Linking Data to Action: Designing for Amateur Energy Management

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ABSTRACT

Design of eco-feedback has primarily aimed at persuading individuals to change behaviours into more environmentally sustainable ones. However, it has been questioned how effective such feedback is in supporting long-term change. As an alternative focus for energy feedback, we present a case study of amateur energy management work in apartment buildings owned by housing cooperatives, and the design of an app that aims to stimulate and support cooperatives in taking energy actions that significantly reduce the cooperative's collective energy use. By linking energy data to energy actions, the users can see how actions taken in their own and other cooperatives affected the energy use, learn from each other's experiences and become motivated as energy amateurs. Based on our housing cooperative case, we reflect on design aspects to consider when designing for energy management in amateur settings.

Author Keywords

Sustainable HCI; Interaction Design; Energy; Housing Cooperatives; Amateur Community.

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION

Designing interactive technologies to understand and reduce the use of energy and other resources is an ongoing challenge in HCI. Previous designs of persuasive technologies for sustainability, often termed “eco-feedback”, have been criticised for having a narrow

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DIS 2016, June 04-08, 2016, Brisbane, QLD, Australia
ACM 978-1-4503-4031-1/16/06.

<http://dx.doi.org/10.1145/2901790.2901837>

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Figure 1. Housing cooperatives in Hammarby Sjöstad in Stockholm, Sweden. Image: CC-BY Hans Kylberg on Flickr.

approach, which may work to a certain extent in the short term but it is questionable whether they can support long-term sustainable change. One major criticism is directed to such technologies addressing the individual level but not acknowledging or addressing other levels (e.g. communities, corporations and governments) that greatly influence the way we use and consume resources [4, 10, 12]. Other points of criticism are that they do not discourage people from adopting new, more resource-intensive, practices [29] and that their potentially negative effects on for example privacy are not considered [5].

It has been suggested that the usefulness of feedback on energy use depends on the user's motivation [19, 25] and that it only is helpful for people who make rational decisions based on this feedback [30]. However, the practicalities of everyday life may get in the way of acting rationally [30, 7] and there can be also infrastructural barriers, such as opening hours of shared laundry rooms, to changing energy practices [23]. In apartment buildings, households are particularly limited in what they can influence since they may not be in control of heating, maintenance of the building or choice of appliances. Tensions between landlords and tenants can also prevent energy efficiency measures from being taken [8]. These

issues further support the argument that actors and contexts beyond the individual need to be considered in energy reduction efforts.

While the focus of eco-feedback is mainly on changing behaviours, rather than taking one-time actions to increase energy efficiency [14], environmental research suggests that one-time actions aiming at long-term effects have higher potential in reducing energy use [15]. Advice may be needed for making investments in energy efficient technologies, and friends and neighbours can be important sources of information perceived as trustworthy [26].

One further shortcoming of many interactive technologies targeting energy reduction is that focus lies mostly on electricity use [14, 24]. This can be regarded as a consequence of the individual focus, since, for apartment buildings, electricity use is something that households are expected to be in control of. However, in many countries with temperate or cold climate, electricity is only a small part of the total energy use; for example, 25% of the energy is used for electricity in an average Swedish apartment household [13]. The other 75% are used for heating and hot water, typically provided through district heating. Heating, in terms of people's perception of thermal comfort and alternatives to traditional space heating, has been explored by for example [6] and [21]. However, since the energy use for heating and hot water is affected by many factors beyond the control of the individual households (e.g. insulation of the building and the pipes, temperature settings, and type of energy system), we see another interesting case in studying and designing for people in charge of the building-level energy work, rather than the "users" of energy.

We have chosen to focus our research on supporting energy reduction actions in housing cooperatives, which are common in Northern Europe. For example, 20% of the Swedish households live in apartments owned by housing cooperatives (37% in Stockholm, where our study is situated) [27]. Housing cooperatives are managed by boards of volunteers from among the dwellers. The boards can propose energy-related decisions such as maintenance or one-time investments, which may be implemented directly or voted upon by all the households in the cooperative. Some boards have designated *energy managers* who lead the energy work. The board members (including energy managers) do not necessarily have any experience of energy management, and they often need to rely on others in the housing cooperative community, or on energy professionals, for taking energy reduction actions.

With our focus on housing cooperative energy management, we aim to inform and perform design that promotes and facilitates collective energy reduction work in settings such as housing cooperative neighbourhoods. There are other examples in HCI [e.g. 16, 9] of designing for social interactions between neighbours to encourage energy reduction in communities. However, our case moves the

design focus from energy use on a household level to building level energy use and energy reduction actions.

We regard both the apartment dwellers and the board volunteers as *energy amateurs*. Indeed, while few of them may pursue a profession related to the energy domain, the boards and the households see every year a major post in the cooperative budget allocated to energy. Without energy expertise, but with amateur knowledge of it, they strive to improve the cooperative's energy situation. Amateurs always act in social groups [28] and relate to others (amateurs or professionals) for learning and for assessing their "performance" in pursuing the respective field. Such social groups, in this case housing cooperatives and their energy-related federations, are termed *amateur communities* [3]. The amateur community framing is useful for us in design, as we have been involved, in other settings, in formulating design guidelines for such communities. We used and revised the guidelines in this case.

In this paper, we present a case study and initial design iterations aiming to reduce collective energy use in a district of Stockholm, where we have worked closely with six housing cooperatives and their energy managers. We detail on the amateur community framework and how it can help structure fieldwork and design, and comment on our field data in relation to this framework. The design of a housing cooperative energy app, which is used by the six cooperatives, is presented and reflected upon. Finally, we discuss how design can support amateur energy management, as a focus beyond the individual household, in settings other than housing cooperatives and we suggest additional design aspects to take into account for future support of collective energy management.

THEORETICAL FRAMEWORK: DESIGNING FOR AN AMATEUR COMMUNITY

We describe a view on voluntary amateur work that has inspired us in our fieldwork and design. The perspective was drawn from one of the authors' previous studies in amateur radio ([1] cf. [18]) and volunteer student association work [3], as well as on studies by Stebbins [28] on amateur sportsmen, archaeologists, and actors. Stebbins classifies the amateurs into *pre-professional* and *post-professional* and this is reflected by our energy managers; some are interested in energy but have never worked professionally with energy matters while others came into their energy manager role because of their former or present energy-related profession.

Amateurs were approached by HCI especially from the CSCW perspective, which is a sign of their collaborative nature, it is difficult to imagine an amateur who would not relate to a community. Grinter [17] presents work on amateur photography and the GROUP conference had a workshop on amateurs [31]. In the amateur community perspective, *amateur work* is fundamentally social and *challenge-driven* [3]. For example, one important amateur radio challenge is to realise radio connections with as little

transmission power as possible, to places as remote as possible. Amateurs value contingencies related to their work and aim to negotiate them. Some leading amateurs *pioneer* new such spaces of contingency, that are a whole new family of challenges, for example a new type of radio transmission in the amateur radio domain. The way challenges are addressed is *reviewed by peers* and good performance in addressing them is regarded as a contribution to community and is subject to recognition.

An important concern in amateur contexts with volunteer work is whether there are enough members to address the community challenges. The amateur community perspective thus also looks at ways in which people can become members of the community and possibly evolve towards a core status and become leaders. Amateur learning is important in this case, and the *community of practice* learning perspective [22] is employed, with new amateurs being regarded as peripheral participants learning from their more experienced peers. To facilitate learning, a community should provide both easy (addressable) and very difficult challenges. Members are thus following a *gentle learning path*. A healthy amateur community is then a community that has a sufficient number of members at all stages of learning about the amateur practice. As more and more challenges are addressed by a member, their prestige among peers is growing [1, 3].

A designer who aims to help an amateur community needs to identify their challenges and spaces of contingency and support the amateur work within these spaces. The designer should also aim to create or support a gentle learning path for the community members. One such design process and design product aimed at amateur programmers in a student association is described by [2], where the design product is still in use over a decade after the researcher left the amateur setting.

It is important for any community to follow up on its progress and all the more so for an amateur community. A designer who works with an amateur community should aim to let them follow to what extent they have addressed their challenges and what are the new kinds of challenges recently pioneered.

From the amateur community perspective, our aim in the housing cooperative energy domain is thus to understand energy managers as energy amateurs, to understand their challenges and spaces of contingency, and to pinpoint the energy notions and practicalities that they need to learn about. We also aim, through design, to support peer learning and to create a gentle learning path so that housing cooperative members who find energy work interesting can in their turn become energy managers.

METHODS

The first step in our design process was to increase our knowledge of the current energy management work in Hammarby Sjöstad in Stockholm, Sweden. During 2014

and 2015 we joined three meetings with the local energy network (attended by energy managers from different cooperatives as well as energy providers, energy consultants and other local energy stakeholders) and we joined or arranged six meetings with representatives from the energy network management group. To better understand the technical challenges of the energy management work, we observed the energy system in one housing cooperative and we also had a meeting with an energy management company.

To discuss potential design interventions on a high level, we carried out two group interviews, early in the process, with two housing cooperative representative in each interview. During the interviews we presented, and received feedback on, four scenarios that described different ways of using ICT for community energy work in Hammarby Sjöstad.

We analysed our notes from the observations, meetings and interviews using the amateur community framework as reference, and we identified a number of design opportunities for ICT to support amateur energy management work. To include all opportunities in a first design was not feasible, so we decided to create a mockup with the features we found most promising and that were furthest away from the tools the energy managers already had access to. The semi-interactive mockup of a mobile app was discussed in a focus group with three energy managers and, based on the discussion, we later iterated our design and developed a first version of a functioning app. Invitations to try out the app were sent to 13 housing cooperatives who had already given the energy network management group access to their cooperatives' energy data. In the end of 2015 we carried out app signup meetings with five energy managers from different cooperatives and with the "energy management group" from a sixth cooperative. During the signup meetings, the energy managers created an account, we discussed their cooperative's energy data and energy actions taken, the energy managers added a couple of energy actions and gave us feedback on the app.

The focus group and app signup meetings were audio recorded and data was also collected through a survey that included: information about how experienced the energy managers were as housing cooperative board members and as energy managers, their rating of energy knowledge in their boards and among other members, and energy related information about the cooperative.

To increase the number of users we will in the future also offer the app to housing cooperatives outside of Hammarby Sjöstad. The recruitment will mainly target board members who make decisions or drive decision-making processes on issues affecting energy use, although they might not identify themselves as energy managers. To reach out to the cooperatives we will collaborate with building management companies or other organisations that regularly are in

Figure 2. Energy network meeting with energy managers and other energy stakeholders (from [32], used with permission).

contact with housing cooperatives on practical matters that may be related to energy use.

AMATEUR ENERGY MANAGEMENT IN HOUSING COOPERATIVES

Everyone who buys an apartment in Sweden must join the local housing cooperative, which owns and manages the buildings and is in charge of the energy needed for heating, cooling, hot water, and electricity in common areas (facilities electricity). The costs, including also loans on the buildings and maintenance costs, are then spread to the households in the form of a monthly fee. This process is managed by the housing cooperative board, which is elected among the cooperative members every year. In the city district we worked with, many boards had appointed an energy manager with the responsibility of attending to energy issues. The energy managers were invited to join meetings with a local “energy network” (see Figure 2), managed by an umbrella organisation including 40 housing cooperatives in the area. The housing cooperatives vary in size, the smallest cooperative in our study has 38 apartments and the largest has 137 apartments, and they have different energy issues and resources to address the issues.

The Board and the Energy Managers

No previous experience or knowledge is required to join a housing cooperative board and the work is usually unpaid or rewarded with a small pay. Nevertheless, the work of the board is fundamental for the existence of the housing cooperative. The role of the energy manager is not compulsory in the board but dealing with energy issues is an inevitable part of the work. Some of the energy managers volunteered for the position because they had previous energy related professional experiences (one energy manager was a building owner for many years and another worked for the Swedish Energy Agency), while others volunteered because they were equally inexperienced as everyone else in the board. The experience of board work in other housing cooperatives varied among our

energy managers, from no previous experience up to 21 years of experience.

The energy managers’ personal drivers and goals for engaging in energy management work were often related to sustainability or minimising energy waste, which in terms of amateur motivation can be framed as their challenge. However, cost was a crucial factor when it came to making energy related decisions in the cooperatives and cost reductions were many times drivers of the collective energy work, which one of the energy managers expressed as follows: *“Personally I actually only consider the environment [in the energy management work] but when I motivate it to the board it is money I talk about.”* It was important that the board and housing cooperative members were convinced that any investment considered would pay off and for energy related investments a payoff time of ten years was perceived as reasonable. While sustainability might be considered, for example when investing in a new energy system, the energy managers did not think that environmental benefits would be enough to convince the board and the other members to make investments with uncertain payoff.

Being part of the board was a learning process for the energy managers, just as in other amateur work, and the local energy network further supported the learning. It was, however, difficult to sustain the learning process and keep the acquired knowledge in the housing cooperative due to the high turnover of community members. Of the nine contact persons in the cooperatives we initially collaborated with, five had changed a year later. It is not only knowledge about energy systems and previous work that is easily lost when people leave, but also the motivation to push for certain energy reduction actions.

Pioneering is an important aspect of amateur work, as it opens new types of challenges that other members of the respective community may appreciate and take in their turn. We have observed cases of for example a new type of contract with an energy management company being tested and an installation of a heat pump resulting in significant reductions of energy use. These cases were proudly presented at meetings with the energy network, which emphasises the importance of the peer audience in amateur work.

Other Housing Cooperative Members

In the amateur community perspective, ordinary housing cooperative members are peripheral participants who in the future may or may not take the amateur challenge and engage with energy matters. However, they are still affected by the cooperative’s energy decisions, for example in terms of limitations of the indoor temperature, and they might be involved in making decisions on energy investments during the annual meeting. The energy managers experienced that the engagement from other members was highest when they were unhappy about something, for example if they thought it was too cold in the apartments, but people rarely offered

help and many did not even attend the annual meetings. One energy manager described it as: *“some people have that hotel feeling, like... I want to have this fixed, you [the board] should fix this for me, preferably yesterday”*.

Although ordinary housing cooperative members have little power to significantly reduce the collective energy use unless they become part of the board, their actions may in some cases affect the entire energy system negatively. One example is members renovating the kitchen and replacing the cooker hood. If the new hood does not match with the building's ventilation system, it can decrease the efficiency of the system in the whole building. The collective consequences are not visible and might not even be known to the individual member, and it is also difficult for the energy managers to detect such issues.

Energy Issues and Energy Actions

The buildings of the housing cooperatives in the study are relatively new; they were constructed between 2001 and 2007 as part of a renewal of the city district. The sustainability ambitions were high for the area, with energy efficient buildings being one goal. However, many buildings were not as efficient as expected and energy audits have shown a potential for housing cooperatives to reduce their energy use with 10-50 per cent [32].

There are many different types of possible energy reduction actions, from small (and inexpensive) optimisations of current energy systems, such as adjusting the ventilation frequency or reducing the temperature in entrances and garages, to costly investments such as installation of a heat pump for heat recovery. Consequently, the scope of the energy challenge for the amateurs is wide and the energy managers have different goals depending on the energy status of the housing cooperative.

We have also encountered examples of energy simply being wasted, such as high electricity use for ventilation because the ventilation filters had not been cleaned for a long time and outdoor lighting that always was on because vegetation had grown and covered the light sensors. The issues were in many cases pointed out by an energy auditor working in the area, while energy managers were unaware of the waste. One energy manager found out that his cooperative used electricity for heating the pavement (meant for melting ice in the winter) during the entire year: *“I was surprised, we were heating water in the autumn. There was a dry spot in the middle [of the wet pavement], you could see where the electricity was. It was ridiculous, I’ve still got pictures of it.”*

Energy, and energy waste, matters also in terms of money. In most housing cooperatives, energy is the second largest post among the expenses, after costs for loans on the apartment buildings. The measured district heating use (for heating and hot water) among the housing cooperatives in our study varied from 0.5 to 1.4 MWh during 2014, which equals costs of around €52,000 (\$56,000) and €136,000

(\$148,000) respectively. Since the costs are high, the savings can also be significant. One of the housing cooperatives in the study installed a system for heat recovery, which in the first year after installation cut the energy costs with €50,000 (\$55,000), or about 40%, and they estimated the payoff time to eight years. However, a lot of work is required from the energy manager and the board for such investments to be realised and it is a long process that may take years of investigation, decision-making and implementation.

In addition, there was a need for involving energy professionals who could analyse the energy reduction potential, recommend solutions and carry out installations. While the amateur energy managers depended on the expertise of the professionals in such situations they also expressed concern regarding whom they could trust. Some housing cooperatives had bad experiences of being cheated by energy management companies and these companies were perceived as having vested interests. This is somewhat different from usual amateur-professional relations [28] where amateurs and professionals collaborate and learn from each other.

Energy Feedback and ICT Support

Through the main energy provider's website, the housing cooperatives can access detailed information about their use of district heating and facilities electricity. Energy data for the own cooperative can be viewed per hour or in different aggregations (see Figure 3) and there is some support for analysing historical data for the purpose of for example deciding on which type of energy contract to choose. This tool is only accessible for members of the board who have the necessary login information. Some of the energy managers we met had used the tool, for example to follow up on their energy work and see how they were progressing in their challenges, while others had never logged in to their accounts.

It is difficult for members outside of the board, who are

Figure 3. Example of energy data the housing cooperatives can access from the energy provider.

interested in the energy use of their own cooperative, to find information that is updated and easy to interpret. Indirect information in the form of yearly energy costs is provided in the cooperative's annual report, which sometimes also includes information about energy investments that have been made. However, this information can be hard to interpret for members not familiar with housing cooperative energy use. It is, for example, not obvious what is a “normal” annual energy cost, or what energy improvement work the cooperative should or could do. For comparison purposes, there is information about the cooperative's energy performance in the legally-required “energy declaration” of the buildings, which is a public document often available on the housing cooperative's website. While the energy declaration to some extent allows for comparisons, the data may not be particularly accurate since the declaration only has to be updated every ten years. Consequently, it might take a long time before the effect of energy reduction actions is visible in the energy declaration.

The energy network in Hammarby Sjöstad was interested in getting an overview of the energy performance of the buildings in the area, and a map-based visualisation (see Figure 4) was created with the energy performance data from the energy declarations. Although the overview was appreciated, and it emphasised that buildings that may seem similar from the outside can have very different energy performance, the visualisation was a static image and they would have liked a more dynamic overview with higher data accuracy.

From an amateur community perspective, none of the energy feedback the energy managers (and other housing cooperative members) had access to provided enough support for learning from peers, for assessing the work of their peers, for identification of suitable challenges or for community follow-up on the challenges. The tool from the energy provider facilitated the energy managers in analysing the energy use of their own cooperative and to follow up on their individual challenges, but it lacked a

Figure 4. Overview of the housing cooperatives' energy use (from [32], used with permission).

community perspective where challenges along with pioneering energy improvement work, are visible to the other energy managers.

THE HOUSING COOPERATIVE ENERGY APP

The aim of the app is to support peer learning between energy managers (both between different cooperatives and over time within a cooperative), to motivate them to find suitable challenges in terms of energy actions, to reward good work and pioneering by providing recognition, and to sensitise other members (peripheral participants) on the housing cooperatives to collective energy issues. We have developed a first version of the app that is currently used by energy managers in six housing cooperatives in Hammarby Sjöstad. For one cooperative also the household members have been invited to try the app and, in addition to the cooperative energy information, they can see their own household's monthly energy use (electricity and hot water). Below we describe the design rationale for the main features of the app as well as for the technical implementation and decisions related to privacy.

Energy Data Linked to Energy Actions

One of the key features in the app, which is not provided through any other energy feedback the energy managers have access to, is the mapping of energy actions to energy data as a way of supporting peer learning and providing follow-up on the energy reduction actions taken as part of their amateur challenge. Energy managers can add energy actions that their cooperative has taken along with information about the type of action, when it was carried out, the cost, and any additional information they think might be useful. After they are added, the energy actions appear as numbers in a bar chart displaying monthly or yearly energy use and the user can compare to the previous year's use to examine the effects of the actions (see Figure 5, left). The information about each action is found in an expandable list below the chart (see Figure 5, middle). All this information is visible to all app users in the district, which helps create a large peer audience, and helps make the energy reduction challenges apparent to prospective new energy amateurs, as well as to existing energy managers.

To make use of another cooperative's experience, more information may be needed than what is added to the action, for example if the energy manager from one cooperative is interested in details on how another housing cooperative optimised their energy system. Contact and communication ways are provided through a commenting function connected to each action (see Figure 5, right) and through an option for the energy managers to add an email address as contact point for energy related issues. Once the energy managers know which other cooperatives have taken energy reduction actions they are interested in, they can also start the discussion offline, during the energy network meetings. Our goal here was thus to spark interest

Figure 5. The housing cooperative energy app. Left: Visualisation of monthly energy use compared to previous year. Middle: The energy actions are listed below the graph. Action number 2 is an installation of a heat pump. Right: Each action can be commented on, for example to ask for more details on the action.

in peer learning and peer review of the energy actions and to promote pioneering of new kinds of actions.

The energy managers believed that the app would support them in learning from other housing cooperatives and they wanted to use the app to find cooperatives with similar challenges and see what actions they had taken. For example, one of the cooperatives was interested in changing the lighting in common areas to LED lights. He would like to connect with other cooperatives that had already gone through the process. The energy managers also thought the app would be helpful for deciding which companies can be trusted, based on the experience other housing cooperatives had with the respective company and what the effects were on the energy use. However, with only six cooperatives, and a few actions added, there is not yet enough data to browse between many different actions.

The purpose of linking energy data to actions is not only to support peer learning between energy managers in different cooperatives, but also to support learning within a cooperative when energy managers and other people in the board leave and are replaced by new members. This supports basic continuity in the amateur community. In some cooperatives there was no documentation (that the energy managers were aware of) related to the energy systems. In addition to documenting actions, the energy managers would like to have support for documenting calculations that are regularly made. As a first step, the app includes calculations of energy performance, which can be used to compare a cooperative’s energy improvements over time or compare the energy use of different cooperatives.

Housing Cooperative Energy Comparisons

One way of motivating the energy managers, and allowing them to follow up on their energy amateur challenges, is to make it explicit how the own cooperative is doing in relation to similar cooperatives. In the app this is done by displaying an overview of the yearly energy performance of the housing cooperatives (see Figure 6). The comparison is based on the previous year’s actual energy use and is calculated as the heating and hot water use divided by the heated area (kWh/m²). To facilitate comparison, the energy performance is displayed both as a number and as a colour (from red for high energy use to green for low energy use). The calculation and the “energy classification” based on colour are designed to be similar to the energy performance calculations in the compulsory energy declarations. The essential difference is that in the app the information is

Figure 6. Overview of the housing cooperatives’ energy performance and number of energy actions taken.

updated yearly instead of every ten years, which gives the housing cooperatives more direct feedback on, and recognition for, any improvements in energy performance. It is important that the energy performance is normalised for outdoor temperature, since it is otherwise impossible to compare energy performance between years.

Another type of comparison that is provided in the app is the possibility to compare a cooperative's monthly or yearly energy use, divided into "heating & hot water" and "facilities electricity", to the neighbourhood average (see Figure 7). Since the cooperatives in our study vary a lot in size (from around 5000 m² up to more than 15000 m²), energy use is also presented as kWh/m² in the bar chart.

Figure 7. Energy use compared to neighbourhood average.

It is difficult to make fair comparisons of energy use since there are variations in what energy data is measured, how the size of the heated area is measured and how the building was constructed. If the comparisons are perceived as unfair, we see a risk of demotivating energy managers, and of making their challenges appear too difficult to address. However, a poor energy performance is not necessarily the same as the energy manager doing a poor job.

The energy managers stressed the importance of easily understanding the reasons for why the energy performance is at a certain level, for example: *"It would be really interesting to compare one self in a simple way: they have 70 apartments, 80 [kWh] per square metre and we have 135 [kWh/m²], 121 apartments, they have taken these actions. So you know what it is you are comparing to."* Therefore, after discussing these aspects with a few energy managers, the app presents housing cooperative information that affects the energy performance: the number of apartments in the cooperative, size in terms of heated area, the building's construction year, and type of ventilation system in the building (see Figure 8). This allows the energy managers to better decide what is an addressable challenge and what is non-addressable in the case of their

Figure 8. Information about the housing cooperative that is important for understanding the energy use.

own housing cooperative. In addition, to highlight good work and pioneering in all types of cooperatives, the map and list overviews do not only show energy performance but also number of energy actions taken. Thus, an energy manager in a housing cooperative that was poorly built from an energy perspective can still share experiences and get recognition for taking actions.

The aim of opening up the energy data is also to make differences between one's own and other cooperatives visible for housing cooperative members outside of the board and to sensitise them to the energy work of their cooperative. However, the energy managers doubted, based on the current level of engagement in the general housing cooperative work, that many members outside of the board would be interested in following their own cooperative's energy use. They rather saw potential in using the app for engaging members in specific questions, such as getting support for energy improvements and investments, by pointing out the energy progress that *other* cooperatives have achieved: *"It can be good if one makes an investment and then points out... now we are doing like this [in terms of energy performance], look at the one that did that... they are doing like this. Then one can... here we can earn money."*

Technical Implementation

The first version of the app, currently used by the housing cooperatives, is a web application primarily accessed through mobile devices, thus its design is optimised for mobile phone screens. We made this priority since the users saw the current features as useful for having a quick look at during board meetings or "on the go", rather than something they would sit down and work with. However, there are possible future features that may work better on a bigger screen, and by keeping it as a web application we can easily add those features later. In addition, one user did not own a smartphone and instead accessed the app on his computer.

Even though the app is used as a web app, it is built using the Ionic Framework¹ for building hybrid mobile applications. Hybrid apps are essentially web applications wrapped in special containers for each mobile platform that

¹ <http://ionicframework.com/>

makes them run on the phone as native, rather than web, apps. However, due to the fast design iterations at this stage, we decided to use it only as a web app in the first stages.

The energy data in the app is acquired through Metry², a web service that provides a unified API for accessing utility data from many utility providers in the country. Since different energy providers have different formats for the energy data, it would require a lot of work to access it directly from each provider.

Selected use data of the app is logged for the purpose of future study and analysis. The data includes a database access log as well as analytics data, gathered through the service Mixpanel³, which captures the interaction in the app (e.g. logins, clicks, navigation).

Balancing Privacy and Openness

Since one of the core ideas of the app is to open up data that was previously only accessible to a few people in the housing cooperative, and share it with the members and other housing cooperatives, there were also privacy concerns to take into account for the design and implementation. In the app, all information that can be seen for the own housing cooperative is also visible to members of other cooperatives, but only the energy manager of a specific housing cooperative has the right to edit the cooperative information (e.g. type of ventilation system) and to add or edit actions.

We decided to present the energy data aggregated on a monthly and yearly basis, since that in most cases is enough for seeing what the effects are of actions taken. Daily or hourly data might also be sensitive, particularly for small housing cooperatives, since it could reveal when many people are not at home and assist burglars in identifying suitable times for breaking in. The energy managers did not see any problem with sharing monthly or yearly data, neither with sharing information about actions taken, basic information about the housing cooperative or their email address. However, some energy managers had concerns about making the information completely open, to people also outside of housing cooperatives, as they feared they might be contacted by a lot of companies offering their services. On the other hand, they thought it would be convenient if selected companies, such as energy consultants hired by the cooperative, could access their energy information through the app.

DISCUSSION

We have explored the potential of designing to support amateur energy managers in housing cooperatives as an alternative to the dominant, and by many questioned [e.g. 4, 5, 10, 12, 30], focus of eco-feedback aimed at individual behaviour change. While the setting of housing

cooperatives is rather specific to Northern Europe, we believe there are other groups of energy amateurs where linking energy data to energy actions, and at the same time sharing this information, could be equally valuable. Other forms of small scale building ownership have similar issues of persons in charge lacking knowledge of energy management in buildings, or even awareness of that there are energy issues that can be addressed. Whether or not they identify themselves as amateur energy managers, we believe there are opportunities for design to support them in work that has a significant impact and long lasting effects. Although we are still in the early stages of a long learning and design process, and further design iterations and evaluation will follow, we already now have some initial reflections and recommendations on what we found are important considerations when designing for amateur energy management.

Supporting Energy Action

While eco-feedback has long focused on different ways of visualising energy data, we see an interesting, and less explored, potential in *linking energy data to energy action*. Our design presents some early attempts in this regard, by linking data to action with the aim of supporting documentation, reflection and learning in amateur energy work. Yet we believe that this is a rich ground for further exploration of other ways of designing and assessing the data-action linking.

For example, a different temporal perspective can be applied by linking past energy data with suitable future action, designing for a catalogue of possible actions and indicating their suitability for the situation as it emerges from past energy data. We also believe that designers should make use of and adapt simulations that exist in the “energy and the built environment” research area to link data to action in the future, not just in the past, and facilitate in assessing energy improvement impact and payoff times. Creative adaptation is required because existing simulations are not directed to energy amateurs, but more to professionals.

Designing at the energy community level also lifts a sensitivity, which we started to explore, for *awareness* within the community. Awareness of suitable energy actions, awareness of peers who may have the same issues or needs, awareness of good professional help one can get, are a few examples that illustrate opportunities for the designer. The CSCW field has long considered the awareness topic in workplaces, as a notion related to coordination [11], yet it has not been explored much in less formal (amateur) work settings such as energy communities. The awareness we would like to emphasise is closer to this collaborative awareness than to “energy awareness” that is prominent in eco-feedback.

Working with Long Time Perspectives

Energy work in housing cooperatives is a slow process that is further affected by the high turnover of board members.

² <https://metry.io>

³ <https://mixpanel.com>

This is similar to energy work also in other settings, since energy investments take time to consider, plan for, decide on and carry out. In addition, the results of investments may not be immediately visible; in some cases a full year is needed to evaluate the effects. Thus it may take many years from an energy action is first initiated until the results show. For the design process, this means we must look for ways to assess our work and judge alternatives that are not directly dependent on actual energy reductions.

The combination of slow processes and the amateur (volunteer) context may lead to energy work being initiated by someone who leaves the community before the work is finished and without any handover. Another design goal should therefore be to bridge such gaps between energy managers. Our current design partly supports this by the option to document energy actions, but we also see a potential in involving actors on higher levels to ensure continuity. For example, energy management companies, which may work with a housing cooperative during a long time, could play a part in using the app for documentation of the work they are doing and introducing new energy managers.

Sparking Energy Interest

To find ways of sparking the interest of peripheral participants [22] is crucial for energy management to become a self-sustainable amateur practice. However, a consequence of the slow processes in energy management is that the content of our app does not change fast, and particularly to the less knowledgeable user the app will often “look the same”. This is not what modern mobile users expect, and it is a challenge that must be considered when designing in an amateur energy management context. One possible way of addressing this is to combine energy data with local community information, which does not need to be energy-related. Another possible design approach is to highlight when there is new information that may be interesting for the user, such as actions taken by the own or a similar cooperative or data showing the effects of actions, and to make it easy for energy managers to share selected challenges or accomplishments in situations where they think peripheral participants would be interested.

A further challenge is that energy management work comprises, to a great extent, resource management decisions, which eco-feedback has been criticised for focusing too much on [30]. This is currently mirrored in the design of our app and while the resource management focus is appreciated by the energy managers, it may be less appealing to others in the community (including possible future energy managers). In fact, we found that the motivation for engaging in energy management work in the first place was often related to responsibility and environmental concern. We thus believe that design, to assist in sparking energy interest among others than the already engaged, should explore how such values can be designed for in relation to energy management work.

Considering intrinsic values, such as caring about the environment, is also in line with suggestions [20] for how HCI can better utilise interactive technologies for sustainability purposes.

CONCLUSION

We have presented a case study of energy amateur management in housing cooperatives, which illustrates collective energy work that has a high impact on energy use in buildings. We have presented and reflected on the design of an energy app that aims to support peer learning among the amateur energy managers, identification of suitable amateur challenges and documentation of energy work. Linking energy data to energy actions was a key design feature in the energy management support and we believe there are further design opportunities in exploring combinations of data and actions. Additional aspects for design to consider are the slow processes and the long time perspective in energy work and the challenges in inspiring community members to become more involved in energy issues.

ACKNOWLEDGMENTS

This work has been supported by EU FP7 programme through the project CIVIS (no 608774) and the Swedish STandUP for Energy Initiative. We are also grateful to the housing cooperatives and energy network in Hammarby Sjöstad, and to our CIVIS project colleagues.

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