Smart community energy initiatives in Smart Cities: Learning collectively about energy.

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Abstract. Community energy term involves different types of communities solving energy issues, including generation, energy use reduction, management and energy purchase, in many different ways. In this document we describe an approach to support the identification and creation of community energy initiatives in Milton Keynes. We discuss our initial design of an application that will facilitate the combining of multi-source urban information and will put advanced urban data analytics into the hands of communities. This tool will allow individuals and groups to learn about and reflect on energy use and future possibilities. To fully exploit this application, citizens must go through a learning process to understand the nature of the data, how to analyse the provided datasets and how to interpret the results.

Keywords: Multi-source integration, Public engagement, Smart cities, Citizens learning.

1 Introduction

Maintaining energy security while meeting climate change objectives is a challenge that the UK has to face in the coming years. The UK government has envisioned a future where, despite the fact that large-scale energy generation will still have a significant role to play, the energy market will no longer be dominated by a small number of large companies. It is a vision that includes other more flexible, competitive and innovative approaches. This brings great opportunities to small and local initiatives that could become important actors of the energy market, generating green and distributed energy across the country, whilst contributing to regional growth and jobs [1].
This vision has been supported since the publication of the Community energy Strategy in January 2014 [2], where the government recognised that “community energy has the potential to be transformative” and identified important benefits of community energy, to:

- maintain energy security and tackle climate change
- save money in energy bills
- bring wider social and economic benefits.

These objectives perfectly fit into the MK:Smart project [3], which will develop solutions to support sustainable economic growth in Milton Keynes (England). This project will innovate in the areas of transport, water and energy supporting the current growth of Milton Keynes without exceeding the capacity of the current infrastructure whilst meeting carbon reduction targets.

To foster small, local and community energy initiatives and as part of the MK:Smart project, we are going to develop a platform which will connect different users such as citizens, small and medium enterprises (SME), Milton Keynes Council members and interested researchers, with meaningful datasets through analytic capabilities which will help to understand how energy is consumed in Milton Keynes and which are the main factors that drive this consumption. The primary goal of this platform is to identify energy community initiatives which make a better use of energy, reducing CO^2 emissions, reducing the bills of the citizens and generating energy in a distributed way. Additionally this will unlock a new energy market for SMEs. As a result we aim to enable bottom-up social action within communities.

To achieve these goals an application will be developed. This application will connect users with a range of different datasets and will provide advanced analytic capabilities to them. Users will in turn share information about their energy consumption patterns, insulation infrastructure and energy generation capabilities, which will contribute to a dataset that could help to understand the energy flows in Milton Keynes and to identify energy opportunities.

2 Multi-source Urban Datasets

To develop this application a number of key datasets have been identified. These datasets comprise a mix of open and licensed data. Key datasets can be classified into three different groups: *Satellite and aerial imagery derived* data, *Socio-economic* data and *Energy* data.

Fig. 1. Example of yield for potential solar panels in Milton Keynes urban area. (Source: ©Bluesky International Limited in partnership with Satellite Applications Catapult Ltd)

Novel *satellite and aerial imagery derived* datasets include location and capacity of existing and potential solar panels in each building of Milton Keynes (Figure 1), datasets revealing building heat loss, location and capacity of heat-pumps installations and potential solar farms in the Milton Keynes peri-urban area.

Socio-economic datasets, such as consumer behavior, employment and income, will allow the characterisation of different areas in Milton Keynes and contribute to an understanding of community cohesion and in developing economic profiles of diverse neighborhoods.

Energy datasets comprise open energy data, published by the Department of Environment and Climate Change (DECC[1]) and the Centre for Sustainable Energy (CSE[2]), and licensed data which includes but is not limited to fuel poverty data and census data.

The above mentioned datasets are going to be used to characterise a number of different spatial features. These features, which will be used as basic units to perform the analyses, include Lower Super Output Areas (LSOA), Output Areas (OA) and Milton Keynes buildings, from more coarse to more detailed spatial resolution.

3 Advanced Analytics

A range of analytical capabilities will be developed in order to connect users with data, allowing them to explore and make sense of all the available datasets. These analytics will comprise basic statistics values such as maximum, minimum, average, median and distribution of the values which will allow characterising features under inspection. Analytic capabilities will also include more advanced statistics and inference mechanisms. In particular, users will be able to perform cluster analysis selecting which variables they want to include into the model and which features to classify. This will allow identification of areas more similar to each other that share characteristics that make them more suitable to develop energy projects.

Basic exploratory capabilities can also be found in a number of online tools designed to make energy datasets better accessible. Thermal Harrow [4], for example, presents data showing heat loss from buildings, and the energetic map of Barcelona [5] presents solar and wind potential for each building in the city. In a similar way, there are a number of tools that facilitate inspection of socio-economic data, such as Datashine [6], which provides insights into UK census data. However, these tools focus on data visualizations but lack opportunities for interactive data explorations by users through advanced analytics, and they do not provide built-in mechanisms to foster mutual relationships between users. As the objective of the proposed application is not only to inform users, but foster community structures and relationships, sharing capabilities will be an important part of the user experience.

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[1] https://www.gov.uk/government/organisations/department-of-energy-climate-change

[2] http://www.cse.org.uk/

4 User Experience

The proposed application aims to support the complete cycle that starts from data and ends with users contributing to the design and planning of the urban energy system of the city, ideally as part of different community energy initiatives such as solar panels cooperatives, heat networks or bulk fuel buying schemes. The application is going to support different users' roles, different types of energy communities and people with different motivations and data management and analysis skills. Dick et al. [7] adapted a classification of roles by Preece and Shneiderman [8] to the case of community energy. They recognised 5 types of users: unaware consumer, aware consumer, collaborator, designer and meta-designer, and designed a tool called EMPIRE to support the migration from the unaware consumer to the collaborator role, breaking the large step between these roles in smaller and affordable steps.

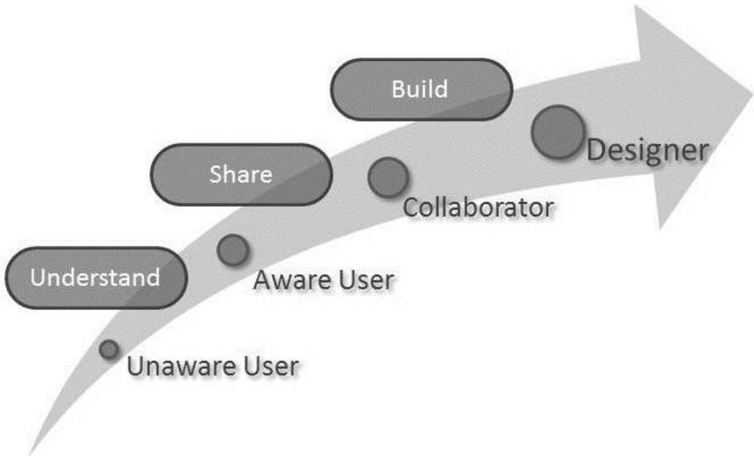

Fig. 2. Unaware user – Designer cycle with the key actions supporting the transition between user types.

As we are interested in bottom-up initiatives which involve citizens collaborating among themselves and designing their own systems, we have planned to take this work further and adapt the transition from the unaware user to the collaborator and designer roles (Figure 2).

From the unaware to the aware user. "Understanding" is the key concept to support the migration from unaware to aware users. Unaware users will be provided with meaningful information that allows them to understand their current energy consumption, how it is different from other users and what the existing alternatives to improve their energy management are.

From the aware to the collaborator. "Sharing" is the key concept to allow the transition from aware users to collaborators. Users will be encouraged to complete an interest profile. The application will then suggest connections among users that are interested in similar projects and should talk to each other. It will support sharing of information between users and it will foster conversations and discussions around energy consumptions and alternatives, allowing people to share their experiences and knowledge. Additionally, messages posted by users will be used to perform natural language processing analyses, finding new areas in which users could be interested in based on their conversations.

From the collaborator to the designer. “Building” is the key concept to support the last step: transition between collaborators and designers. It will be supported by the afore-mentioned analytics. Users will be able to make hypotheses, perform analytics, analyse the results, find areas of interest and share their results with other users that could be interested in their projects. Additionally legal and economic information, such as applicable grant schemes, will be available to users interested in starting a new community.

In this process it is important to take into account that users have different motivations to be part of community energy initiatives. Radtke [9] identified that users can be classified in three different groups based on their attitudes: *Ecological, Structural conservatism* and *Investors* attitude. *Ecological attitude* motivation is characterised by a contribution to achieve different environmental goals (e.g. low CO^2 emissions, green energy consumption…). *Investors attitude* is characterised by financial benefits motivation and *structural conservatism motivations* are a mix between the two. The application will include enough information to satisfy attitudes and needs important to these different groups, for example by expressing results as money and CO^2 emissions savings.

5 Learning Process

To be able to progress between these roles, user will need to improve their data literacy. To design this learning process different workshops are going to be held, which will inform the resources that help users to make sense of the data, designing the tool based on final user needs. The intention is not only help users to make sense of energy data and promote community energy initiatives, but also include the appropriate tools that help users share their findings, fostering collective learning.

These are challenging objectives as datasets involved in this platform are complex in nature and the analytics that will be available to users are not trivial.

6 Research Goals

The main research goal to which this project aims to bring clarification is to understand the process that starts with datasets and goes through a citizen led innovation process to achieve a social, environmental and economic benefit.

Therefore there is a key aspect that needs to be understood in this process: to identify which are the users’ needs to make more informed decisions around community energy initiatives.

By the end of the project we aim to answer which learning resources or process should be included in the platform, which datasets are most important for citizens to understand energy demand and to foster community energy initiatives and how this information should be provided so that citizens can make the best use of it.

To design a successful tool, user motivations may not be enough. Community energy initiatives have to overcome a number of barriers. Some of these barriers are inherent to community energy such as cost of implementation, data availability and difficulties connecting to the existing infrastructure [10][11]. Other more general issues arise when people share resources, time or skills. To overcome these issues it is interesting to look at what initiatives of different types have done. Particularly, some similarities have been found with sharing economy initiatives, which have to face similar problems, such as the need of trust among members, the need of internet access and the ability to manage complex bureaucracy processes when implementing these initiatives [12].
What seems a key aspect to convert projects envisioned by *designer* users to successful community energy initiatives is the capacity of members to build relationship of trust [13]. Therefore it will be important to provide this project with mechanisms to build these relationships. In this sense, how strategies learned from *social capital building* researches could be integrated in the proposed platform will be investigated.

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