Journal of Cleaner Production 224 (2019) 789–801

Contents lists available at ScienceDirect

Journal of Cleaner Production

journal homepage: www.elsevier.com/locate/jclepro

Exploring the viability of a local social network for creating persistently engaging energy feedback and improved human well-being

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ARTICLE INFO

Article history:
Received 30 June 2018
Received in revised form
21 January 2019
Accepted 11 March 2019
Available online 21 March 2019

Keywords:
Energy feedback
Consumer engagement
Energy behaviour
Social networks
Smart grids

ABSTRACT

Long-term engagement of residents is crucial for demand response management, and thus grid stability in energy systems, but current approaches often fail to maintain or even achieve the necessary changes in consumer behaviour. Thus future customer engagement approaches will have to relate more strongly to customer needs in order to achieve long-term engagement. This study presents an approach based on a central need identified in psychological research, namely the need to belong to a group. A mixed methods approach was used to examine how an energy feedback approach that connects to this need could be designed. First, based on the Theory of Planned Behaviour and Social Identity Theory, a survey was conducted to examine the influence of e.g. norms held by the local social group of neighbours on energy behaviour. In contrast to previous studies on the influence of social groups on sustainable behaviour, no significant influence was found. However, other findings indicated that this was due to the low level of group identity, leading to the assumption that the need for social belonging was not fulfilled in the survey group. Second, focus group discussions were conducted to test this assumption in more detail. Findings from the focus groups confirm the assumption and reveal detailed insights on residential needs for stronger connections between neighbours. We conclude that a local social network could be a suitable solution to the need for local social belonging and, while also providing a context for energy feedback. Thus, implementing a local social network could lead to both persistently engaging energy feedback and also improve human well-being.

1. Introduction

A substantial reduction in greenhouse gas (GHG) emissions is required to contain the global temperature increase within the internationally agreed limit stated in the Paris Agreement (United Nations, 2015). This requires an overall decrease in energy use (International Energy Agency, 2016), and with households being associated with 20% of the European GHG emissions (Eurostat, 2016), they are an important contributor to the emissions reduction effort. Emissions reduction also requires a sharp increase in the share of renewables in the power grid (International Energy Agency, 2016). To better handle this intermittent power production from renewable energy sources such as wind and solar power, the grid is gradually becoming 'smarter'; a process with its own challenges (Speer et al., 2015). Demand-side flexibility is one of the key factors in this smart grid concept (Strbac, 2008) and will require utilisation of e.g. latent flexibility in residential consumers by facilitating their increased engagement (Bigerna et al., 2016) through so-called demand response programmes (Siano, 2014).

The aim of demand response programmes is to reduce peak loads and move shiftable electricity loads, such as cooking, vacuum-cleaning, washing clothes, and charging digital devices and electric vehicles, from peak hours to off-peak hours. This so-called "load-shifting" can lead to fewer expensive and polluting backup power plants being used and fewer blackouts caused by instabilities in the grid. As homes gradually become smarter, with smart, remotely controllable appliances such as air conditioning, water heaters, washing machines or refrigerators, most of this load shifting could occur automatically with little intervention from the user and in many cases without the user even noticing that an

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https://doi.org/10.1016/j.jclepro.2019.03.127

appliance has been temporarily switched off (Harper-Slaboszewicz et al., 2012). However, this future is still far away in most urban districts and thus households' contribution to demand-side flexibility will continue to depend on user engagement and behaviour changes.

However, engaging households in energy-related matters and making them change their behaviour to reduce their energy consumption has proven to be difficult. Except when the electricity cost is a significant part of the household income (Podgornik et al., 2016) or the savings have a symbolic value (Murtagh et al., 2014), the monetary savings from reduced energy use are often too low compared with the lost comfort (Hargreaves et al., 2013; Murtagh et al., 2014). Likewise, appealing to environmental concern, which is believed by users themselves to be an important motivator, has little effect in practice when used in isolation (Cialdini and Schultz, 2004; Nilsson et al., 2018). Providing effective energy feedback is challenging (Nahiduzzaman et al., 2018). It can lead to engagement and a consumption reduction for a few weeks or months, but there is a lack of studies following up this engagement over longer periods (Nahiduzzaman et al., 2018; Delmas et al., 2013; Vine and Jones, 2015). In fact, longitudinal studies suggest that even if there is initial interest in environmental feedback (e.g. from energy apps or in-home energy monitors), it diminishes over time (Hargreaves et al., 2013) after becoming "backgrounded" – also known as the "honeymoon effect" (Murtagh et al., 2014).

One reason why many current approaches fail to achieve long-term engagement may be that they are technology-push oriented (Pierce et al., 2010; Goncalves Da Silva et al., 2012). Therefore, in this study we examine a different engagement approach which rests on identifying *household needs* and providing energy feedback in a context that can meet those needs. On a basic level, we opted to focus on the need to belong to a group, which has been identified as one of the most important human needs in psychological research (Maslow, 1970). However, recent work has revealed a trend of people becoming "globally connected yet locally isolated" (Hayes, 2007), meaning that people may lack social bonds in their immediate environment despite being well-connected globally, e.g. via online social networks. At the same time, research in social psychology shows that the social influence of a group with which people identify affects their behaviour and results in behaviour change in a variety of contexts (Fishbein and Ajzen, 2010; Ajzen, 2011), including energy conservation behaviour (Cialdini and Schultz, 2004; Schultz et al., 2007; Allcott, 2011). Hence, a service that addresses people's need for social belonging while also presenting energy feedback to its users could potentially also utilize social influence to further increase engagement in energy-related matters. One way for such a service to increase social belonging is by making people feel part of a group. Taking into account the trend of 'local isolation', we decided to focus upon the group of people living within a neighbourhood. We therefore propose a *local social network*[1] *for neighbourhoods* as a service that fulfills these requirements. Restricting the communication geographically to the neighbourhood would foster communication between neighbours, thus increasing connections within the group of neighbours. Being a digital service, a social network would allow energy feedback to be presented on a daily basis in a scalable way, while the inherent social aspect would allow for utilising social influence between neighbours.

[1] Our use of the term *social network* refers to a *digital online social networking service* such as Facebook, featuring social media concepts of being a Web 2.0-based internet application, relying on user-generated content, having profiles for users and groups, and allowing users to communicate with other users/groups (Obar and Wildman, 2015).

The aim of this study is to further explore the viability of a local social network as a context for providing energy feedback promoting long-term engagement in its users. The objectives are to i) measure the status quo of social bonds between neighbours in order to determine the need for increasing these bonds, ii) determine a baseline for existing energy behaviour in the neighbourhood, iii) investigate the influence of group norms (i.e. neighbours' norms) on energy behaviour, and iv) identify and refine everyday household needs that a local social network should address to be useful to its users. To fulfil objectives i-iii, we conduct a survey based on the Theory of Planned Behaviour (Ajzen, 1991) and Social Identity Theory (e.g. Tajfel, 1974; Turner and Oakes, 1986). To fulfil objective iv, we conducted focus group discussions.

This paper starts by taking a deeper look at the need for social belonging on a local level, followed by a presentation of social influence as a effective behavioural change mechanism. It then looks briefly at some earlier studies that used social networks as a context for energy feedback. Next, the methodology used in the survey and focus group discussions is presented, followed by a discussion of the most relevant results. Finally, the implications of the results are considered in the conceptual design of a local social network called LocalLife, ending with a discussion of its potential for improving neighbourhood-related aspects of social sustainability such as the feeling of safety, trust, and sense of community (Dempsey et al., 2011) as well as its advantages as a context for energy feedback.

2. Overcoming the engagement barrier for intervention strategies using social influence

2.1. A needs-based approach for making energy feedback visible

Households are expected to contribute to grid-related GHG reduction efforts by reducing their overall energy consumption and participating in demand response programmes, which aim to shift and decrease household peak loads. Since this requires varying degrees of behavioural changes, households need to choose to contribute and participate, and then make changes and maintain them over time. To support such changes, households can be provided with some type of feedback about state, progress and cues for action. However, as consumers are facing increasing information overload (Levitin, 2014), capturing and retaining attention on an activity is becoming increasingly difficult and must compete with what are considered core needs and responsibilities such as family, work and health.

We propose that, in order for an engagement programme to be successful, it needs to take into consideration its users' key interests and needs. Our decision to focus on the need for social belonging (Maslow, 1970) is primarily motivated by recent findings on local isolation in urban contexts (Hayes, 2007). In just a decade, we have become globally connected, with numerous social networks providing real-time interactivity with friends and family around the globe, public figures and organisations, and colleagues across continents. At the same time, there has been a trend for increasing 'local isolation', exemplified by the fact that more than 50% of Americans (Smith, 2010) and over 70% of all Swedes living in an apartment (Svenska Postkodlotteriet, 2016) only know a few, if any, of their neighbours well. This local isolation erodes local social capital (Putnam, 1995), the very fabric that holds societies together. From a needs perspective, neighbours often have a common interest in using, maintaining and improving the facilities and areas in which they live, and can support each other with information and help that is not readily available elsewhere.

Having identified the need for social belonging as a potential basis for an energy feedback context creating long-term engagement, in the following section we examine this social approach to

energy behaviour change in more detail. We begin by reviewing findings from social psychology on this issue and then connect these to the literature on residential demand-side management.

2.2. A social approach to energy behaviour change

As a large part of household energy use can be linked to behaviour (Gram-Hanssen, 2011), a good understanding about behaviour-changing mechanisms is important when designing energy feedback. The most popular psychological theory on behaviour change, including human behaviour in sustainable development in general (Bögel and Upham, 2018) and energy behaviour in particular, is the Theory of Planned Behaviour (TpB) (Ajzen, 1991, 2011). Meta-studies also suggest that it is the most successful approach in this regard, i.e. in terms of statistically predicting behaviour (Webb et al., 2010). TpB and its successor, the Reasoned Action Approach (Fishbein and Ajzen, 2010), suggest that behavioural intention is the proximal determinant of actual behaviour. Behavioural intention is, in turn, affected by three factors: 1) attitudes (Will the behaviour benefit us?), 2) perceived behavioural control (Can we do it?) and 3) social influence (How we think important others want us to behave (injunctive norm) and how we think others actually behave (descriptive norm)). Regarding fields of application, studies using TpB focus on individual behaviour, often in the form of consumption behaviour. TpB was one of the most influential approaches in early sustainable consumption research (Liu et al., 2017) and is still being used in this regard in socio-technical transition research on consumer acceptance, e.g. regarding renewable energy system adoption by consumers. For example, Yun and Lee (2015) coupled the socio-technical perspective with TpB to analyze consumer adoption of renewable energy systems. Their study confirmed the influence of attitude, subjective norm and perceived behavioural control on consumers' intentions to use renewable energy systems (Yun and Lee (2015)). In addition, previous studies support the predictive value of attitudes, norms and behavioural control for energy use behaviour (Clayton et al., 2015).

Within the field of energy conservation, the power of social influence in particular has not only been demonstrated using theoretical models (Jain et al., 2013) and in limited field tests (Cialdini and Schultz, 2004; Schultz et al., 2007) but also as part of the relatively large Behavioural Demand Response programme run by Opower, a company that provides customer engagement and energy efficiency services to utilities. Without any reliance on home-side automation, but by simply prompting users to reduce their energy use during peak hours and afterwards giving comparisons with similar nearby households, peak loads can be reduced at a lower cost than with conventional load-shifting measures (Allcott, 2011). This approach also seems to work on a large scale, one example being an average peak load reduction of 2.6% over 200,000 North American households in summer 2015 (Opower, 2015).

While this practical example highlights the role of social influence, meta-analyses have shown that among the TpB components, subjective norms are the weakest predictor of intentions (e.g. Armitage and Conner, 2001; Blue, 1995). Previous studies suggest that depending on the context, empirical research based on the TpB might have underestimated the role of social norms, possibly due to the operationalisation of social norms in the theory (Fielding et al., 2008). Subjective norms are defined in the TpB as the norms of relevant other people in an individual's environment with regard to their behaviour, e.g. whether friends would approve or disapprove of attempts to save energy in the household. In contrast, Terry and colleagues (Terry and Hogg, 1996; Terry et al., 1999) claim that the behaviour of the relevant reference group, here e.g. neighbours, provides more relevant norms than the aggregated impressions of important others. Thus, although social norms are reflected in the current version of the TpB and e.g. considered in research on consumer acceptance using TpB (see e.g. Sopha et al., 2013), such use of the theory has only been explored in a rather cursory way (Axsen and Kurani, 2014; Jackson, 2005).

To overcome this limitation, a study by Fielding et al. (2008) on behaviour and behaviour change in agriculture suggested combining TpB with Social Identity Theory. Social identity is defined as 'the individual's knowledge that he belongs to certain social groups together with some emotional and value significance to him of the group membership' (Tajfel, 1972; cit. Jackson, 2005, p. 79). In the context of the present study, social identity refers to belonging to a local group, e.g. neighbours within a building or a certain city district. In general, identity-focused approaches are considered to be important in overcoming the attitude-behaviour gap (Hibbert et al., 2013). It is claimed that identity is a key driver of energy behaviour (Nye et al., 2010) and studies on energy behaviour actually confirm that having a pro-environmental self-identity has a positive effect on energy use reduction (Clayton et al., 2015). However, most of these studies focus on the individual level of self-identity. In contrast, social identity theory relates to the social context, namely social identity as part of self-identity (Jackson, 2005). In their study on (sustainable) agricultural practices, Fielding et al. (2008) found that the group norms were a significant predictor of behavioural intention, especially for people with a high identification with their group. This suggests that if people feel that they are part of a group, such as their neighbourhood, there is a higher probability of them following the ideas, rules and expected energy behaviour of this group.

2.3. Previous studies combining energy feedback with a social network

Our proposed engagement approach of presenting energy feedback within a social network is not completely new. Although theoretical modelling suggests that a social network could be effective in spreading energy-conservation attitudes and thus making people reduce their energy consumption (Azar and Al Ansari, 2017), to our knowledge the concept has not been widely explored in practice, except for a few small-scale studies using already existing social networks. One such study by Mankoff et al. (2010) resulted in StepGreen, a plugin to the MySpace social network that gave users suggestions on energy-savings actions to which they could commit and which were publicly visible on the user's MySpace page. It was piloted by 32 users during three weeks. Another example is EnergyWiz (Petkov et al., 2011), a design prototype of an Android app using different types of comparative feedback. Two of its comparison features used Facebook: the possibility to challenge a Facebook friend to a week-long energy savings competition, and a ranking feature between similar Facebook-connected users who made weekly posts to a special Facebook group. A prototype of the app was tested on 17 individuals, who were later interviewed. A third example is Wattsup (Foster et al., 2010), a Facebook app that like EnergyWiz offered user ranking and the possibility to compare energy consumption with participating friends using the app. A pilot study on eight households over 19 days showed that the social features were the most popular.

These studies have some limitations. The first relates to the measurement of the electricity consumption, which is either not measured at all (StepGreen), making it difficult to evaluate the effects of any interventions, or requires installation of a special energy meter connected to a computer in each household (EnergyWiz, Wattsup), which in turn requires participating households to be part of a pilot programme or pay for the

equipment. Another issue is the short study time of a few weeks; all these studies propose longer-term investigations to explore user retention and long-term effects of the feedback. Yet another issue raised by some users of StepGreen and EnergyWiz is that discussing energy-related matters within the "generic" social networks used in the studies (i.e. MySpace and Facebook) feels out of place, as not all of their friends are interested in sustainability issues. Our approach has the potential to overcome these limitations; this is discussed further in section 5.3.

3. Methodology

3.1. Survey on energy behaviours and social identity

To allow for a measurement of a neighbourhood's social sustainability and energy attitudes and behaviours, and to explore whether neighbours' energy attitudes affect individual energy behaviour, a questionnaire was designed using questions and scales based on Social Identity Theory and TpB together with questions about different aspects of social sustainability from various sources. The survey started with some initial questions about the living situation of the respondent followed by two main sections. The first section dealt with group identification and social sustainability, while the second section assessed energy-saving attitudes and behaviour, focusing on household electricity use. The questionnaire ended with some demographic questions.

The questions and their theoretical background are described in more detail below. To better align the structure of the explanations below with the theoretical background in section 2.2, the scales are presented by theoretical construct rather than the order in which they appear in the survey. Some of the scales included are not explained as they are not relevant for the scope of this paper. The question numbers (Qxx) refer to the full list of questions (see Appendix A).

The living situation was assessed by three questions (Q1001-1003): What kind of household does the respondent live in (apartment, row house, detached house, student room, other), the ownership of the building they live in (housing cooperative, rented, self-owned, other) and their personal ownership of the apartment/house they live in (own, rent, rent second/third hand, lodger, other). The answers to these questions were used by the interviewer in all following questions to replace generic terms such as "your building"/"your neighbourhood" with the actual names of the individual participants building and neighbourhood to make the questions more relatable and relevant for the participants.

The items used to measure the constructs relevant to the TpB (Ajzen, 1991; Fishbein and Ajzen, 2010) were mainly based on those in Fielding et al. (2008), adapted for the context of energy-saving behaviour, to enable comparison of our results against previous findings on the connection between social identity and sustainable behaviour.

The general attitude towards saving energy in the individual participant's household was therefore measured using six semantic differentials (Q2801-2806). Participants were asked to rate each of the statements "I feel that saving energy at my household is good (… is wise/beneficial/pleasant/satisfying/favourable)" on a seven-point scale (where 1 = *extremely bad* and 7 = *extremely good*).

To measure perceived behavioural control, we asked how much control participants have over saving energy in their household (1 = *very little* to 7 = *a great deal; Q38*); whether saving energy is easy for them (1 = *very difficult* to 7 = *very easy; Q39*); and to rate their knowledge about possible ways to save energy (1 = *very low* to 7 = *very high; Q40*). We only used three of the five items from Fielding et al. (2008) for this construct, to limit the overall length of the survey. For past behaviour, participants were asked how much effort (Q41) and how much time and labour (Q42) they devote to saving energy (both 1 = *none at all* to 7 = *a lot*). Behaviour at the present time (Q43) and behavioural intention (Q44) were each measured with one item, asking to what extent participants were saving energy at the time of the survey and to what extent they planned to do so in the next six months (1 = *not at all* to 7 = *a lot*).

As a detailed understanding of current energy saving behaviour is a focal point in this study, we also added some further questions to measure several concrete energy-saving actions. These were taken from the 2016 version of an annual public survey "Du och din miljö" (You and your environment) conducted by Stockholm Municipality (Stockholms Stad, 2016), but with items not relevant to apartments removed, and using a "often/occasionally/never" scale instead of the original "yes/no". First, participants were asked whether they purchase environmentally certified electricity (Q45). The interviewer asked whether the participant had made any actions in the past to save energy for their household and to list these actions (Q461). This was to determine which actions participants spontaneously remembered in the context of saving energy. Afterwards, the interviewer read out a list of several predefined actions, such as "I turn off the lights when not needed" and asked participants if they had done so in the past (Q462). Actions the participant already mentioned in the first step were skipped. Finally, the interviewer read back to the participant all items on the list that the participant had affirmed, together with any actions mentioned in the first step that were not on the predefined list (relevant options from Q4601-4612). For each action, the participant was asked how often they had done it (with the response options *often, occasionally* and *never*).

In this study, we sought to examine different forms of social influence, i.e. not only the influence exerted by the broader group of important others but also the influence of relevant reference groups (see Terry and Hogg, 1996; Terry et al., 1999). In the present context, neighbours living in the participant's building are seen as a relevant reference group for energy-saving behaviour, and hence their social influence was also measured. For the subjective social norms with regard to important others, participants were asked if people important to them would approve of them saving energy (Q29), would think saving energy is desirable (Q30) and would think that they should save energy (Q31). To measure the perceived group norms of people living in their building, the interviewer asked how many people in the participants building would think that saving energy is a good (Q32), how likely it is that other people in the building save energy (Q33) and how much agreement there is among residents in the building that saving energy is a good thing (Q34). All answers were given on a seven point Likert scale (e.g. from 1 = *disapprove/very few* to 7 = *approve/most*). Again, these items were adapted from Fielding et al. (2008) for our context, but shortened to three instead of five items each.

Group identification with the neighbours in the building was assessed with four items (Q1-4), which were a shortened adaption of Hogg and Hains' (1996) *group relations questionnaire*, in accordance with Fielding et al. (2008). Participants rated how important the people in their building are to them (from 1 = *not important at all* to 7 = *very important*), how much they identify with them (1 = *not at all* to 7 = *very much*), how strong the ties to them are (1 = *very weak* to 7 = *very strong*) and to what extent they see themselves as belonging to the people in their building (1 = *not all at* to 7 = *very much*).

As the concept of the neighbourhood as a social network is central to this study, we included several items to measure constructs related to this in more detail. These were adaptations from a survey on building environment and health used by Eriksson et al. (2010) (based on several other instruments, see e.g. Onyx and Bullen, 2001; Narayan and Cassidy, 2001). To measure the social

bonds participants experience in their neighbourhood, we first asked how common it is for neighbours at the place where the participant lives to talk to each other when they meet (1 = *not common all at* to 7 = *very common; Q14*). Like the items above, this was an adaption from Eriksson et al. (2010) where we changed the response format to a seven-point scale. We also added two scales and a single-item measurement from the same survey to further assess this construct. The first scale contained five statements describing the social bonds in the participants living area (Q15), e.g. "Where I live, you take responsibility for each other's children", which were rated on a three-point scale (*1 = Too much/2 = Moderate/3 = Too little*). The second scale assessed the social network of the participants by asking if they have a good social relationship with their family, relatives, friends, neighbours and peers (with a yes/no/not applicable scale; Q16). The participants were then asked how many of their neighbours they know (six options ranging from 0 to 16 or more; Q17) Finally, participants were asked how often they spend time with any of their neighbours (from 1 = *daily/almost daily* to 5 = *never; Q18*).

At the end of the survey, participants were asked some demographic questions regarding year of birth, age, education, occupation and country of birth (Q48-49, 52–55). This section also included some questions about the household in which the participants live (Q50-51,56), such as the number and age of people living in the same household, the size of their apartment/house and if they felt they could live comfortably on their current household income. These were also mainly adapted from Eriksson et al. (2010). Finally, participants were asked whether they were using LocalLife (Q68).

The survey answers were analysed using IBM SPSS statistics. The statistical analysis consisted of (i) descriptive statistics including percentages, mean values, standard deviations and correlations, and (ii) for factors that were assumed to influence behavioural intentions, we conducted hierarchical multiple regression analysis. The regression analyses based on TpB and social identity theory were conducted in accordance with Fielding et al. (2008) to maximise comparability of the results.

Many of the constructs were measured using scales, i.e. multiple questions worded in a slightly different way or covering slightly different aspects of the same construct to get better reliability and validity. The average value of these questions was then calculated to represent the construct. Table 1 shows descriptive statistics and intercorrelations of the scales measuring possible influencing factors of people's behavioural intentions regarding energy saving in accordance with TpB (Ajzen, 1991; Fishbein and Ajzen, 2010) and Fielding et al. (2008). As all scale reliability values (based on Cronbach's alpha) were $\geq$0.7, the scales were deemed to have adequate reliability (Field, 2013).

The questionnaire-based survey was conducted during April-May 2018 in Stockholm Royal Seaport (SRS), a new urban district with a strong environmental profile and relatively homogeneous group of well-educated, high-income residents. SRS is still under development and is expected to have approximately 12,000 households and 35,000 workspaces when finished in 2030 (Stockholms Stad, 2017). Thus, it should be noted that people are continually moving into the area and that the area is new for most of them. Data collection was performed using phone surveys by the marketing research company Novus, who conducted 300 interviews with residents representing the same number of households. The households were randomly chosen from the full set of 2686 households in SRS having at least one person between 18 and 79 and a phone number. The participants were informed that the study was being conducted by the Royal Institute of Technology to gain an understanding of the social context in their neighbourhood, in order to prepare for energy technology interventions.

Of the 300 participants, 142 (47.3%) were female and 158 (52.7%) male, all aged between 18 and 81 years ($M = 49.55$, $SD = 16.71$). The majority of participants were born (91.0%) and/or raised (95.0%) in Sweden and had a university degree (82%), while 17.0% had finished secondary school and 1.0% had a primary school education. Most participants were either employees (56.0%), retired (23.7%) or self-employed (9.0%). Each interview took about 25 min.

3.2. Focus group discussions on neighbourhood-related needs

A local social network could potentially address the need for local cohesion. In order to identify neighbourhood needs that would be facilitated by a local social network and to design features that catered for those needs, neighbourhood-based *focus groups* were consulted. Focus group consultation is a research method where one or more focus group leaders (often researchers) chair an informal group discussion about a specific subject. The participants are chosen because they are expected to provide valuable contributions to the discussion subject (Liamputtong, 2010). The interaction and discussion between the participants can make them "explore and clarify their points of view" and thus "uncover aspects of understanding that often remain hidden" in surveys or in-depth interviews (Liamputtong, 2010).

Five focus groups were established among residents in Hammarby Sjöstad, an eco-district in Stockholm. During autumn 2015, on average 2–3 meetings were held with these groups, each consisting of 4–8 members, to define priorities for the residents. One of the focus groups, led by a researcher and aiming to discuss general neighbourhood needs, consisted of local residents recruited during a community event. The other four focus groups explored local needs within the following theme areas: homeowner associations; environment; culture and local associations; and school. These groups were established and (in all cases except homeowner associations) led by local individuals chosen for their strong engagement and their local leading role within their area. At least one researcher was present in all groups except for the school group. The five focus groups, consisting of mixed gender participants aged approximately 30–70 years, and the topics discussed are summarised in Table 2.

Table 1
Means, standard deviations, correlations and scale reliability of behavioural and social scales, measured using a seven-point scale.

		M	*SD*	1	2	3	4	5	6	7	8
1	Reported behaviour[a]	4.80	1.37	/							
2	Behavioural intention[a]	5.23	1.78	.604**	/						
3	Past behaviour	4.01	1.39	.528**	.431**	.76					
4	Attitude	5.46	1.12	.506**	.501**	.528**	.84				
5	Subjective norms	5.17	1.32	.406**	.377**	.468**	.535**	.82			
6	Behavioural control	5.10	1.16	.635**	.448**	.411**	.469**	.346**	.70		
7	Group norm	4.97	1.15	.351**	.309**	.271**	.338**	.504**	.380**	.72	
8	Group identification	3.82	1.32	.269**	.148*	.198**	.188**	.249**	.145*	.246**	.85

[a] Measured by single item, *$p < .05$, **$p < .01$. Scale reliability on diagonal.

Table 2
Details of the five focus groups (FG) used to refine neighbourhood needs in Hammarby Sjöstad, Stockholm, during autumn 2015.

Focus group	Description	Lead	Topics discussed
FG1: Residents	Five residents from the area to discuss the needs of residents	Researcher from KTH	How the residents usually learn about what happens in the neighbourhood, how they get recommendations on what to do/see/eat, how well they know their neighbours and whether they feel safe in the area
FG2: Homeowner associations (HOA)	Four board members from local HOA	Researcher from KTH	How a local social network could help board members in homeowner associations in their internal work and in their communication with the members, and also in what way they believed that members would benefit
FG3: Environment	Five HOA board members, with an interest in, and responsibility for, energy-related questions.	Energy manager in one of the homeowner associations	How communication regarding energy use and environmental matters is currently done, what tools are used, and how a local social network could improve this communication
FG4: Culture & Local Associations	Seven representatives from cultural associations in the area	Manager of the local cultural association	The needs of the local associations to promote their local activities.
FG5: School	Parents and school representatives.	School IT coordinator	What digital communication tools are used within the local schools, whether a local social network could fill any need.

Prior to the first meeting, the leaders were given brief written instructions on how to chair a focus group. For each meeting, a list of guiding questions to discuss was provided. The researcher (when present) or the focus group leader made written notes about what was discussed.

4. Results

The results from the survey in Stockholm Royal Seaport and the focus group discussions in Hammarby Sjöstad are presented below.

4.1. Descriptive results from the survey in Stockholm Royal Seaport

4.1.1. Living situation

Almost all of the 300 participants (97.3%) lived in an apartment. Most of these apartments belonged to a homeowner association (58.7%) or were rental apartments (39.0%). The average household floor size was 70.75 m^2 ($SD = 24.97$). On average, the participants shared their household with 1.30 other people ($SD = 1.14$). The majority of them said the current income of the household was enough to live on comfortably (46.7%) or very comfortably (30.0%), 19.0% were coping on current income and 4% found it difficult or very difficult to live on their income at the time of the survey.

4.1.2. Ecological sustainability: status quo of energy-saving behaviour

On average, participants rated the extent to which they currently save energy in their household as 4.80 on a seven-point scale ($SD = 1.37$). Past efforts to save energy were rated 4.41 ($SD = 1.57$), while past time and labour invested in this goal was rated 3.61 ($SD = 1.53$). Overall, 39.9% obtained environmentally certified electricity, 21.0% obtained other forms of electricity and 39.7% did not know what kind of electricity their household used.

When asked whether the participants performed any energy saving actions in their household (Table 3), most participants (83.7%) spontaneously mentioned at least one action. However, after listening to the examples from the interviewer's pre-defined list (i.e. the first seven actions in Table 3) this percentage rose to 91.3%. Almost half the participants (43.0%) mentioned at least one action that was not covered by the pre-defined list. These included the use of energy-saving light bulbs, recycling and composting. The most frequently mentioned energy-saving behaviour was turning off unused lights (45.0%). For almost all behaviours (except insulation of windows and walls, and setting and defrosting fridges/freezers), the majority of those who claimed to perform a behaviour reported doing so often. In all, the participants mentioned 41 different behaviours they use to save energy that were not included in the pre-defined list. The most frequently mentioned of these actions are shown at the bottom of Table 3.

4.1.3. Status quo of social sustainability

Overall, participants reported good social relationships with all groups of people covered in the survey (Fig. 1), with especially high numbers for friends (98.3% reported a good social relationship), family (96.0%) and relatives (86.0%). Neighbours, on the other hand, received by far the lowest value, with only 56.0% of participants reporting a good social relationship, compared with 70.0% who reported positive bonds with their peers/co-workers.

Fig. 2 shows the second measurement of social bonds included in our survey. The majority of participants rated the specific aspects of social bonds as neither too high nor too low, which can be seen as an indication of satisfaction with the current level of social support in the neighbourhood. However, 25% of participants reported that people in their neighbourhood have too little insight into each other's lives, and 23.3% of those who expressed an opinion about taking responsibility for each other's children believed that this could be improved.

Regarding our measurement of social contacts (Fig. 3), about half the participants (49.3%) reported meeting some of their neighbours in a social setting at least a few times a month. However, another third (33.0%) reported never spending time with any of their neighbours.

4.1.4. Factors influencing behavioural intention to save energy

In order to test the effect of the factors influencing people's behavioural intentions on saving energy listed in Table 1, hierarchical multiple regression analysis was performed using two different models (Fig. 4). Such analysis comprises two or more steps, where in each step one or more predictor variables are added to the model and the results are assessed to see whether the added variables provide a better fit to the observed data. These analyses were conducted in accordance with Fielding et al. (2008) to maximise comparability of results.

The results from the models are shown in Table 4. Model 1 shows that attitude and perceived behavioural control are significant predictors of intention to save energy and can explain variance

Table 3
Energy-saving behaviours mentioned in the survey and their frequency.

Action	Mentioned		Frequency		
	sponta-neously	when read from list	often	occasionally	never
Turned off lights when not needed	45.0%	48.0%	93.2%	6.8%	0.0%
Turned off TV instead of using standby	21.7%	45.7%	77.7%	18.8%	3.5%
Bought energy-efficient home appliances	10.7%	36.3%	68.1%	24.1%	7.8%
Set temperature in fridge/freezer, defrosted	2.3%	55.7%	49.4%	45.4%	5.2%
Lowered indoor temperature	13.3%	31.0%	59.4%	36.1%	4.5%
Added insulation to windows or walls	3.3%	11.7%	40.0%	51.1%	8.9%
Lowered consumption of hot tap water	22.3%	42.3%	68.0%	28.9%	3.1%
Other 1 Item	43.0%	–	89.1%	9.4%	1.6%
Other 2 Items	14.0%	–	86.4%	13.6%	0.0%
Other 3 + Items	4.0%	–	100.0%	0.0%	0.0%
Used/bought energy-saving light bulbs[a]	15.0%	–	–	–	–
Recycled/sorted waste[a]	6.3%	–	–	–	–
Ran washing machines only when full[a]	5.7%	–	–	–	–
None	16.3%	8.7%	–	–	–

Note: Frequencies are percentages only of those who mentioned the action, either spontaneously or when read from the pre-defined list.
[a] Behaviours mentioned by participants not on the prepared list.

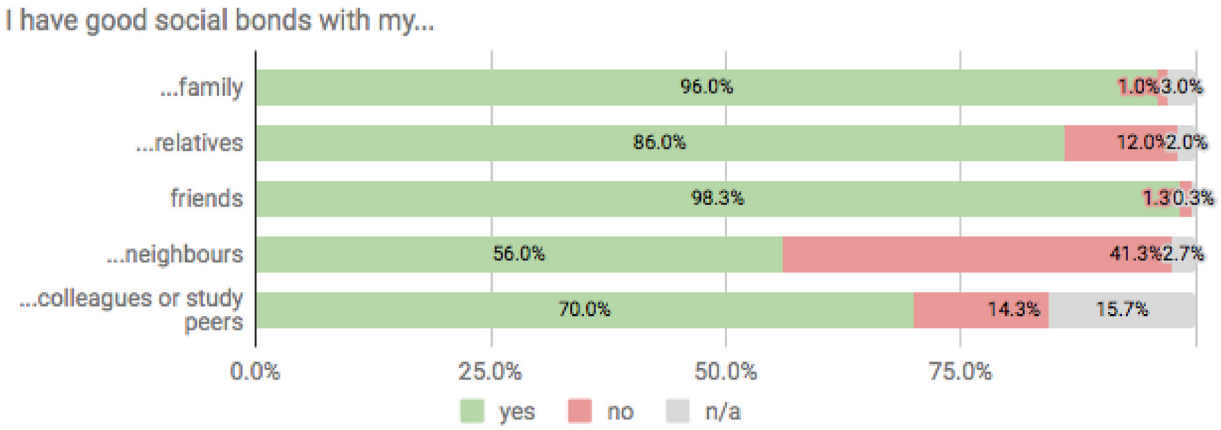

Fig. 1. Frequency of good social bonds with different groups of people potentially belonging to the participants' social network.

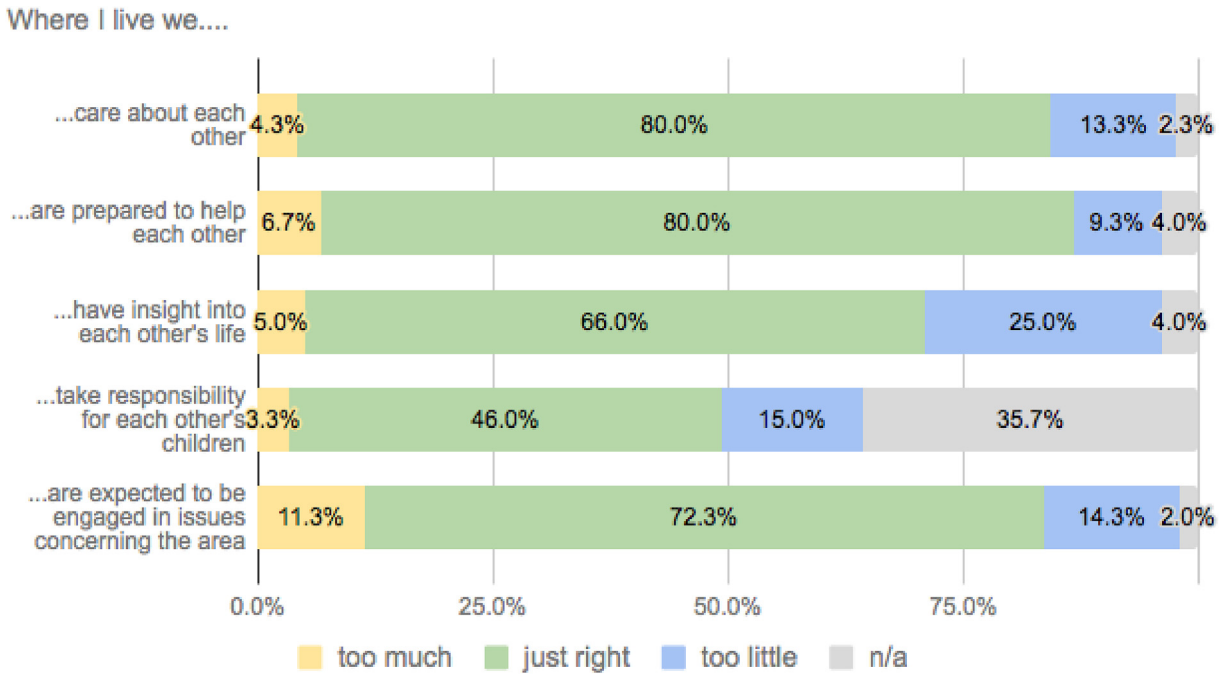

Fig. 2. Frequency of different forms of social bonds with neighbours.

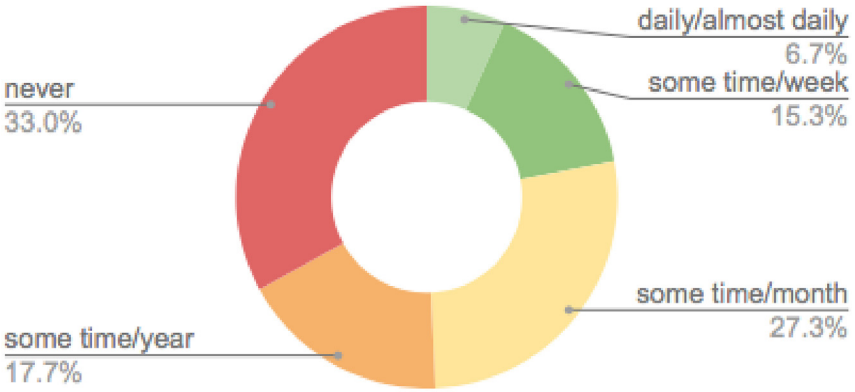

Fig. 3. Frequency of social meetings with neighbours.

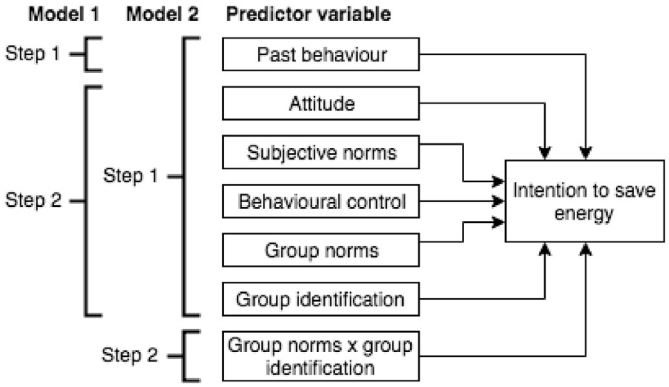

Fig. 4. The two hierarchical multiple regression models used to predict the intention to save energy.

beyond past behaviour. We did not find perceived group norms to be a significant predictor, meaning that the perceived norms of the other residents in the building in which an individual lives do not have a measurable influence on the individual's intention to save energy.

To test for the possibility that group norms only have an influence when the respondent identifies himself/herself with the group, we included an interaction term between group norms and group identification in the second regression model. This interaction did not explain any additional variance.

4.1.5. Summary of survey results

Regarding group norms affecting behaviour, we could only partly replicate the results from Fielding et al. (2008) in our context of energy behaviour. Attitude towards saving energy and the perceived behavioural control over such actions had an impact on behavioural intentions for the next six months above the influence of past behaviour. However, we did not find any significant influences of social or group norms, or any interaction effects. Still, the overall norms for the participants were clearly in favour of energy-saving behaviour, with a mean value of 4.97 on the seven-point scale.

4.2. Results from focus groups in Hammarby Sjöstad

Following our assumption that a local social network could fulfill local user needs and thus be a suitable context for energy feedback, we consulted local focus groups to find out what types of local needs such a network should fulfill. Based on the specific theme of each group, the focus groups discussed questions regarding the needs of the neighbourhoods, the types of digital tools already used to fulfil these needs and the kind of needs a local social network could solve. The main needs are summarised in Table 5, while a written summary of the meeting discussion protocols can be found in Appendix B.

The main needs identified by the focus groups that were compatible with the concept of a local social network were related to a better way of local communication at different levels. At the neighbourhood level, local organisations expressed a need to spread information about events, while residents reported a lack of

Table 4
Results of hierarchical regression analyses predicting intention to save energy, obtained using Model 1 and Model 2 (see Fig. 4 for details).

Step	Predictor	R	R^2	R^2ch	Δ F	df	ℓ
Model 1							
1	Past behaviour	0.43	0.19	0.18	67.94**	1/298	0.16**
2	Attitude	0.58	0.34	0.33	13.56**	5/293	0.27**
	Subjective norms						0.05
	Behavioural control						0.21**
	Group norms						0.07
	Group identification						0.01
Model 2							
1	Past behaviour	0.58	0.34	0.33	25.01**	6/293	0.16**
	Attitude						0.27**
	Subjective norms						0.05
	Behavioural control						0.21**
	Group norms						0.06
	Group identification						0.01
2	Group norms x identification	0.58	0.35	0.32	0.184	1/292	−0.02

Notes: *$p < .05$, **$p < .01$. ℓ-Coefficients were computed with all variables in the model.

Table 5
Findings from focus group (FG) discussions in Hammarby Sjöstad, Stockholm, regarding neighbourhood needs. '-' represents something negative, '+' something positive, '•' an observation, '?' a suggestion and '!' an identified need.

Name	Discussion results
FG1: Residents	**General neighbourhood needs and opportunities** - There is no comprehensive list of current local events - There is poor coverage of local news - Information from the municipal authority and city hall is lacking • Existing interest in organic and locally produced food ! Existing need for facilitating and saving time in everyday life **Local trust and safety** - When construction work is done, information to nearby residents about what is being done and how long it will take is lacking. In addition, the residents usually have no way of giving input prior to or during the work, even though it affects their local surroundings. - Using Blocket (Sweden's largest classifieds site) does not always feel safe + The area is generally perceived as safe • The existing Facebook group is the primary channel to report/discuss incidents and to report lost and found items ! One place for all types of error/incident reporting would be nice
FG2: Homeowner associations (HOA)	**Needs of HOA boards** - Getting an updated list of members is difficult, conflicting information is provided by different actors - An internal discussion forum that can be used for raising sensitive topics such as problems with pests and vermin is needed - Having a dialogue about co-operatively owned spaces is a complex task ! Better coordination is needed among HOAs in tendering processes involving subcontractors ! A single place for error reporting is needed
FG3: Environment	- The residents think they are environmentally friendly enough because they use district heating, they don't realise that many of their daily actions affect the environment - Apart from monetary savings, there is usually no reason for HOAs to be environmentally friendly; interest needs to be awakened ? Comparing energy use between HOAs would be useful, and gamification could be used to reduce the energy consumption ! Showing energy-saving tips to residents would be nice ! A possibility to compare energy consumption between HOAs would help their boards understand whether their own consumption is too high
FG4: Culture & Local Associations	**Needs of local cultural associations** ! An event calendar is needed, it is difficult to know what is happening in Hammarby Sjöstad. ! Internal discussion groups could be of use, but the greatest need is to inform others in the area ! Rating and reviews of events could be of interest
FG5: School	**Needs of local schools** - Digital tools for schools already exist, no need for new tools • Do not want to expose children to advertisements ? Could pupils be involved in creating content such as news or events as part of school assignments? ! Crowdfunding could be used by school or school classes to gather money for school projects etc.

such information. There was also a need for internal communication within the homeowner associations about various issues of importance.

5. Discussion and practical implications

The results from the survey and the focus groups only partly confirmed our assumptions.

To begin with, the survey results indicate that, while the respondents were content overall with the social relationships in their neighbourhood, there is in fact some degree of the 'local isolation' mentioned by Hayes (2007) in Stockholm Royal Seaport. Close to 50% of participants did not consider that they have a good social relationship with their neighbours. Furthermore, around one-third of participants never have any social interactions with their neighbours and another 18% have such interactions only a few times a year, yet around 25% of the participants wanted more insight into each other's lives within the neighbourhood. So there appears to be both scope and a need for improvement in the social climate between neighbours.

The survey analysis showed virtually no evidence that the norms of local social groups, e.g. neighbours, have a significant impact on households' energy behaviour or, in this case, the behavioural *intention* of saving energy. This was not totally unexpected since, according to Social Identity Theory, group norms will only significantly affect intention if the user strongly identifies with the group. Our average group identification of 3.82 (SD = 1.32) (on a seven-point scale) was relatively low, one possible reason being that much of the Stockholm Royal Seaport district is new and thus residents may not have had enough time to build up local social capital (Coleman, 1990; Sampson et al., 1999). In fact, our value was much lower than in the successful experiment by Fielding et al. (2008) (5.41, SD = 1.51) and even lower than in their first experiment (4.58, SD = 1.63) where they could not show any significant effect of group norms. Thus, if the group identity of individuals with their building and neighbourhood could be strengthened, this could lead to a stronger influence of building or neighbourhood norms on the individual's energy-saving intention and, hopefully, behaviour. This is something we aim to further explore in our planned follow-up survey.

Even without the help of group identification, the overall norm of saving energy was relatively high among participants – possibly higher than in Sweden in general, as Stockholm Royal Seaport is an eco-district with a strong environmental profile. This high norm could indicate an underlying interest in engaging in energy-related behaviours, increasing the odds of energy feedback, especially personalized feedback (Desmedt et al., 2009), being effective (Nilsson et al., 2018), provided that households can be made aware of this feedback.

This brings us to our engagement mechanism for households which aims to increase the visibility of energy feedback by addressing a core need while relying on group identity. This is presented in the next section.

5.1. Implications: proposed engagement mechanism – a local social network as context for energy feedback

Taking into account the results from the literature review, the

surveys and the focus group discussions, our proposed engagement mechanism for energy feedback can be summarised as follows. The survey confirmed the issue of local isolation and indicated potential for increased social capital (Putnam, 1995), while the focus group consultation indicated a significant need for improved local connectivity and communication. Therefore, the engagement mechanism has three main components:

1) Using a local social network to address real needs of residents

By addressing the actual needs of belonging to a group and by facilitating other non-energy-related local needs through local interactions, a local social network has the potential to become a useful tool for people who live in a neighbourhood. Therefore, providing energy feedback within the social network partially circumvents the experienced information overload. We believe that compared with common methods of providing energy feedback and even with relatively advanced home energy management systems, such as that studied by Nilsson et al. (2018), the feedback provided within a social network has a significant potential to sustain user engagement.

2) Fostering a sustainability norm

The second part of the engagement mechanism is to create (or in the case of Stockholm Royal Seaport, to strengthen) and foster a positive energy conservation norm and also introduce other sustainability-related norms. This can be done by communicating sustainability-related information in posts and emails in the social network. According to TpB, a sustainability-oriented norm could increase residents' intention to conserve energy, and thus their interest in energy feedback.

3) Leveraging social identity

Strengthening the sense of local group identity, through increased online and offline interactions, increases the opportunities for social influence (Fielding et al., 2008) on energy behaviour.

Increased interaction and knowledge sharing between neighbours has the potential to facilitate everyday tasks (Quan-Haase and Wellman, 2004), such as getting a recommendation about a local dentist, notifying neighbours about a lost wallet, borrowing a tool or quickly alerting neighbours about local incidents. Furthermore, self-organising local interest groups could help neighbours find others with similar interests, increasing the social capital and sparking initiation of local projects – as has been demonstrated by the Social Mirror and Community Mirror digital interventions in the UK (RSA, 2015). This would increase the number and quality of the so-called local weak bonds (Granovetter, 1973) and physical (offline) meetings between neighbours, breaking the 'local isolation' confirmed by our survey. It could also help strengthen the sense of trust (Rohe, 2004), safety (Dallago et al., 2009) and place attachment (Lewicka, 2004; cit. Lewicka, 2005, p. 392).

5.2. Implications: proposed design of the local social network

Taking into account the findings from the survey and the focus group discussions, we concluded that our idea of using a *social network specifically targeted at neighbourhoods* as a context for energy feedback is worth being explored in practice. We have therefore been involved in developing such a local social network, called LocalLife, which aims at improving neighbourhoods in the following two ways:

1) Facilitating local interactions

In our focus group discussions, very different communication needs were identified on different urban scales. Therefore LocalLife is divided into three levels of geographical boundaries: the building, the neighbourhood and surrounding neighbourhoods. This allows for relevant discussions on the right level. For instance, a break-in can be discussed within the homeowner association, a babysitter may be requested within the neighbourhood, while a lost pet can be communicated to everyone in one's own neighbourhood and the surrounding neighbourhoods. Given the importance of local interests (RSA, 2015), building-level or neighbourhood-level local interest groups can be created. The neighbourhood level can also be used by representatives from the municipality to spread information and discuss ideas with the residents. This design has the potential to meet most of the local information- and communication-based needs identified by the focus group members in this study, as shown in Table 6.

2) Increasing trust

To ensure a high quality of interactions in and between the urban scales, LocalLife verifies the identity of each user, and each user has to use their real name when using the network. This assures the users that it is indeed only their actual neighbours who receive their communications, which is particularly important for safety-related issues.

5.3. Implications: benefits of presenting energy feedback within a social network

Feedback presented within a social network can leverage the 'standard' network features to influence local norms, for instance by providing encouraging posts in the user's feed about the energy performance on different levels (household, building or neighbourhood) in relation to set goals. Further, and perhaps most importantly, it can utilize social influence by e.g. providing comparative feedback or including gamification elements such as showing an energy-saver badge on the user's profile or giving collective rewards for achieving collective goals.

A potential benefit of our approach compared with other common social networks is the inclusion of a building and neighbourhood level. This gives a possibility to present collective energy feedback, such as collective competitions or collective goals for the building or the neighbourhood, potentially increasing the feedback effectiveness according to the Social Identity Theory, provided that the group identity to the building or neighbourhood is (or can be made) strong enough for the group norms to be effective.

Regarding the limitations of other similar approaches discussed in section 2.3, namely complicated enrollment, energy consumption measurement, long-term engagement and uncomfortability with discussing energy issues in "ordinary" social networks, our approach has four key differences that could overcome these limitations. First, the feedback is fully integrated with the social network, which the users are already using for other reasons than to follow their energy consumption, i.e. to fulfil their social needs. Thus, the users do not need to actively download a separate energy app or learn about and install a plugin or Facebook app. Second, electricity consumption data is automatically obtained from the household's existing smart meter through data transfer from the participating district system operator (DSO) and thus there is no need to install a separate energy meter or submit manual meter readings as required in other pilot studies (e.g. Loock et al., 2011). Users still need to consent to transmission of consumption data

Table 6
Features of the communication platform on different urban scales according to identified needs.

Geographical scale	Features	Fulfilled needs identified by the focus groups (FG) (see Table 5)
Building/homeowner association	- Allows for private communication within the cooperative to discuss sensitive matters - Gives the board an easy way to communicate with its members and supplies recent contact details for each member	- FG2: An internal discussion forum for the homeowner association - FG2: Need for an updated list of members
Neighbourhood/surrounding neighbourhoods	- Provides a channel for communication and for spreading information about local news and events. - Serves as a way of citizen empowerment by facilitating discussions about important community matters.	- FG1: Better information about current local events - FG1: Better coverage of local news - FG1: Better and more frequent information from the municipal authority and city hall - FG4: Need for an events calendar - FG5: Need for channel for school pupils to create local content
Interest groups	- Creates bonds between neighbours - Allows local organisations to spread information to the neighbourhood.	- FG4: Channel for local groups/organisations to inform others in the area about events etc.

from the DSO, but this sign-up process is visible and available for eligible users directly in the social network app. These two differences are expected to lower the threshold for participation. Third, the feedback is presented to the user as long as they are using the social network (i.e. years instead of a few weeks or months), so it has potential to lead to long-term engagement. Fourth, since the social network is sustainability-oriented, discussion of energy-related matters, i.e. environmental sustainability, is encouraged and fits better than if done in a general social network such as Facebook.

Finally, it should be noted that conceptual and visual design to make the feedback engaging, and customization of the feedback to take full advantage of the possibilities offered by a social network, are important parts of the proposed approach. These aspects will be explored in future studies.

5.4. Limitations

A limitation of the study is that the focus group discussion and the survey differed both in time and place. Although both were conducted in Stockholm, Sweden, the focus group meetings were held in the district of Hammarby Sjöstad in autumn 2015, while the survey was performed in the district of Stockholm Royal Seaport (SRS) in spring 2018. If the results from these studies need to be combined, it could be argued that these differences would make it difficult. However, as they attempted to answer different questions (not the same questions from different perspectives), the results do not need to, and are not intended to, be combined.

The time gap between recording the needs expressed by the focus groups and creation of a local social network based on those needs could be an issue, but we have no reason to believe that there has been a significant change in the general needs of a neighbourhood during the period.

Regarding the generalizability of the results, it should be noted that both districts are eco-districts with residents on an upper middle-class income, so care should be taken when extrapolating the results to districts with significantly different demographics. While the neighbourhood-related needs expressed by the focus groups are expected to be relatively similar in many urban districts in Sweden and similar countries, the results from the survey are largely specific to the actual neighbourhood surveyed. This is not an issue, however, as the purpose of the survey is to provide a baseline for measurement within the same neighbourhood, and enable different neighbourhoods to be compared. However, the survey was conducted in a eco-district, where environmental awareness was probably higher than in an ordinary (non-eco) district.

6. Conclusions

It is difficult to maintain, or even achieve, the consumer behaviour changes required for demand-response management programmes using current approaches. In this study, the psychological need to belong to a group was used as the basis for a novel customer engagement approach. Analysis of theory and practical examples revealed that social influence is an important ingredient in energy feedback. A mixed methods approach was used to examine how an energy feedback approach that connects to this need could be designed. First, based on the Theory of Planned Behaviour and Social Identity Theory, a survey was conducted in a city district in Stockholm, Sweden, to examine the influence of e.g. the norms held by the local social group of neighbours, on energy behaviour. In contrast to previous studies on the influence of social groups on sustainable behaviour, no significant influence was found, although this could be a consequence of the low level of group identity found among survey participants. The survey also revealed a relatively low level of social connections and interactions between neighbours. Second, focus group discussions were used to obtain detailed insights on local residential needs, which mainly concerned sharing local information and having better communication within the neighbourhood.

Based on these insights, we concluded that a local social network can offer a suitable solution to the need for local social belonging and at the same time provide a context for energy feedback utilising social influence. In future studies, we plan to examine implementation of the energy feedback within the social network and to evaluate the effectiveness of this approach.

Acknowledgements

This research was funded by i) Sweden's innovation agency VINNOVA as part of the Citizen Communication Platform project with reference number 2015-00305 and ii) the InteGrid project, which received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 731218.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jclepro.2019.03.127.

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