to explain human behaviour[2]. A widely recognised and tested model is the Model of Normative Decision-Making by Schwartz and Howard (Schwartz 1977; Schwartz and Howard 1981). The model was developed to explain pro-social behaviour but can be used to explain all kinds of so called altruistic behaviour[3]. As Klöckner and Matthies (2004) declare, pro-environmental behaviour could be seen as a kind of altruistic behaviour and so the Model of Normative Decision-Making with a focus on norms can be used as an explanation. Nevertheless they see some deficits and add situational cues and habits to the model as a powerful predictor of present behaviour (see Figure 1).

[2] For example: Theory of Reasoned Action by Fishbein and Ajzen(1980), Theory of Planned Behaviour by Aizen (1985), Rational Choice Theory or Attitude-Behaviior-Model by Fazio (1989)

[3] There is an ongoing discussion in research about what altruistic behaviour is and if such a behaviour really exists, but that would go to far.

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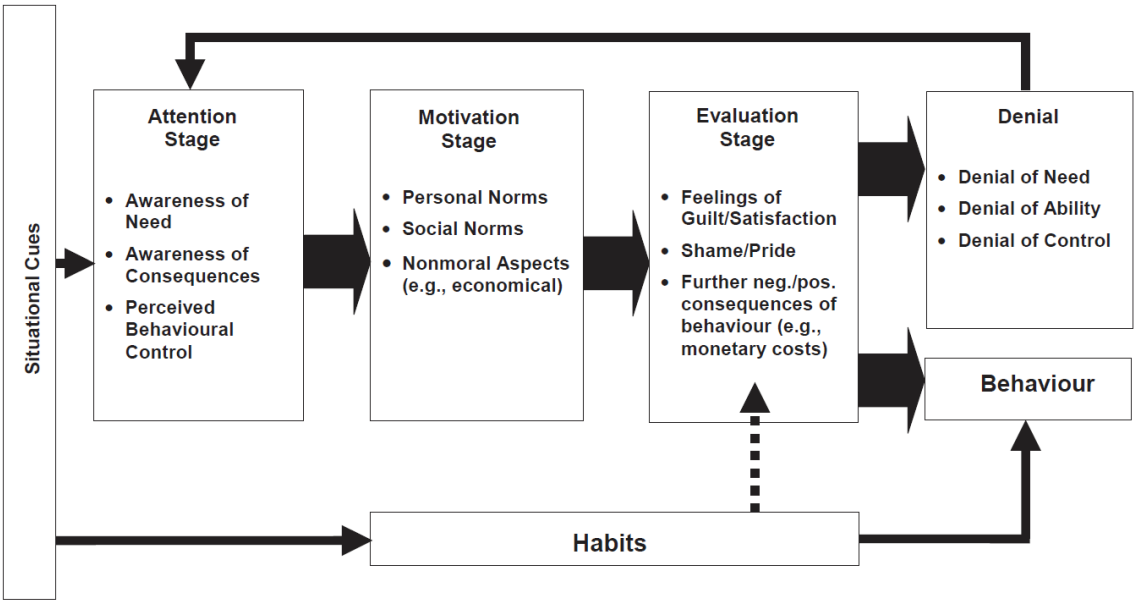

Figure 1: The extended model of normative decision making (Klöckner and Matthies 2004)

Detailed description of the model with the example of Peter

To explain the extended Model of Normative Decision-Making in detail, we look at the behaviour of Peter (see also Figure 2): Peter is sitting in his office and although the room temperature is 20°C, he freezes a bit. He now has two options: raising the room temperature or put on his sweater. In terms of THE4BEES mission to foster energy efficient behaviour, Peter should choose the second option. How would he get there?

As necessary preconditions, people have to be aware of need, of consequences and perceive the control of their behaviour (*attention stage*). All preconditions have to be answered positively before it comes to the next stage. In the example, Peter has to be aware that the environment needs protection and that the consequence of raising the temperature (use of energy, CO_2 emissions etc.) will harm the environment. Additionally, he has to be convinced that his action can help the environment. So he might think that wearing a sweater does not have an impact at all on the environment and therefore he will simply raise the temperature and not come to the next stage, which is the *motivation stage*. The motivation for a specific behaviour could be a social norm (everybody is wearing a sweater), the expectation of relevant others (his boss always talks about wearing a sweater in winter), an internalised social norm that has become a personal norm (I should wear a sweater when it is cold), or non-moral aspects (I can save money by not turning up the heat). When the motivation for a specific behaviour is clear, benefits and costs of possible alternative actions have to be evaluated (*evaluation stage*). Several aspects can play a role for the evaluation. These could be feelings of guilt or shame (to raise the temperature might be the easiest option, but will harm the environment), loss of time (he might have to go to another room to get his sweater) or further consequences (he might forget to lower the temperature when he leaves the office). If the evaluation leads to a clear decision, Peter will put on his sweater and everything is alright. If the evaluation makes Peter feel uncertain about the right decision, he will come to the fourth *stage of denial*. This means that the process begins again with the attention stage under new conditions. This could lead him to deny his responsibility for the protection of the environment or redefine the

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situation by denying the problem (denial of need), the consequences of his action (denial of ability), or his control over his actions (denial of control). In this case Peter will raise the room temperature.

For all these stages, *situational cues* are relevant. As mentioned, the sweater could be in a different room, Peter might have to stand up in order to raise the temperature, or colleagues are sitting together with him in the room etc.. According to Klöckner and Matthies (2004), *habit* is another important aspect. Especially in contexts with highly repeated activities of daily life, people develop stable patterns of behaviour. If Peter is always simply has raised the room temperature when it was cold, without even thinking about alternative actions, he will behave without going through any of the stages. Situational cues play a crucial role to determine the process. For example, the more people in the room are affected by an increase in temperature, the more Peter will think about an action that only affects him and puts on his sweater. The assumption that the decision *not* to behave in accordance with one's normal activities may lead to defence mechanisms and again to the denial stage, which itself could lead to start with the *attention stage* of decision making.

Figure 2: The extended Model of Normative Decision-Making and the example of Peter (©H.Bories)

Of course, a person is not aware of these stages of decision making. But, when we have knowledge about these stages we can think about several approaches for interventions. The model is also applicable to identify constraints and possible risks of implementing intervention measures.

Interventions

Interventions. Intervention or stimuli 'shape the individual's action possibilities or have an influence on the effects of any actions performed' (Flury-Keubler and Gutscher 2001: 113). In the context of THE4BEES, an intervention is a measure that aims to change energy related behaviour.

There are several kinds of interventions that are described in detail below. They can be categorized as 1) direct (real-time or nearly real-time) vs. indirect (delayed) feedback (Darby 2006) or 2) opt-in (deciding to take part in a programme, e. g. online) vs. opt-out (not actively decide to take part, e.g. monthly reports of energy consumption sent to customers from the energy supplier) feedback programs (Carroll et al. 2009).

Psychological background and principles

'Human needs or goals cannot be influenced at will.' (Flury-Keubler and Gutscher 2001: 111). High-level goals - such as eating, drinking, and surviving - are determined predominantly by universal biological necessities. Lower level goals, such as to eat at a specific restaurant or to regulate the room temperature in a certain range, are triggered more individually and can therefore be influenced all the more by others (ibid).

Looking at 'pro-environmental behaviour', people are mostly dominated by non-environmental motives in their everyday life (e.g. buying food, travelling, spending free time in a pleasant way), but their behaviour has got an impact on the environment. An important goal of interventions is therefore to motivate them to 'incorporate pro-environmental motives into their personal set of everyday motives' (Flury-Keubler and Gutscher 2001: 114). There is a tendency in humans to have pleasant experiences and to avoid unpleasant ones. This has to be considered when planning interventions.

Approaches for interventions

There are various ways to influence people's behaviour. Having the extended Model of Normative Decision Making (Klöckner and Matthies 2004) in mind, interventions can address each stage as well as the 'habit route'.

Attention stage (awareness of need and awareness of consequences): A first approach for a strategy to motivate somebody to change his or her behaviour is to give him *background information* (e.g. reasons why a change of behaviour might be meaningful), *information about possible actions* (hints and tips) or *feedback information* about energy consumption and related parameters (Kastner and Matthies 2014; Langevin et al. 2012). In most cases a deficit of knowledge about energy efficient and pro-environmental behaviour can be found (Karlin et al. 2015; Selvefors 2014). There are several strategies for intervening in behaviour with information (Mack 2007: 58–68). Various examples of concrete information-based intervention programmes can also be found in the project list linked to THE4BEES (Roser et al. 2016). Of course, mere information strategies do not change behaviour as other factors like routines, norms or perceived control of behaviour influence behavioural change as well. This is why information should be combined with other intervention strategies (Kastner and Matthies 2014).

Motivation stage: Another approach is to 'build bridges', which means that the environment is transformed in order to make a certain behaviour more suitable to achieve a certain goal or allowing to make new experiences. In contrast, interventions that make a certain behaviour less suitable for achieving goals are 'barrier building' interventions. As we know that peoples' tendency is to make

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good experiences, barrier building interventions might lead to negative feelings and might lead to bad evaluation of a behavioural option and therefore ineffective or even negative consequences of an intervention. It also has to be pointed out that without motivation to conserve energy, information about how to do it and how well one performs is useless (Fischer 2007). Behaviour can also be changed by requesting people to behave in a certain way. In order to being successful, requesting actions should be based on a polite or casual style instead of combining it with the threat of punishment. Flury-Keubler and Gutscher (2001) differentiate between action appeals with and without arguments. They point out: 'Action appeals without arguments are only effective if they can activate a motive that the addressee already has.' (p. 120). When arguments are given with a certain appeal, new information such as scientific findings regarding energy consumption or air pollution are supposed to result in the agreement of the addressee and might consequently lead to behavioural change.

Evaluation stage: As we know that peoples' tendency is to make good experiences, the above named barrier building interventions might lead to negative feelings and might lead to a bad evaluation of behaviour and therefore ineffective or even negative consequences of an intervention. Some research results indicate that the perceived risk of losing money is stronger than the expectation of gaining money through behavioural change (Kahneman and Tversky 1979). This means that the protection of financial disadvantages should be clearly communicated.

Even successful interventions tend to show a decrease of these effects over time. Thus, interventions and campaigns should be repeated in order to *stabilise the desired effects*. Participation processes in terms of involving the target group of a specific intervention, are appropriate to foster positive effects. More and more intervention projects design intervention strategies in co-creating processes directly with the users themselves as it is done in THE4BEES as well (Fell and King 2012; Lockton et al. 2013).

In addition to these pre-conditions, it is important *to tailor the interventions to different groups* of *people* according to their habit strength, knowledge background, intention and environmental constraints (Abrahamse et al. 2007; Klöckner and Matthies 2004; Maréchal and Holzemer 2015; Mourik et al. 2015).

Research design and measurement of interventions

Assessing the effect of interventions aimed at energy related behaviour change is a difficult topic. Karlin and colleagues (2015) found evidences in the literature that there is no standard way of collecting intervention data. There are so many influencing factors on energy consumption that it is difficult to find out if the triggered behaviour change of one single person may or may not have led to observed kWh changes. In most cases, a change of behaviour is measured indirectly (through outputs as energy savings) or by subjectively reported behaviour through interviews or questionnaires (Mourik et al. 2015). Especially long-term effects of behaviour change are hardly measured (Gulbinas et al. 2014: 1077). However, missing reliable information about the impact of energy consumption does not necessarily determine the (in)effectiveness of interventions.

Regarding the measurement of interventions, a pre-post-design would be desirable (see Figure 3), but is often not possible because of the lack of control groups, the lack of sufficient resources or the lack of options for pre-test measures (Abrahamse 2016).

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	Time →		
	Pre-test measure of energy use		Post-test measure of energy use
Intervention group	No intervention	Information	No intervention

Figure 3: Example of a (hypothetical) pre-test-post-test non-experimental design to measure the effect of information to encourage energy conservation (Flury-Keubler and Gutscher 2001)

Thus, in the THE4BEES project a non-experimental design with only post-test-measures is chosen as an approach. However, some disadvantages have to be mentioned: it will be difficult to identify the influence of confounding variables that might affect the effectiveness of the intervention and to draw reliable conclusions.

C • DIFFERENT TYPES OF INTERVENTIONS

Research strongly recommends to use **a mix of several intervention types** in order to overcome barriers of changing behaviour and to repeat interventions several times in order to achieve long-term impact (Fischer 2007; Lewis et al. 2012; Mack 2007; Maréchal and Holzemer 2015; Nies et al. 2015, 2015). Especially the combination of **energy usage feedback with advice** how to adjust routines over a minimum period of three months is necessary for the persistence of savings (Carroll et al. 2009; Darby 2006). In contrast, programmes which include **reward incentives** in order to achieve energy savings (extrinsic motivation) lead to short-term behavioural changes that revert as soon as the reward is taken away (Carroll et al. 2009: 35). Another way to combine measures is to integrate environmental interventions into interventions regarding other topics such as integrating information about energy savings in flyers for migrants, for example. When energy consumption is the issue, it could also be linked to information on energy production at local level.

The use of **media**, e.g. photography, music or video, can be used to present specific parts of the environment to people, in order to trigger emotions in the target individuals of an intervention. Especially **storytelling** can benefit from supportive images or sounds. **Apps** as situational cues in the field of energy consumption fulfil different functions. They are appropriate to raise awareness and to initialise the change of behaviour, e.g. by visualisation or giving information about the behaviour of others (role models). Additional functions, such as a weather forecast, could also make informative ICT tools more attractive (The S3C Consortium 2012-2016).

In regards to energy consumption, one has to bear in mind that it is not just ‘one behaviour’ that has to be changed. Instead, it concerns a set of **different behaviours in different contexts** that are influenced by seasonal conditions as for example in winter more light is needed than in summer (Karlin et al. 2015).

To be considered for all kind of interventions

According to research (D’Oca et al. 2014; Jacucci et al. 2009; Karlin et al. 2015; Mack 2007; Maréchal and Holzemer 2015; Nies et al. 2015) for all kind of information based intervention it has to be considered that:

- Present information as tailor-made, accordingly designed, personally, easily understandable, lively and colourful as possible according to the habit strength, knowledge background, intention and environmental constraints of the target group.
- The intervention should be linked to daily life and adapt information to the reference frame of the target group. For example feedback effects differ between target groups.
- Information should be linked to the addressed behaviour: e.g. prompts at the switch instead of elaborated manuals.
- The impact of current behaviour needs to be explained and the advantage of behavioural change has to be visible and plausible (e.g. depict the water consumption of a five minute shower compared to a ten minute shower).
- Possible actions should be directly realisable with moderate effort (e.g. switch off the light when leaving the room).
- Face-to-face information is more effective than (impersonal) flyers and posters. However, less people can be reached by face-to-face propaganda. A combination of both types of information might be meaningful (e.g. in schools, energy saving topics should be discussed

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during lessons and supported by posters; in social housing, on-site visits in the flats can be supported by flyers).
- Do not provide too much information on different appliances. Otherwise, this might lead to an overload and drop-outs.

In the following, different intervention strategies are described in more detail in the context of digital intervention strategies: feedback in general, hints and tips, additional information, unusual usage alert, comparison and competition, gamification, storytelling and financial incentives. In THE4BEES project a dashboard for energy managers and a web app for users were developed in order to intervene in energy relevant behaviour, considering some of the following aspects. The greyish textboxes give praxis examples from the seven pilots of THE4BEES project. The information was mainly collected during co-creation workshops.

Feedback

Feedback is used to inform about consequences of energy related behaviour (see attention stage), for example regarding energy consumption or duration of lighting hours. It bridges the gap between abstract energy related behaviour and its consequences. Information about past or present energy use is intended to influence behaviour in the present or the future. Research does not show clear results of feedback intervention, since effects cannot be analysed separately from other contextual factors (Faruqui and Sergici 2010).

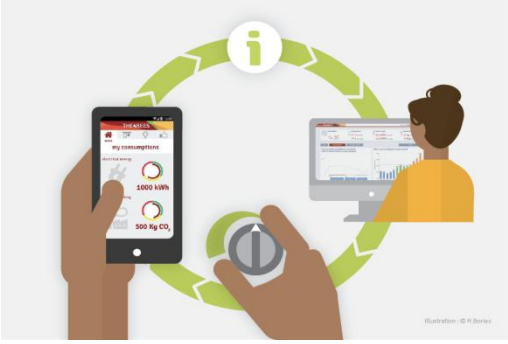

Figure 4: Feedback via app and dashboard (©H.Bories)

Feedback can also be used for predictions of future consumption (Lewis et al. 2012), which could itself be used for competitions or challenges. As interest in feedback usually wanes over time, it is an important issue to remind and motivate people to stay involved through ongoing messaging (Carroll et al. 2009: 30; Maréchal and Holzemer 2015).

In THE4BEES project feedback was integrated in a web app for users that gives for example feedback about energy consumption in a classroom or office and users can rate comfort level. In addition a dashboard was developed and mostly targeted for energy managers with more detailed measurements within a building (see Figure 4). Data for the feedback is collected via sensors.

From the pilots:

Social Housing: Almost all tenants in the Italian pilot have been given access to the dashboard to check data on energy comfort (especially temperature) and energy consumption in their flats. In households the measure points should at least be in the most used rooms (living rooms and kids bedrooms). A very simple presentation of high or low energy consumption with a red or green light was very much appreciated by the tenants. The use of the tenants' WIFI systems, instead of a dedicated project internet connection, has turned out to be causing some problems to the gathering of data as WIFI are sometimes switched off and in those case the monitoring systems (HALADIN) stop to send data to the platform for cyclic periods.

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Workplace: The most energy consumers in the German pilot are electric devices, lighting and heating. The sensors installed for the pilot provide measuring data about energy usage. The dashboards of the smart data platform visualize these measured sensor data. Feedback is important to improve applicableness of such IT tools. Positive feedbacks could also help users considering their behaviour changes. Employees in the French pilot expressed their wish to implement a meter with a common interface in each office, ideally located next to the office door (visible when users leave the room), a personal dashboard and a mobile application. Finally, only the common office dashboard was selected. It is less intrusive than a mobile app and more favourable to exchanges between users. It seemed more effective in generating group effects (common decisions to implement significant changes). Preferred content would be for example: weekly energy consumption of the office, weekly average energy consumption of the office and of the best office in the building. All three values should be shown on a targeted energy consumption range. Feedback should be provided weekly on the electrical consumption of lights and electrical appliances (separately) taking into account user attendance. User presence could be estimated by the number of office computers connected to the network. This test showed that user presence is well correlated with office power consumption. This is explained by the type of user activities (mainly computer work). For reasons of anonymity, the monitoring of personal computer connections has been abandoned. In order to show impact of standby energy consumption, average energy consumption for the office overnight could be shown. It was also pointed out by the employees that a user's guide must be accessible and known to users. They must be encouraged to use provided interfaces and therefore informed about their use. Therefore, for this target group very detailed information and various preference settings might be important.

Schools: The three most mentioned consumers in the three school pilots were computer & electric devices, heating and lighting. Feedback should be complemented by hints and tips and additional information. It was discussed, that smart tools and sensors would support better energy behaviours by providing quantitative measuring data and, most importantly, information and guidance through notifications and advise on behavioural options. Students also stressed that positive feedback is very important if they achieve consistently better results. From the Slovenian pilot experience, the feedback functionality is an essential part of addressing energy users and should be expanded within future project activities. It was clearly demonstrated that further personalization of applied IT tools that would be tailored to the individual and would learn from their past behaviour (login, UI customization, customized level of thermal comforts, etc.) would be necessary to improve their ability to engage and impact behaviour on the level of final consumers.

Huts: As students hosted in Chalet della Luna spent only a short time in the hut (dinner, evening and breakfast) they don’t care much about feedback information about their consumption. Most of them did not pay attention to the set point of the radiators and kept high indoor temperature without worrying about the opening of the windows. Also the number of accesses to the mobile app, they were invited to do to verify the temperature of the room, was very low.

Hints and Tips

Giving information about environmental friendly behaviour is not enough; hints have to be given at the very location of an action in order to raise awareness and showing alternative behaviour options. A simple three-step of (1) information - (2) knowledge - (3) appropriate behaviour usually only works in situations where danger must be averted (Hanss and Böhm 2010; Hanss et al. 2016). As mentioned before, it is important to combine feedback and other information with hints and tips on how to change behaviour in order to facilitate action (Karlin et al. 2015). The user needs to

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understand which options for action he has and how to use its appliances in a responsible way. In addition, knowledge-building hints and tips help to raise awareness about ones behaviour (Björkskog et al. 2010; Gamberini et al. 2009: 4; Jacucci et al. 2009; Mack 2007).

In order to tailor hints and tips to the needs of users, it can be directly linked to feedback. For example, if the energy consumption of lighting is higher than usual, a tip about switching off the light when leaving the room can appear on a display. Also the consumers capacities and constraints, as for example time and budget constraints or material environment, have to be taken into consideration (Maréchal and Holzemer 2015: 236).

The time of the day at which a tip or advice pops up on a display should also be taken into consideration (Lewis et al. 2012: 29). For example, it may be more meaningful to provide tips such as ‘switch of the light when it is bright’ in the middle of the day and ‘turn off your computer, do not leave it in standby mode’ at the end of the day.

Hints and tips can be supplemented by a quiz to test the knowledge. When knowledge gaps are detected, tips and hints can be presented to fill the gap. In this way, hints and tips are also tailored to the needs of the user (Gamberini et al. 2009).

In THE4BEES project hints and tips are integrated in the web app on a dedicated section. Several hints and tips are presented with relevance for the specific pilot (see examples in Figure 5).

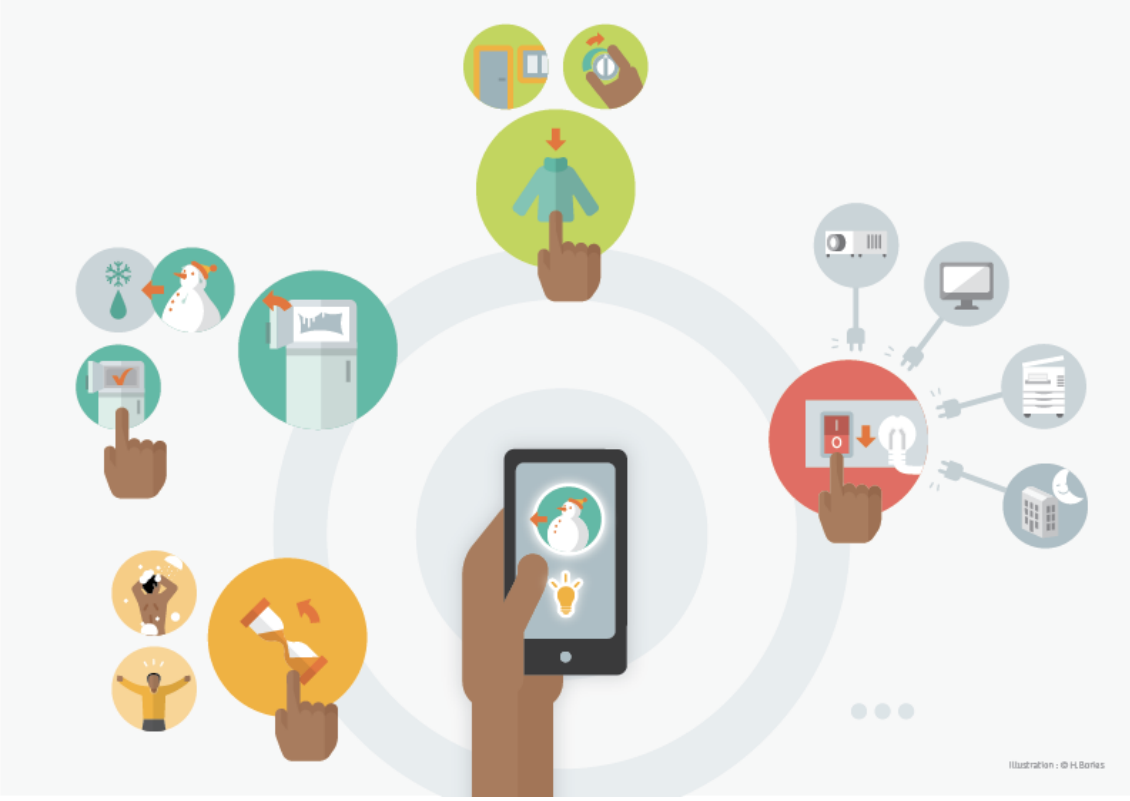

Figure 5: Examples of Hints and Tips in the app (©H.Bories)

Tips and hints are very useful for ICT tools but also for flyers and stickers that can be put directly on the appliance (see Figure 6). For example, a sticker on the freezer might tell you not to leave the door open.

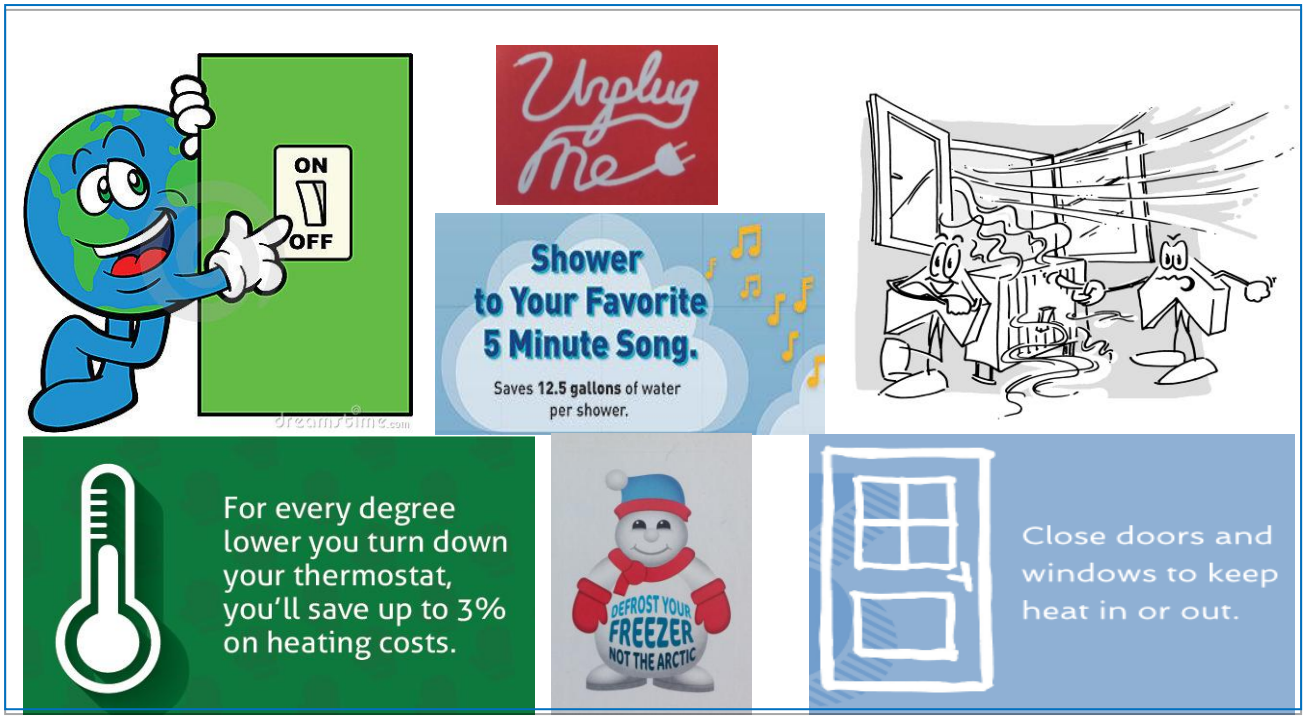

Figure 6: Examples for hints and tips stickers (sources see under References below)

From the pilots:

Hints and tips were discussed in every pilot within several sessions:

Social Housing: The residents were interested in learning to read an energy bill and in learning behaviours to better use their heating system, water heaters and electrical appliances. The intention to take part in the project was described as the expectation to gather information on how to affect their energy consumption with consequent economic savings.

Workplaces: The wish in the French pilot is to get hints and tips to reduce energy consumption on an office interface, a personal dashboard or/and a mobile app was expressed. These tips should be focused on light and electrical appliances (turn off when not in use). Examples were phrased: 'Think about adjusting the intensity level of the light.' / 'Consider turning off your computer in case of extended break (one hour or more).' In addition improvement opportunities for temperature regulation were expressed: 'Open the windows only to ventilate and not to regulate the temperature.' / 'In winter, wear a sweater to work and reduce the set point temperature by -1 ° C.' It was also mentioned that people need to be educated how building automation, settings and users interaction possibilities with the building is working. Also in the German pilot the employees think that more information and guidance should be provided for citizens about what are energy efficient behaviours.

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Schools: Information was seen as a crucial factor both in Italy and Slovenia. Students identified a lack of knowledge about energy waste and of possible solutions among the most important causes of inefficient energy behaviours by users. To inform people about the consequences of their behaviour was assumed by students as a way to change it. Here information about (induced) costs and potential savings were guessed to be more effective than 'general' recalls to 'more environmental friendly' behaviour. The students also highlighted the importance to inform people early, from childhood on. Another group pointed out to provide suggestions on actions that could be undertaken to improve the current state within an ICT tool. Hints and Tips introduced to the final consumers/target groups would also benefit from a personalized user experience, as it is increasingly difficult to define a set of hints and tips that would be relevant to a varying group of individuals. Providing a hint or tip that is irrelevant, off-topic and random can have a reverse effect on the consumers behaviour.

Huts: Hints and tips identified in Chalet della Luna Hut were: 1. Heating and Cooling in Winter: If the indoor temperature is above 20°C, lower the set point of the thermostatic valves of the room radiators and close the windows. Keep the windows open for no more than 5 minutes. 2. Lighting: Before leaving the room, check that the windows are closed and the lights off. 3. Shower/Bath: Take short showers, as long as your favourite song. One minute shorter duration corresponds to an energy savings of 0.5 kWh.

Additional Information

Another kind of information that can trigger energy conservation is the information about an impact on the environment. The premise for such an intervention strategy is that people have an activated norm for the necessity of environmental protection (Mack 2007: 58). If the awareness of need is given, but knowledge about positive or negative impact of actions is missing, this kind of information can fill the gap. The next step is the user's recognition that it is his or her responsibility to take action to protect the environment (Klöckner and Matthies 2004). Glaas et al. (2015) recommend to highlight the anticipated impacts of climate change on a local level and in the relatively near future and relate them to experienced weather-related risks. A study review of Karlin and colleagues (2015) shows that the effect of environmental information in combination with cost or energy measurements is not significant.

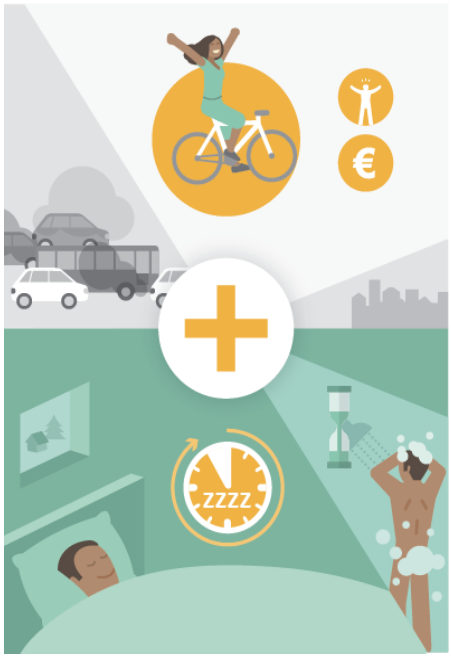

Figure 7: Additional information: co-benefits (©H.Bories)

A new approach of providing information is to present co-benefits of energy saving behaviour. In some cases, motivation of energy saving behaviour can go beyond saving energy. For example, when costs can be saved, health can be preserved, quality of life can be improved or daily patterns can be simplified (see Figure 7). It depends on the target group which co-benefits are relevant (Nies et al. 2015). For example, cost savings may be an important motive for low-income households; independence through cycling instead of going by bus may be an important motive for students; not to get up early for a long shower may be an important motive for mountain hut

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tourists.

In THE4BEES project it was decided not to integrate additional information as this would lead to high comlpexity.

From the pilots:

Workplace: An uncertainty regarding energy efficient behaviour and the circle of consequences was expressed in the French pilot which might have an impact on purchasing decisions. A maximum of for example temperature regarding health could be a motivator to keep temperature down. A focus more on preserving resources than on saving energy is perceived as a more positive frame. The employee in the German pilot agree that energy saving combined with expenses could provide a better impression about necessity of energy saving and behaviour change. For example saved 100 Euro can be understood by people much better than saved 1000 kw.

Schools: Students were interested in additional information about ecology (better conditions of life on the planet, respect for environment) and co-benefits of savings (fewer expenses, less taxes, more resources for other things). It was assumed that to inform people about the consequences of their behaviour may work to change them. Opposite to the workplace working group students discussed specific information about saved costs would be more effective than general messages about environmental impact. Visualization of complex data is key to convey the message to the students, particularly in the form of demonstrations and infographics. In the Slovenian pilot health issues regarding radon in classrooms might be interesting due to its regional characteristics.

Unusual Usage Alerts

It is exhausting to integrate new behaviour into everyday life and people have to be constantly reminded of it in the first phase (Birzle-Harder et al. 2013: 10). For this reason, alerts or notifications as a pop-up in a dashboard or an app can be helpful in order to detect critical deviations in energy consumption. Breaking with daily routines and habits should irritate the user and raise awareness of his behaviour: unconscious behaviour will be changed to conscious behaviour. Alerts make a change in behaviour more probable, provided that the user knows how to change (see hints and tips) and at a time when there is still time to do something about it (Lewis et al. 2012).

Unusual usage alerts need to be transparent about what they relate to. Figure 8 shows an example with the information that is needed for the user to assess the relevance of the alert without being too schoolmasterly:

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Figure 8: Example of an unusual usage alert

An argument against unusual usage alerts is that they do not support the 'design for pleasure', which focuses on positive emotions and experiences (Burmester et al. 2014: 10). Another argument against alerts is that consumers do not want to be controlled without permission (Lewis et al. 2012). Unusual usage alerts could possibly give them the feeling of being watched. Therefore, when alerts are provided the user should have the possibility to opt-out, that is to switch off the alert function. When alerts pop up, it is also important that users understand the relationship between their behaviour and its impact. For this reason, it would also make sense to provide background information. The third argument against alerts is that consumers could rely on them and will no longer think for themselves in the future. Alerts may lead people not to think for themselves and not to interpret graphs and other information themselves. In this case, alerts inhibit long-term effects of the intervention (Lewis et al. 2012). Good habits should be encouraged instead of discouraging bad ones.

In THE4BEES project it was decided not to integrate unusual usage alerts as this would lead to high comlpexity.

From the pilots:

Social Housing: Most of the tenants in the Italian pilot have expressed their interest in receiving sms that can notify them when some parameters are above a certain threshold (e.g. temperature; windows opening; appliances consumption). Only one of them has given a negative feedback on the opportunity to use such an alerting system, which he considers too invasive.

Workplace: Ideas in the French pilot were: Display a 'pop-up' notification at the interface located next to the door each time someone opens it to remind to turn off the lights and electrical appliances. Display on the office interface the CO_2 rate in terms of thresholds to warn the user when he has to open the windows to ventilate. If possible, allow users to turn off cooling in the summer to work with the window open. Do not forget to shut down alerts (notifications) if this is the case. German pilot participants think that some unusual cases could be alerted by IT tools. Accompanying guidance should also be provided about how people should behave and which activities should be undertaken in these unusual cases. Pop-up notifications were used at the beginning of the experiment to inform users when the recommended CO_2 limit was exceeded. To avoid spam on the dashboard and considering the CO_2 index sufficiently explicit, these notifications were abandoned during the experiment.

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Schools: It was said that notifications on inconsistencies in data measuring is very important. In this case ICT tools should provide feedback and suggestions on actions that could be undertaken to improve the current state (guidance and advice). An approach similar to workout or learning applications would be welcomed (such as 30 day workout program, Endomondo, Duolingo, etc.), whereby the user is confronted with challenges and alerts that are designed to produce internal motivation and action. The applications should also allow the comparison between the present and past performance in order to quantify and stress the improvement an individual was able to achieve.

Comparison and Competition

Our behaviour is strongly influenced by others (see e. g. Bandura 1985) - by their experiences, attitudes and goals. Especially when observing the behaviour of others in specific contexts, we can draw conclusions about how they achieve their goals. This also applies to desirable behaviour such as energy saving.

Several studies of interventions for behavioural change came to the conclusion that it is not enough to provide individual feedback about current consumption (Delmas and Lessem 2014; Karlin et al. 2015). End users would like to have a benchmark in order to evaluate how well they do. A comparison of consumption gives people the information they need to classify their consumption and relate it to other consumers (Fischer 2007; Maréchal and Holzemer 2015). Comparison can serve as a motivation and stimulate competition as long as it is accepted and appreciated individually (Karlin et al. 2015). There are different possibilities to compare consumption (see Figure 9):

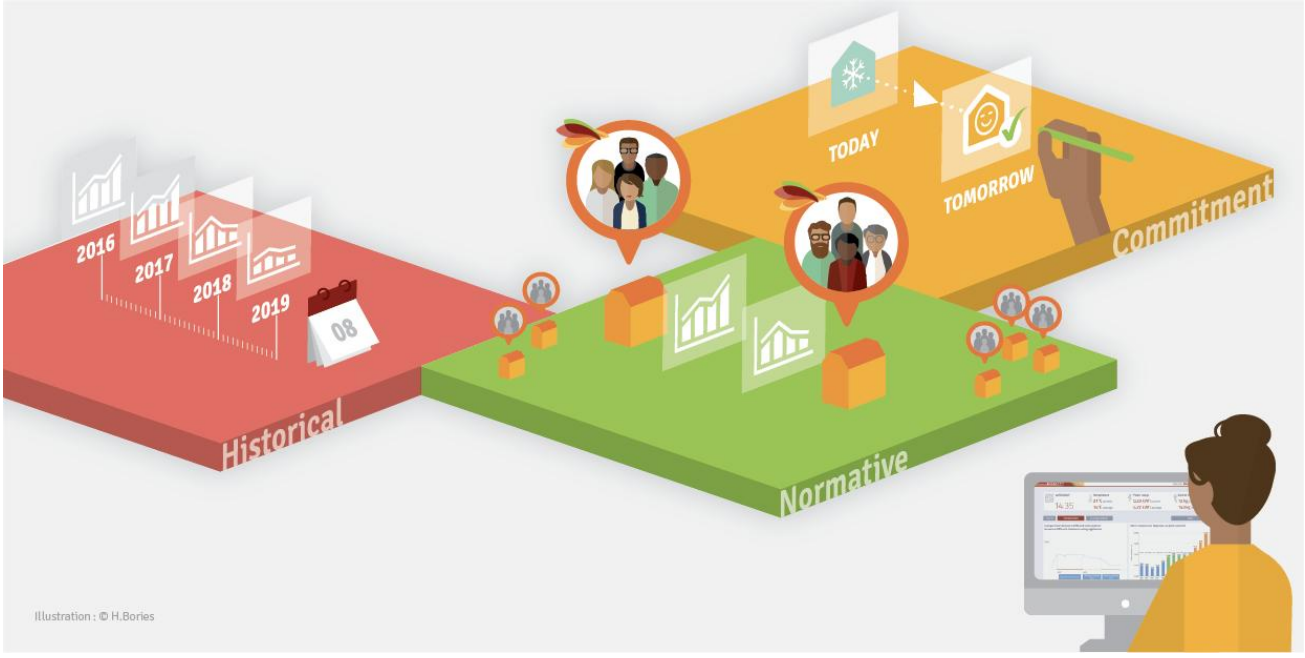

Figure 9: Different possibilities to compare consumption (©H.Bories)

First, current consumption can be compared to *historical consumption*. That is either the actual consumption related to the consumption of prior periods or to the consumption in the same period one year ago. If the same period is considered, the consumption has to be temperature-adjusted (Fischer 2007). Usually, graphs are used that show the consumption of several periods side by side. Research indicates that a historical comparison of the own consumption is more effective than a comparison with other households or defined targets (Darby 2006; Gamberini et al. 2009: 4; Jacucci et al. 2009: 268; Jain et al. 2013b). A historical comparison can effectively motivate energy efficient behaviour, as it provides a personal norm and benchmark to assess consumption (Karlin et al. 2015).

Second, current consumption can be compared to the consumption of a comparable group of consumers. This comparison is based on the premise that a user is influenced by actions of others in his or her social network. This is also called *normative comparison*, as the consumption of our peers is seen as the 'norm' that should be achieved (Jain et al. 2013a; Jain et al. 2013b; Maréchal and Holzemer 2015). The important thing here is that the reference group has to be comparable. That means, the consumption patterns should be as similar as possible and the consumption to which the comparison relates should also be as similar as possible (same time, same reference appliances, same numbers of users, same context etc.). For this reason, the type of normative comparison has to be made visible and people need to have the perception that the condition of the comparison is relevant (Gamberini et al. 2009). Some studies have shown that the simple comparison of household consumption with average household consumption (same number of people) is more effective than the opportunity to save costs or protect the environment (Carroll et al. 2009). Carroll and colleagues (2009: 29) also found out that a minority found it unacceptable to be judged against their neighbours.

Normative comparison can be made visible just for private purposes or it can be made public. Public information can be a motivator for people (Delmas and Lessem 2014), but it is a sensitive topic in regards to data privacy. There is also a risk in normative feedback, when we consume less than our peers. In this case, the signal is that we do not have to change, we even may consume more and still stay in the norm (Carroll et al. 2009; Fischer 2007). Nies et al. (2015) show that this kind of normative comparison has a particular influence on the energy consumption of low income households. Normative comparison is a kind of silent competition, as consumers are generally competitive (Lewis et al. 2012). But competition can also be made public, for example when the household with the best energy savings after three months is rewarded. Research shows ambiguous results regarding the effectiveness of normative comparison: some find it to be very effective compared to other interventions (Gulbinas and Taylor 2014; Jain et al. 2013a), while other studies found that social comparison is not effective at all (Fischer 2007; Karlin et al. 2015).

Third, current consumption or saved energy can be compared to a defined target value to which consumers have committed themselves in advance to reach ('*commitment comparison*'). Personal commitments can be an effective means to drive long-term behavioural changes, especially for people with weak norms (Ayres et al. 2009; Black et al. 2009; Carroll et al. 2009; Ehrhardt-Martinez 2010; Klöckner and Matthies 2004). It is recommended to ask consumers specifically to set a personal objective, but goal setting is also effective if people silently decide to use less energy until a certain date (Lewis et al. 2012). The goal can be related to a specific action (e.g. turn off the light when leaving the room), to a self-salient outcome (e.g. improving one's personal carbon footprint) or to a goal in between (e.g. improve the energy efficiency of a room). Feedback about progress towards that goal can trigger behavioural change. Karlin et al. (2015) also found that this kind of comparison strategy is most effective.

In THE4BEES project historical comparison of the own consumption is provided on the app as well as on the dashboard. The historical reference (weekly, monthly etc.) varies from pilot to pilot.

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From the pilots:

Households: In the Slovenian school pilot it was discussed that for households, the information that motivated energy consumers the most might not the amount of money they were wasting with unnecessary energy use, but the fact that they were consuming more (having a bigger impact on the environment, in essence doing worse from a sustainable perspective) than their neighbours.

Workplaces: Employees in the French pilot expressed their wish that a consumption target to be reached is displayed. In addition a comparison and ranking with between offices is seen as a motivation to reduce consumption. The different dashboard provided a appreciated in the German pilot as people can exchange experiences. They can see how other people have done the same activity. It is a chance to learn from each other.

Schools: Students pointed out that comparisons are an important part and that at least hourly comparisons are necessary. But the teachers of at least four schools did not want to integrate a competition into the ICT tool. It was suggested, that the simulation of what can be achieved if specific suggested measures are undertaken can be one of the features. Users can then apply those measures and try to achieve these simulated goals. Comparison and competition in general are great ways to engage and motivate students (users in general) in energy virtuous behaviour. The issue remains to secure good comparability of data and clear rules that unify the efforts and activities of each participant, which is very difficult in the field of energy use. A good way forward would be to organize such competitions in the form of training “boot camps”, where participants would be able to demonstrate their knowledge/behaviour in a comparable setting.

Huts: The behaviour of the occupants of different rooms in Chalet della Luna have been estimated from the monitored environmental data and compared in order to select the room whose occupants revealed the best a-priori behaviour in terms of energy efficiency.

Gamification

Within the intervention strategy ‘gamification’, all other intervention strategies described can be integrated. Serious games are a very effective way to both change habits and educate users in a playful manner (Orland et al. 2014). ‘Gamification is the usage of game mechanics and game thinking in serious contexts. [...] Using prepared and predefined rules and goals, gamification approaches produce results within a game which are connected to a real world outcome.’ (The S3C Consortium 2012-2016, Guideline Gamification). Huber and Hilty (2015) defined four requirements for a good gamification-based approach: 1) respecting consumers as individuals, 2) respecting the consumers’ autonomy, 3) introducing social level and 4) enabling collective action.

A very simple way of gamification is to present a quiz where, for example, users can choose the best way of how to save energy in different situations. The result of the quiz can be linked to hints and tips of energy saving measures. This kind of unintentional learning can be a key factor for a change in behaviour (Huber and Hilty 2015).

Gamification also integrates aspects such as reaching different levels and gaining points, for example, points for every saved kWh, for solving a quiz, or for logging in to the web portal (Björkskog et al. 2010: 296). Ranking lists can motivate users to compete with each other. Frequent changes in game episodes can help to keep users interested in the game. Serious games can also be used via social networks as facebook, where users can directly compete with their friends. This

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can be used as an additional incentive to participate in the game and to be a successful player (Reeves et al. 2014).

Serious games help to integrate interventions into daily patterns, but they have to be tailored to the target group (e.g. another design for adults than for children) and follow simple rules that do not discourage end users from participating (The S3C Consortium 2012-2016). The effects of gamification depend on the context and the users (Hamari et al. 2014). A game lives from its users, the more there are, the more effective a game is. This is why a game has to be promoted through different communication channels.

An avatar or mascot can serve as a symbolic communication that is often linked to positive feelings, especially for younger target groups (Reeves et al. 2014). The language should be narrative and positive emotions should be triggered (definitely not shocking or depressing).

An argument against gamification is that an intrinsic motivation to change one's behaviour can be replaced by an extrinsic motivation. This means that the behaviour may only be changed to earn points and not to save energy or protect the environment as part of a personal goal. In this case the behaviour change will not persist once the user stops playing the game. If less rewards are used and gamification is mainly used for information purposes, this effect might be avoided, but users should not use the game over a longer period of time (Nicholson 2012). In addition, data usage and data security principles should be made perfectly clear right in the beginning of the project. It also is recommended to update gaming content regularly. The challenge is to find the balance between keeping participants committed and not to overburden them in everyday life.

In THE4BEES project it was decided not to integrate gamification elements as this would lead to high comlpexity and only be attractive to some of the school pilots.

From the pilots:

Workplaces: Gamification features were seen as motivating by employees in the French pilots. This could be a ranking or a target to reach (see comparison). Another way could be to give a weekly, clear and playful feedback of consumption per box office. Finally, a comparison of consumption between offices was set up but no gamification. After reflection, designing a game with rules, objectives and rewards seemed too complicated and required too many resources for the limited timeframe. The ideal would have been to devote a co-creation lab to the development of a game to guarantee the interest of the participants. Without participants' inputs and with limited development time, benefit from a gamification approach was not seen as sufficient and that a comparison between offices was preferred. Gamification is also not important in the German pilot. It is seen as a training method for children and young people to learn environmental friendly behaviour.

Schools: Incentives and gamification were two ideas of students to support positive contest and therefore behaviour change. Gamification was also considered an important tool in the meaning of penalties to be introduced (ex. extra-charges for non-energy-efficient guests in huts). Also in the Slovenian pilot it was concluded from the CClabs that gamification of the learning process is something that is very effective and should be included in a larger extent by formal education on all levels. In other schools such as the Austrian ones gamification was not considered to be relevant.

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Storytelling

The storytelling method is mainly used in school and in companies in order to illustrate abstract issues, relations, experiences etc. At the same time, telling stories is one of the oldest communication instruments in the world. The advantages of storytelling are: the target group directly gets a realistic impression of the topic and reproduces it in its own world. The people of the target group can easily tell the story to their friends. Storytelling addresses mind and feelings at the same time and builds trust. Stories can be told about complex ideas, new perspectives, changes, future visions, knowledge and values and give illustrative examples. When people tell stories they have to be creative and empathise with the addressee. (Faust 2006; Moezzi et al. 2017; Raven 2017) Having environmental behaviour in mind for example a story could be told about how my colleagues and me contribute to climate protection (see Figure 10).

Figure 10: Storytelling example at work (© H.Bories)

There are also some pitfalls that could arise when storytelling is used as a method. Data that should be presented has to be sorted, organised and prepared. You have to know the target group, their knowledge and skills, their needs, their everyday life and environment, their interests and expectations, in order to use the right content and medium. The wrong story for the wrong target group could have negative effects.

Within THE4BEES project storytelling maps are used like shown in Figure 11. Storytelling maps are a special instrument that helps to present different types of information in an exciting and powerful way. Story maps tell the story of an event, place or trend in a geographic context. These kinds of maps enable to combine interactive maps (2D and 3D), text, images and other multimedia files to tell stories that are easily understandable and attract the attention of the 'reader'. Storytelling maps have the potential to bring about change, influence opinions, create awareness, raise the alarm, and spread news.

Figure 11: First page of THE4BEES storytelling map platform

From the pilots:

Workplaces: Story telling was not involved in the German pilot. However, it could be considered to add story telling in further activities in the future. In the French pilot the storytelling method was used to present the project and the intermediate results to the Swiss steering committee. The main actor was a typical new occupant of the Blue Hall (pilot building) who had needs, desires and questions in relation to his work environment. He was able to be heard and to make proposals during the co-creation phase of the project. During the test phase, he benefits from a dashboard which allows him to interact with his office but also to have a feedback of his consumption. He continues to give his opinion on the IT tool in order to continuously improve it. This presentation was appreciated by the steering committee and the story telling will be reused to present the final results to the participants after the trial phase.

Schools: The students in Austria enjoy the idea of having and creating a story map in Austrian schools very much. They say that it is an ideal tool to communicate the message of energy consumption and energy saving. In France, a participatory self-evaluation workshop will collect stories to answer the question 'In what extent THE4BEES contributed to a behavioural change of high school pupils?'.

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Financial Incentives

At first sight, financial incentives are a strong motivator to change behaviour, especially for low-income households, but for all other target groups as well (Maréchal and Holzemer 2015). Financial incentives can be, for example, rewards for gaining points or the first place of a competition, share of benefits in schools (e.g. the class gets 50% of the saved costs for an exhibition), or the option of active users to take part in a monthly lottery.

An argument against financial incentives and rewards for a specific behaviour is that they can decrease intrinsic motivation, which is important for a long-term fundamental change in behaviour. Financial incentives serve as an extrinsic motivation, making the behaviour not relevant if the incentive stops (Jacucci et al. 2009). For this reason, monetary incentives should be avoided to achieve a stabilized modified behaviour. If one decides, nevertheless, to use financial incentives for quick success, the price needs to be chosen wisely and should not be too valuable. It is recommended to put the price into a regional context, for example offer tickets for regional events or provide financial support to local schools. It also seems to be very effective to combine individual and collective rewards.

Another type of financial incentive is a dynamic tariff system. This means that prices are higher or lower during the day, depending on the availability of renewable energy and on the demanded of consumers. Dynamic pricing does not only help to manage supply and demand of energy and avoid peak load, it also has the effect that people think more about their energy consumption. This is an effective instrument to raise awareness about energy related behaviour (The S3C Consortium 2012-2016). The premise for a dynamic tariff system is a smart meter and a substantial difference between lower and higher tariffs. Inhibiting factors are external events such as weather and privacy issues as well as the design of the tariff system.

From the pilots:

Schools: Financial incentives were discussed in the some pilots but not integrated in the developed intervention. Students focus on appealing to the mind of people. Nevertheless, financial incentives could be a possibility to continue behaviour change actions after the project. From the Slovenian pilot it was concluded that virtuous behaviour once quantified should be rewarded. The capability to motivate energy users by making them part of the energy savings would go a long way. Great success was made demonstrated past initiatives, such as implementing the 50/50 methodology in schools, however more efforts should be made to reward the individual responsible for the desired outcome, rather than the organization or the managing authority. However, the legislation and administrative procedure is prohibitive, therefore this option was not further explored within the Slovenian pilot. Part of the financial savings could be reinvested in new electronic equipment that students could use to build gadgets and tools in their school electronics/robotics classes, especially equipment used for building and learning on the field of energy, energy measuring and energy consumption. In this case both learning purpose and awareness raising purpose could be achieved, but there would have to be consistent support from the school/managing authority.

Huts: The hut manager of Chalet della Luna offered a free weekend at the hut for the occupants of the room that revealed the best a-posteriori behaviour in terms of energy consumption.

Other pilots did not take financial incentives into consideration.

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D • RECOMMENDATIONS FOR ICT DEVELOPMENT

In the previous chapters it was described which content could be displayed by the ICT tool. This chapter summarizes the results and their implication for ICT development. In addition, a few options regarding channels and design are presented in the following. Within the development of ICT tools, usability tests have to be performed on a prototype to ensure that users' requirements are met. The challenge is to keep it simple, but to provide sufficient information (Jacucci et al. 2009). As an ICT energy saving tool has to be developed, it should also be energy efficient and not need too much battery in order to be credible. It should also be considered whether the tool is only web based or whether it can also be used offline. Also the level of control for individual user groups has to be carefully considered in order to obtain maximum comfort and energy efficiency (Korte et al. 2015).

Feedback and information should be integrated into an app or ICT tool, taking into account the following criteria shown in table 1 in order to achieve a sustainable change in behaviour:

Table 1: Criteria for developing ICT tools as intervention measures

CRITERIA	DEFINITION	RELEVANCE FOR USER INTERFACE
Easy access	Quick and easy access (involvement should be as low as possible). The technology should be designed to be used as far as possible without much (conscious) previous knowledge.	Makes using the app intuitive.
Integrated into daily patterns and routines	Adapt information to the reference frame of the target group.	Log in may be a barrier. Usable for devices used by the target group (e.g. computer for office buildings, shower for households and huts, open windows for schools, light for all target groups).
Positive emotions	User experience approach: using positive emotions which might have further positive consequences.	Attractive design that is fun to use.
Language	In order to make energy consumption and its impact visible, the language has to meet the needs of the target group. The use of administrative and technical terms might not be appropriate.	Clear labelling and explanation of labels, acronyms and technical terms. Do not just provide KWh or carbon emissions but make them illustrative (e.g. trees, financial terms).[4]

[4] A good calculator from the United States Environment Protection Agency can be found here: https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

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CRITERIA	DEFINITION	RELEVANCE FOR USER INTERFACE
Interaction	Interactive elements can engage households, arouse their curiosity and stimulate experimentation.	Provide interactive elements.
Choice	The choice of multiple options for feedback or a specific design can be crucial to meet the demands of the target group.	Give people the opportunity to choose between designs (e.g. type of diagrams), information (e.g. hints and tips) and frequency of reports.
Content	Different contents (e.g. kWh, costs) activate different motives and norms. Costs would be more informative for private households than for students or employees.	Decide which content is suitable for which target group. Support numbers by graphic presentations that are clearly labelled. Do not provide too much information.
Actionable information	Provide information with a clear impact that can be addressed through behaviour.	Support feedback through hints and tips.
Relevant information	In the best case, users set a specific target that they want to reach. The feedback should then relate to the target. Another way to make information relevant is to provide target group tailored information.	Provide the possibility to set a target. Provide tailored/personalized information.
Traceable information	If people can track which action leads to which impact, this can be a high motivation.	Provide the possibility to insert actions that can be tracked.
Direct feedback combined with indirect feedback	The more immediate feedback you give after an action, the more effective it is. Direct feedback can lead to 5-15 % energy savings; indirect feedback can lead to 0-10 % energy savings. Direct feedback also allows users to experiment with the impact of their behaviour. On the other side, there is a high drop-out risk with direct feedback.	Provide real-time or nearly real-time feedback (at least more often than only monthly). Combination with monthly or weekly reports. Make reports also available on request.
Historical feedback	Historical feedback has proven to be more relevant than comparative feedback (comparison has to be relevant).	Provide historical feedback.
Sensitive feedback	The feedback must be sensitive to small savings as users may experiment with just one appliance.	Provide data sensitive feedback to small savings. Provide feedback for every device/appliance.
General feedback	In order to discourage rebound effects, overall building/household consumption should be provided.	Provide general feedback for the building/household.

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CRITERIA	DEFINITION	RELEVANCE FOR USER INTERFACE
Specific feedback	The more detailed the feedback can be traced back to the consumer of energy, the more effective it is. This is due to the same reasons why direct feedback is more effective than indirect feedback.	Provide as much detailed and appliance specific feedback as possible. Combine appliance specific feedback with overall consumption feedback to avoid rebound effects.
Frequent feedback	Frequent feedback helps to improve the correlation between actions and consequences. In addition, it provides more opportunities to engage users' attention.	Provide feedback as frequent as possible. Look for ways to remind and motivate the programme participants to stay involved.
Feedback duration	If feedback is given over a longer period of time, sustainable effects might be more likely.	Provide long-term tools for feedback that can also be used after the project is finished.
Comparable feedback	Comparison can serve as a motivation and stimulate competition.	Consider to provide several ways to compare (e.g. comparing to own prior consumption, to peer consumption, to goal set)
Sources: Burmester et al. (2014), Carroll et al. (2009), Chen et al. (2014: 461), Faruqui and Sergici (2010), Fischer (2007), Gamberini et al. (2009), Gulbinas et al. (2014), Jacucci et al. (2009), Jain et al. (2013b), Karlin et al. (2015), Keyvanfar et al. (2014), Laib et al. (2015), Lewis et al. (2012), Maréchal and Holzemer (2015), Orland et al. (2014), The S3C Consortium (2012-2016).		

Channels and Devices

As table 2 shows, different channels and devices can be used to influence the behaviour of end users. Several factors have to be considered when deciding to use one of them (Burmester et al. 2014; Carroll et al. 2009; Fischer 2007; Karlin et al. 2015; Kastner and Matthies 2014; Lewis et al. 2012; Mack 2007; The S3C Consortium 2012-2016). For example, the usability of apps should cover a variety of components such as being effective, efficient as well as satisfactory (i.e. comforting in terms of physical and psychological ease and acceptability). Information overloading for the users should be avoided and the displayed information should be self-explanatory (Jacucci et al. 2009).

It is recommended to provide several channels so that consumers have a choice of what they want to use. In addition, the probability of reaching users is higher (Lewis et al. 2012). Research also indicates that interactive feedback channels via electronic media are slightly more effective than other channels (Karlin et al. 2015).

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Table 2: Overview of channels and devices

CHANNEL/DEVICE	PRO	CONTRA
Electronic media		
In-house display	• can provide a variety of feedback • can provide real-time feedback • provides feedback to all who pass by (low involvement is required) • can be interactive • stimulates users' experimenting	• in-house display has to be purchased and installed (‘opt-in’) • quickly becomes boring • difficult for users who are not used to electronic media
Online tool	• can provide a variety of feedback • relatively easy and cheap • can be accessed by several devices (PC, tablet, smart phone etc.) • can be interactive • stimulates users' experimenting	• internet connection is needed • a login to a web portal can be a barrier • high involvement is needed • if a PC is needed, this could be a barrier (turning it on, waiting, starting the app) • difficult for users who are not used to electronic media
Smart phone app	• can provide a variety of feedback • accessible any time from (almost) anywhere with low effort • possible to provide alerts • can be interactive • stimulates users' experimenting	• internet connection (Wifi) may be needed • high involvement is needed • difficult for users who are not used to electronic media
Ambient display (e.g. small LEDs glowing in different colours)	• minimal involvement is required	• amount of information is very limited
Written material		
Informative billing/ regular reports by mail	• does not require advanced metering infrastructure (AMI) • no internet connection is needed • low involvement is required • provides an explanation of bills • cost-effective approach • no self-selection of ‘participants’ • is read carefully and might raise interest • customized reports and additional information	• informing end-users on paper once a year or once a month – no real-time feedback • amount of information is limited • requires integration with system data • impact of discrete behaviour and individual appliances may not be detected

CHANNEL/DEVICE	PRO	CONTRA
Prompts (posters/fridge magnets)	• can raise awareness for specific aspects • provide information to all who pass by (low involvement is required) • no internet connection is needed • do not require advanced metering infrastructure (AMI) • catch people in their daily routines	• people have to remember to take action • people might get 'used to' prompts in their everyday life
Brochures and leaflets	• low involvement is required • no internet connection is needed • provide a generic overview • do not require advanced metering infrastructure (AMI)	• people are overwhelmed by leaflets • amount of information is limited ('components are typically kept to the minimum')
Personal advice	• individually tailored to the person to be adviced	• high involvement is required

Regarding the effectiveness of those channels, there are unclear results in research (Faruqui and Sergici 2010; Lewis et al. 2012; Vassileva et al. 2012).

Graphical Visualisation

Besides the content and channel used for an intervention tool, the way of presenting it is equally important. Nevertheless, the same rule applies for content and channel: the presentation should be simple but not simplistic and different types of presentations should be combined (Darby 2006; Fischer 2007). It is recommended that users can choose what should be displayed as preferences, depending mostly on the target group and individual needs (Bordass et al. 2007). Possibilities are:

- Text
- Graphs and diagrams (load curves, bar charts, pie charts, horizontal lines or bell curves)
- Tables with numbers
- Symbols or avatars
- Depiction of the building
- Background colour of the display is interactive to the energy saving performance
- Traffic light system of energy saving performance
- Metric of trees to represent kWh (should be transparent regarding consistent conversion factors and rely on a reputable source)

The first step of graphical visualisation is to develop a corporate design with common colours and styles so that all material is recognised. A consolidated and simple presentation of the corporate design brings the content of the project into the focus of the users.

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E • THE SEVEN PILOTS SITES OF THE4BEES

As the characteristic of the target groups is very important for developing intervention strategies (Glaas et al. 2015: 57), we describe here some aspects that have to be considered with a focus on the pilot sites of THE4BEES project.

Private Households (Social Housing)

Housing is an essential need, the private environment is experienced as 'own territory' with a highly perceived degree of control over the environment and frame for a great number of habits and routines also regarding energy related issues.

In the case of THE4BEES project one pilot works together with social housing tenants. The pilot is in **Italy within the Lombardy Region in the city of Sondrio**, with approximately 21,876 inhabitants (2015). The pilot area integrates three buildings with 29 apartments and 90 people living in there, in sum. In addition the building managers as well as professors and students of a technical school (ITIS Sondrio) are involved in the project. The buildings were built between 1954 and 2006. 14 % of the participants are a one-person-household, 28 % two-person-households, 58 % family households. Most of the residents are 31 – 65 years old (16 % <14, 13 % 14-18, 12 % 19-30, 50 % 31-65, 9 % >65). Slightly more than half of the people are female (57 %). Tenants are generally low income people. They pay a very low rent but they normally have to pay their expenses for electricity, gas, heating (they are assisted in their expenses only in case of hardships). It is assumed that they spend at least 340 days per year and 12 hours a day in their flats. At the state before THE4BEES project there was no monitoring and/or feedback system of energy consumption in the building. The residents have influence on energy consumption within their flats but no or minor influence on energy consumption or investment on energy efficient refurbishment regarding the building as a whole. The residents use their mobile phones or smart phones (WhatsApp, SMS, ...) as well as the internet (Emails, Facebook/Google+, ...) regularly (at least twice per week) what can be used for the ICT development. Before THE4BEES project there has been no energy related campaign. Despite that the tenants of social houses in Sondrio have been found to be remarkably aware of their consumptions and interested in learning methods to reduce them; in some cases they already have a high level of awareness and a good technical level (some of them even tested energy consumption of their appliances, deciding to change them when it was too high). The real problem for tenants of social house is not their rent (as it is very low) but their expenses. That is why reducing their expenses is a very important goal for them. The behavioural change in terms of better use of energy to be achieved within the THE4BEES project and spread to all the Lombardy Region by ALERS (soft policies), together with refurbishment of buildings done in recent years and also in progress (hard policies), will result in significant energy savings.

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For all pilots, the high awareness and motivation of the social housing tenants in the pilot is a good preposition for behavioural interventions (Carroll et al. 2009: 28). The most important barrier is the missing knowledge about how to reduce energy. The focus should therefore be at information based interventions using several communication channels (feedback, hints and tips, options for actions) as well as participation possibilities such as regular exchange events. Due to the age of the participants an highly technical and social media based interventions as well as gamification is not recommended (Carroll et al. 2009: 31). It has also to be checked if an app for smart phones would be appropriate. In similar project participants preferred web portals for feedback as they were unfamiliar with smart phone apps (The S3C Consortium 2012-2016). The fact that more than a half of the residents are female can play a role as usually women do most of their daily work at home (Birzle-Harder et al. 2013: 11).

Workplaces

Environmental issues are recognised by a great number of organisations, leading to the implementation of environmental management systems. However, organisational structures sometimes might complicate decisions regarding energy related issues.

Service and administration buildings play a crucial role in the CO_2-emission generation. Besides the implementation of energy efficient technologies in office buildings, the impact of user behaviour on energy consumption is shown by research to be a relevant factor (Carroll et al. 2009; D'Oca et al. 2014; Darby 2006; Fell and King 2012; Karlin et al. 2015; Kastner and Matthies 2014; Keyvanfar et al. 2014; Matthies et al. 2011; Orland et al. 2014), but the potential is not yet fully exploited in real settings. While responsibility for costs and energy saving in households normally are directly linked, responsibility for energy consumption at the workplace is far more unclear to most employees e.g. due to the lack of knowledge or options. Responsiveness plays an important role for motivating employees at the workplace (Whittle et al. 2015). Strong effort is needed to get employees engaged in pro-environmental behaviour. This can be achieved by proving energy-use information of other people in their organisational network (Gulbinas and Taylor 2014). In addition, the workplace is often experienced as 'own territory' with a high expectation regarding individual control options over room conditions e.g. indoor climate quality.

In the case of THE4BEES project two pilots work together with employees and managers of office buildings.

One is located in **Switzerland, Fribourg**. The blueFACTORY district is designed to be a place of excellence in creativity and innovation. Three buildings and 80-100 offices belong to the pilot area with about 150 people working there. The users work in one of 41 innovative scientific or technical companies associated to creation or environmental protection. The employees are quite young (about 40 % of them are 19-30 years old and about 60 % are 31-65 years old) and most of them (70 %) are male. Besides offices there is a shared kitchen, a conference room, large halls and a parking lot available. Windows opening sensors, air quality sensors (CO_2 rate) were already installed in the two offices participating in the trial phase in anticipation of the THE4BEES project. Not all offices in the building are equipped in such a way. The building is used 150 days a year and at least 8 hours a day. At the state before THE4BEES project there was no monitoring and/or feedback system of energy consumption in the building. The

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employees have no or minor influence on energy consumption or investment on energy efficient refurbishment regarding their offices and the building as a whole. The employees use their smart phones (WhatsApp, SMS, ...), laptops as well as the internet (Emails, Facebook/Google+, Skype/Jabber/Voice, Xing/Linkedin, ...), the intranet and VPN regularly (at least twice per week) what can be used for the ICT development. The pilot site aims to become the first Swiss zero-carbon innovation quarter. To achieve this, it has to find a balance between emitting and reducing CO_2. The district is owned by a private company (itself owned by public shareholders). It is at the very beginning of its development and also aims to become a driver of social cohesion, a living place where shops, restaurants and cultural spaces can flourish. A high level of awareness for energy (efficiency) topics can be found in the population of the region and especially among the employees of the participating companies due to economic and socio-cultural characteristics (highly educated people, workers from 20 to 60-year-old and for a sub-group, working on energy and environmental questions). Energy related events take place regularly in the blueFACTORY, but involvement of employees as users of the buildings did not occur yet. Despite that, energy consumption per capita is very high. Most relevant barriers are missing knowledge about the functioning of the building and its system and missing feedback of behaviour impact on energy consumption. An appropriate intervention strategy might be feedback instruments, advices, comparison, games or contests as well as involving users through exchange processes.

Another pilot area analysing office buildings is located in **Germany, in the region of Baden-Württemberg and the cities Stuttgart and Freiburg**. In sum 10 buildings are part of this pilot with 10 companies and 3-50 employees per company. They use several offices, several shared kitchens conference rooms and assembly rooms. The buildings are in use at least 200 days per year and 8 hours a day. At the state before THE4BEES project there was no monitoring and/or feedback system of energy consumption in the building. The employees have considerable influence on energy consumption within their offices and the buildings but no influence on or investment in energy efficient refurbishment. The employees use their smart phones (WhatsApp, SMS, ...), laptops, personal digital assistan (PDA) as well as the internet (Email, Voicemail, Facebook/Google+, Skype/Jabber/Voice, Xing/Linkedin, ...), the intranet and VPN regularly (at least twice per week) what can be used for the ICT development.

For all working place pilots, regarding energy consumption, real-time feedback interventions were identified to be of relevance when it comes to behavioural change of employees (e. g. Chen et al. 2014). Individuals are primary agents of change, but are influenced by social norms and other context factors. Thus, against the background of an intervention which affects the socio-technical workplace environment a variety of aspects have to be considered in the implementation phase as well as in the accompanying evaluation phase: a) physical context (e.g. indoor climate, control options), b) individual level (e.g. comfort needs, habits, expectations of an employee, attitudes, beliefs), c) the social context (e.g. comfort needs, expectations, norms in group settings) and d) the organisational context (e.g. structures and policies of the organisation or company).

In order to get acceptance of interventions as well as to get a tailored intervention, a sufficient communication phase and participative process is needed before implementing an intervention e.g. an app as there is evidence that lower levels of participation decrease the outcome of energy saving (Kastner and Matthies 2014). Based on change management principles the staff and relevant representatives (e.g. energy manager, board members) should be involved in preparing the implementation of an app regarding function, consensus of goals and cooperation of the different stakeholders, mutual gain aspects, barriers or data security (e.g. data privacy).

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Educational Buildings

Typical aspects in educational buildings are different target groups (e.g. students, teachers, building managers) as well as different age groups (different stages of development). Results show that students' responsiveness regarding energy issues vary by age (e.g. project EnEFF:Schule, Reiß et al. 2017). Teenagers are much less interested in energy topics than younger or older ones.

In the case of THE4BEES project three pilot teams work together with several high schools, their students, teachers and building managers.

One Pilot is a high school situated in **Velenje, Slovenia**. The School Centre Velenje (ŠCV) is primarily focused on practical aspects of learning, so that students can achieve higher professional and technical education that is very specifically focused on market and industry needs, while the dislocated unit Interbusiness Educational Centre (MIC) has become a center of excellence and modern technologies and in its classrooms and laboratories students can achieve quality functional knowledge in the field of energy, computer science, mechanical engineering, business, ICT and so on. Specifically, the students who participated in the largest extent in the pilot activities had previous experience in electrotechnics, electronics, automatization, computer programming or any of the multidisciplinary related fields. This approach was applied in order to achieve the greatest possible impact and multiplicator effect (students become teachers, mentors and ambassadors) of the co-creation activities. The Slovenian pilot was designed to influence behaviour of persons involved in the educational process on the secondary and tertiary levels. The core sensing network was developed and tested for the purposes of pairing data on energy use (pre-existing energy monitoring information system) with monitoring data on microclimate parameters and indoor air quality within 6 buildings of the ŠCV. The sensor equipment was primarily tested and calibrated at the MIC. An interesting aspect in this pilot is the location of the school on the top of a lignite mine with presence of gas radon that was also measured with sensor boxes. Special focus was attributed to measurements of indoor air quality, which is defined as a prerequisite and benchmark for monitoring and optimizing energy use with reference to existing health and safety standards. To this end, the developed sensing network measures indoor levels of carbon dioxide (CO2), formaldehyde (H2CO) and radon (Rn) gases. The core group of that participated in co-creation pilot activities consisted of 22 students from the above-mentioned schools, age from 14-18 and male. With the intent of gaining a better understanding of the needs and requirements of educational institutions within the region as well as to establish a stronger platform for promoting policy adaptation, it was necessary to engage additional schools that were willing to carry out the activities of the project and consent to installing the sensor equipment and support the monitoring processes. To this end, measurements were carried out within the premises of 3 additional educational institutions, the School Center Celje (ŠCC), School Center Ravne na Koroškem (ŠCR) and the elementary school Črna na Koroškem (OŠ Črna). Each of the 3 associated partner schools were provided with a set of measuring equipment, (sensor boxes and external radon sensor) and were engaged in monitoring and awareness raising activities.

Another pilot is located in **Austria, in the city of Salzburg**. Three high schools are taking part in this pilot, one with a technical focus (HTL Salzburg), one with an agricultural focus (HBLA Ursprung) and another one with a focus on natural and musical sciences (BORG Oberndorf) (Photos from up to down). The participants in Austria come from altogether five classes with about 15-20 students per class and 3 teachers in sum. The students are 16-19 years old. They spend about 185 days in the school and 5-8 hours a day (not on weekends). At the state before THE4BEES project there was no monitoring and/or feedback system of energy consumption in the building. Students and teachers have minor influence on energy consumption in

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the building as well as on energy efficient refurbishment. The students use their smart phones (WhatsApp, SMS, ...), laptops as well as the internet (Email, Facebook/Google+, Instagram/Snapchat/flickr, Twitter, YouTube/Vimeo ...) regularly what can be used for the ICT development. It is seen as essential that students learn more about energy topic and become more aware about energy efficiency. Pupils are very interested and motivated in the topic “energy saving”.

A third pilot in **France around Lyon, in the region of Auvergne-Rhône-Alpes** is working together with two high schools (“Picasso-Aragon” in Givors and “Condorcet” in Saint-Priest). The focus of the high school is on technical and marketing issues. Two classes with about 16 seventeen year old, male students and two teachers take part in the pilot. The participants spend 150 day a year and about 8 hours a day in the school (not at weekends). There was a monitoring and feedback system about energy consumption implemented prior to THE4BEES project in one high school. It gives macro information (not detailed) about the energy consumption of the whole high school. Students and teachers have minor influence on energy consumption in the building because they have no possibility to modify the temperature by the central heating controlled by managers. They can reduce energy consumption only by switching off the lights and electric devices as computers. The students use their smart phones and mobile phones (WhatsApp, SMS, ...), laptops as well as the intranet and the internet (Email, Facebook/Google+, Instagram/Snapchat/flickr, YouTube/Vimeo ...) regularly (at least twice per week) what can be used for the ICT development. Within the school there have already been some energy related activities such as a week dedicated to energy, a video shot by the students to sensitize students about environment and energy saving. The students fell involved in and concerned with energy saving through their curriculum and school projects. Through THE4BEES project students should become even more concerned about environmental issues and behave more in order to protect the environment.

In France, one of the specificities is the collaboration and intervention of psychology-social experts and students from a master 2 of Lyon II University. The two year outreach and training activities proposed by the students and experts were welcomed by high school pupils. It contributed to the acquisition of new knowledge about behaviour change, to the creation of nudges by the pupils, installed in their classrooms. The other specificity is the assessment process, ongoing in April 2018. The project launched a participatory self-evaluation workshop, the final report will be available in French at the end of April, and a synthesis will be translated in English.

Alpine Huts

In the Alps about Selleries and Chalet della Luna Alpine Huts can be found either as a shelter for hikers, as a private holiday home or as a guest house for tourists. As construction and retrofit of mountain hut is a complex issue, human behaviour has a huge impact on energy efficiency in these huts. A simple reduction of energy use could provide more benefits than highly technological solutions. Small investments for example in accurate energy monitoring can support energy saving measures to a great deal.

The two pilot mountain huts of THE4BEES project are located **in Italy, in the Piedmont Alps**. Many different people will be involved in the trials: student, tourists, owners and managers. Both huts have one building but differ in their energy saving potential.

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One of the two pilots is the **Rifugio Selleries Alpine Hut** which is located in the heart of the Natural Park Orsiera Rocciavrè and constitutes the starting point for many hiking and alpine itineraries. It is located at 2023 m above sea level. It has one building which contains a total of 40 beds within 12 rooms. Besides the apartments the hut offers a shared bathroom, a kitchen with staff, a parking area, a restaurant and a common dining room. The Selleries Alpine Hut is open 365 days a year and people with disabilities can access the hut thanks to an elevator. During the winter the hut is accessible by foot and also by car from June to September/October. The alpine hut is visited mainly by students and tourists. About 30% of the guests are 18 years old or younger, about 20% are older than 65 and the rest is in the range of 19 and 65. 13 staff members work and live in the hut.

From an energy point of view (light & heating) the building is autonomous except the above ground propane vessel for the kitchen ovens. It also includes a stand-alone system with micro hydroelectric turbine. At the moment the possibilities for energy saving are limited. Heating is performed by canalization of warm air but without a thermostat. As a result the manager can just turn it on and off. Guests are not able to interact with it in any way; the heating control is not accessible for them. For the hot water supply an electric boiler is available. The managers can turn the air heating, the lights and the appliances on and off. They can also switch the ovens from electric to gas power (this action is done in an empirical way and it is not tailored). The tourists who frequent the Selleries Alpine Hut are able to turn the lights on and off and charge their own device.

The ICT infrastructure consists of a satellite phone, a protected Wi-Fi network only for hut managing and an outdoor weather station. The 3G network coverage is limited. There has not been any monitoring or feedback system of energy consumption in the building before THE4BEES. The guests and employees have minor influence on energy consumption in the building including their rooms. There is also no way they can benefit from energy saving. Most of the students use internet regularly but the Wi-Fi in the hut is protected and not available for guests. The phone network connection is also low covered. The hut manager is be the main stakeholder for THE4BEES project because he is the one who really manages the resources.

The second pilot is the **Chalet della Luna Hut located at Clavière in the Susa Valley**, very close to the French border. It is located at 1760 m above sea level and constitutes the starting point for many hiking routes. The building contains 23 user rooms on four floors. It's open between Christmas and Easter and during the summer months. It offers Wi-Fi connection on the ground floor which reaches the rooms of most floors. The 3G network is covered.

The thermal system is powered by centralized diesel fuel with a possibility of manual (rough) reading of the fuel level status no more than once a week. At the ground level one single temperature sensor is located which controls the building temperature. Radiators are equipped with thermostatic valves in all rooms. In addition the building has double glass windows everywhere. To save energy the tourists of the hut can control the heating by acting on the radiator thermostatic valves. They can close or open the window, decide how long their shower takes as well as switching on and off the lights.

In general, tourists use huts for a short time, thus the relationship to the environment might not be very high in comparison to private housing. As tourists spend holidays in the Alps, the intervention should not interfere with the expectation of having a pleasant time.

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