Enhancing user engagement in local energy initiatives using smart local energy engagement tools

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1. Introduction

To address the growing concern of climate emergency, the UK government has committed to a net-zero emission target by 2050 [1] by limiting the temperature rise to 1.5°C [2, 3]. Local energy initiatives can help in meeting this target by delivering cleaner, cheaper and desirable energy services for end users [5] by integrating smart (digital) use of data and communication technologies to interact with users [6]. Deploying effective Smart Local Energy Engagement Tools (SLEETs) in local energy projects that allow users to better manage, control and observe energy will help to reduce this pressure, while encouraging users to become active participants [6]. SLEETs are enabling smart tools that enhance user engagement by supporting energy users to reduce energy use and energy cost, match energy demand and supply, improve energy efficiency and management [7]. They also allow users to measure their own energy consumption and investigate energy efficiency measures and environmental impact of the energy systems [8]. These tools can provide advice and support to improve energy use behaviour and help users to participate in local energy market such as peer-to-peer trading and grid balancing [9]. For SLEETs effective they should address engagement between *people and people* [10] and *people and technologies* [11]. It is also important to improve inclusiveness of SLEETs by including vulnerable users and those who are not digital to ensure no one gets left behind in the local energy transition.

This paper examines the prevalence, effectiveness and inclusiveness of smart local energy engagement tools (SLEETs) that have been deployed in local energy projects across the UK and internationally to enhance user engagement and participation in local energy management that includes supporting users to engage with energy efficiency, energy generation and demand side response.

2. Methodology

A meta-study approach was adopted to identify what types of SLEETs were deployed across local energy projects during the period 2008 to 2019 to cover major funding programmes on local energy projects such as *Low Carbon Communities Challenge* (LCCC), *Localised Energy Systems*, *Network Innovation Allowance* (NIA), *Horizon 2020* and the *Local Energy Action Fund* (LEAF).

About 86 local energy initiatives were identified that used SLEETs to enhance user engagement. These projects were undertaken in the UK (73), EU (7) and outside of EU/internationally (6). They were characterised by *lead actor* (e.g. DNO, university, private sector, community group, local authority and partnership collaboration), *funder* (e.g. government, research council, DNO and regulator), start year (2008 to 2019), *type of initiative* - community energy (CE), local energy (LE) and smart local energy systems (SLES) and *energy vector* (Electricity, Heating, Transport).

Analysis framework was devised to characterise SLEETs in terms of their *interface design* - numeric, visual or aural, and *type of interaction* offered - information driven (one-way), information & interaction (two-way), information & control or decision support (Table 1). A total of 111 SLEETS were identified across the 86 projects. These were grouped into eight types of SLEETs that included: In-home-display (IHD), digital energy platforms (DEP), digital voice assistant, spatial mapping, thermal imaging, gamification, mobile app and online energy dashboard.

Table 1: Analysis framework to characterise SLEETs

Extend of interaction	***Interface***		
	Numeric	***Visual***	***Aural***
	Example of SLEET	Example of SLEET	Example of SLEE
Information driven (one-way) -could be *numeric* or spatial.	In-home-displays (IHDs)	Spatial map (energy flows across scale)	-
	-	Thermal imaging	-
Information & interaction (two-way)	Online dashboard/ web portal	Gamification (Energy mapping tools that require input from users for example to assess solar potential)	Digital voice assistant
	Mobile app	-	
Information & control- could be manual or automated	-	-	
Decision support - to help operation of systems by providing energy related data to users	Digital energy platforms (DEP)	-	-

3. Results

Statistical analysis revealed the prevalence of different types of SLEETs across 86 local energy initiatives. Digital energy platforms that visualise energy data were most popular (30 out of 111 SLEETs), followed by in-home display (IHD) that provide energy feedback (29 out of 111 SLEETs) and thermal imaging that highlight heat losses from building fabric (23 out of 111 SLEETs). Interestingly *information driven* (54) and *decision support* (31) tools with *numeric* and *visual* interfaces were dominant. *Information & interaction* tools were less popular – these included, mobile app (10) and gamification (9), followed by online dashboard (5) and digital voice assistant (2).

Majority of SLEETs (34%) were deployed in project areas with network constraints including South East (20 out of 86) and South West (9 out of 86 projects) of England (Figure 1). Interestingly there were active community energy groups in these areas and local authorities with local energy action plans, who acted as intermediaries to improve user engagement [17] [18]. Projects funded by Government, regulator or research councils were found to deploy SLEETS to engage users with energy management. However only 27 out of 86 projects considered inclusiveness of SLEETs in relation to low income groups and vulnerable users.

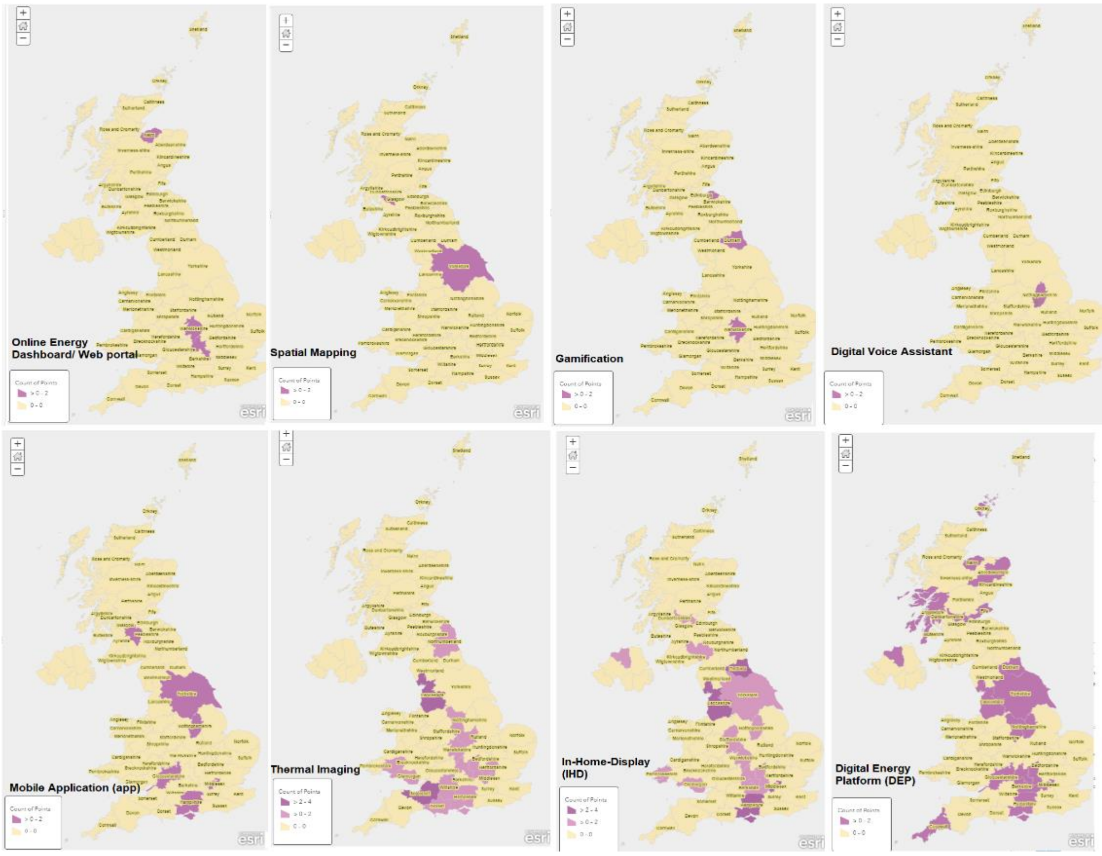

Figure 3: Distribution of SLEETs in the UK at spatial resolution of county

Statistical analysis revealed significant co-relation between types of energy initiative whether it was CE, LE and SLES and type of SLEETs. There was widespread deployment of thermal imaging in CE projects for encouraging behaviour change ($p<0.001$), while Digital Energy Platforms (DEPs) were prevalent in SLESs as decision support tool for improving energy management ($p<0.001$) (Figure 1). There was also some association between SLEETs and the engagement pathway adopted in local energy initiatives. In-home dispaly and gamification were adopted as engagement tools for *communication* (p-values < 0.05), while DEP and thermal imaging were used as *informing* tools.

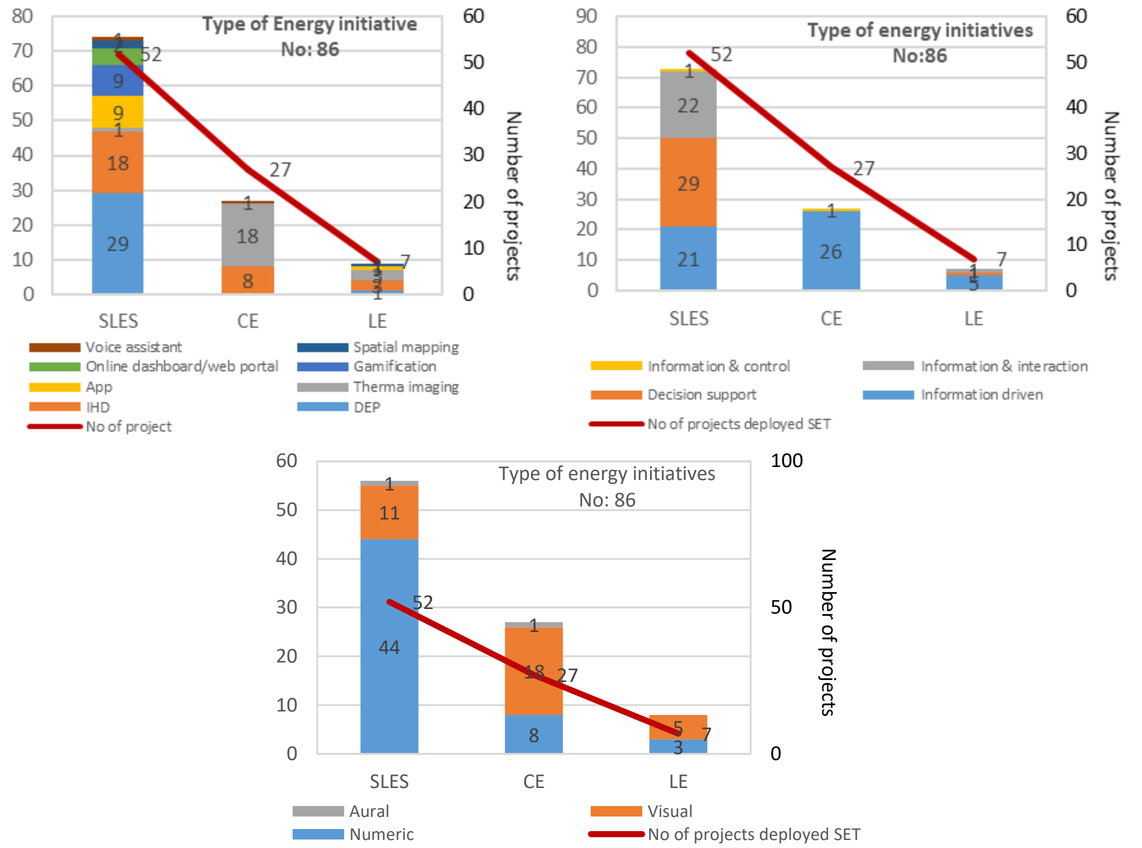

Figure 1: Type of local energy initiatives and (a) SLEETs (b) extent of interaction (c) interface design

4. Discussion and conclusion

It was evident that majority of the energy projects that deployed SLEETs were SLES (61%) since these projects focused digitalisation of energy and smart approach for integrate heating and electricity generation, distribution, storage and EV infrastructure [15]. Spatial distribution of SLEETs in relation to local energy initiatives confirmed that SLEEts were deployed in areas wuth high capacity for renewable energy technologies, while having grid constraints issue [16] as well as prevalence of active community energy groups and local authorities.

Integrating social aspects with interactive engagement tools such as mobile app, online dashboard, gamification and digital voice assistant can empower users to manage energy services. For this to happen, transparency should be improved to allow users to know what data is collected and how it is being used (Döbelt et al., 2015) alongside developing energy platforms by trustworthy intermediaries to foster trust. Digital voice assistants may be more appropriate for vulnerable users and those who prefer not to use a thermostat or smart app. Most importantly SLEETs also have a new role during the time of Covid-19 pandemic, since they can allow long-term user engagement with less face-to-face interaction.

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