Article

Citizen Engagement for Co-Creating Low Carbon Smart Cities: Practical Lessons from Nottingham City Council in the UK

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Abstract: Cities constitute three quarters of global energy consumption and the built environment is responsible for significant use of final energy (62%) and greenhouse gas emissions (55%). Energy has now become a strategic issue for local authorities (LAs) and can offer savings when budget cuts have threatened the provision of core services. Progressive LAs are exploring energy savings and carbon reduction opportunities as part of the sustainable and smart city agenda. This paper explores the role of citizens in smart city development as "buildings don't use energy: people do". Citizens have the potential to shape transitions towards smart and sustainable futures. This paper contributes to the growing evidence base of citizen engagement in low carbon smart cities by presenting novel insights and practical lessons on how citizen engagement can help in smart city development through co-creation with a focus on energy in the built environment. A case study of Nottingham in the UK, a leading smart city, is analysed using Arnstein's Ladder of Citizen Participation. Nottingham City Council (NCC) has pledged to keep "citizens at the heart" of its plans. This paper discusses learnings from two EU funded Horizon 2020 projects, REMOURBAN (REgeneration MOdel for accelerating the smart URBAN transformation) and eTEACHER, both of which aimed to empower citizens to reduce energy consumption and co-create smart solutions. Although these two projects are diverse in approaches and contexts, what unites them is a focus on citizen engagement, both face to face and digital. REMOURBAN has seen a "whole house" approach to retrofit in vulnerable communities to improve liveability through energy efficiency. User interaction and co-creation in eTEACHER has provided specifications for technical design of an energy saving App for buildings. eTEACHER findings reflect users' energy needs, understanding of control interfaces, motivations for change and own creative ideas. Citizens were made co-creators in eTEACHER from the beginning through regular communication. In REMOURBAN, citizens had a role in the procurement and bidding process to influence retrofit project proposals. Findings can help LAs to engage demographically diverse citizens across a variety of buildings and communities for low carbon smart city development.

Keywords: citizen engagement; co-creation; smart cities; lessons learnt

1. Introduction

There is widely acknowledged need to reduce energy use and carbon emissions to mitigate climate change. The built environment constitutes a significant use of final energy (62%) and is a major source of greenhouse gas emissions (55%) [1]. At the same time, cities are facing sustainability

challenges, with more than half of the world's population now living in urban areas while consuming 80% of the natural resources [2]. The concept of the "Smart City" emerged as a major response to urban challenges to achieve sustainability. In the past, much of the focus has been on technological interventions, but technology alone may not be enough [3]. Local communities and citizens are often an untapped source of potential to help local authorities deliver smart city innovations. The intention of smart cities can only be met by making the citizens smart and involving them in city governance and decision-making [4]. Novel citizen engagement approaches need to be explored, both within wider society and specific organisations to aid transitions towards energy efficiency in smart cities [5]. Cortés-Cediel et al. [6] argue that there is a lack of research to know how this new governance is taking place in the citizen centric smart city arena. Therefore, the there is a need to build the evidence base of how citizen engagement can be practically embedded in the smart city activities of municipalities. The aim of this paper is to provide insights and practical lessons on how citizen engagement can help in smart city development through co-creation with a focus on energy in the built environment. Smart city refers to smart sustainable city (and low carbon) as cities cannot be truly smart without being sustainable [7]. This paper explores two distinct approaches to smart city co-creation with citizens, drawing out practical lessons for local authorities. Both are EU funded Horizon 2020 energy and carbon reduction smart city projects in Nottingham (UK): REMOURBAN (REgeneration MOdel for accelerating the smart URBAN transformation) and eTEACHER. The paper first explores the theoretical underpinnings of citizen engagement, with an emphasis on Arnstein's Ladder of Participation [8] and existing research on community and citizen involvement in smart cities and energy reduction (Section 2). After discussing the research methods used in this study (Section 3), the two case study projects are presented with analysis and reflections on lessons learnt in engaging citizens in smart city journeys (Section 4). Finally, the main research findings are discussed in relation to the existing literature with a set of conclusions and implications of the research are also discussed (Section 5).

2. Literature Review and Theoretical Background

2.1. Smart City Development

Smart and sustainable cities are rapidly building momentum and attracting a global spotlight [9,10]. There is little consensus on what a smart city is, and it is still considered a fuzzy concept [11–13], but early definitions of smart city tended to focus on the technical aspects [14]. There are a range of industrial definitions for Smart Cities, as discussed by Bull and Azzenoud [15]. Companies, notably including IBM, Schneider Electric, CISCO and Siemens, have exploited the smart city concept to market their visions of future cities, essentially the "application of complex information systems to integrate the operation of urban infrastructure and services such as buildings, transportation, electrical and water distribution, and public safety" [16]. Smart cities have become a major development area for the European Union (EU) that defines them as "systems of people interacting with and using flows of energy, materials, services and financing to catalyse sustainable economic development, resilience, and high quality of life; these flows and interactions become smart through making strategic use of information and communication infrastructure and services in a process of transparent urban planning and management that is responsive to the social and economic needs of society" [17].

Harrison and Donnelly [18] draw attention to the smart city's conceptual roots in the 1990s Smart Growth Movement. While the "Smart City" has largely been perceived as tantamount to a high-tech municipality [14], Nam and Pardo [19] note there is no single template or one-size-fits-all definition. Through the three dimensions of technology, people and institutions, they go on to lay out strategic principles of smart city development: integration of infrastructures and technology-mediated services, social learning for improved human infrastructure and governance for citizen engagement. Pham et al. [20] meanwhile suggest that there are three key factors to a smart city's success: human capital, citizen empowerment, and human interaction and involvement. Chourabi et al. [13] set out an integrative framework casting organisation, policy and technology as the main pillars of a smart

city, built upon with secondary factors including governance, people, economy, infrastructure and natural environment.

2.2. The Role of Citizens in Smart City Development

Citizen engagement is now commonly central to smart city definitions and is said to be essential to address urban challenges [21]. However, actual practical examples are often lacking. Information and communication technologies (ICTs) offer unprecedented opportunities for expanding public participation [22,23]. Europe's manifesto on citizen engagement towards inclusive smart cities accentuates the importance of co-creating solutions. Lea et al. [24] argue that smart city projects are commonly, in practice, top-down through their application of ICT to manage city infrastructure such as transportation, traffic control and monitoring of energy and pollution monitoring. However, grassroots, citizen-driven smart city projects can deliver better value and success that can also be aided by ICT tools. The "smart" approach can sometimes view people's behaviours as an obstacle to navigate as opposed to a resource to be used. Leach et al. [25] contend that top-down technocentric projects are less likely to deliver their objectives. The former UK Department for Business, Innovation and Skills (BIS) stated that smartness makes cities more "liveable and resilient", ideally allowing citizens to engage with all public and private services on offer, in a way optimally tailored to their needs. It incorporates "hard infrastructure, social capital including local skills and community institutions, and ICT technologies to fuel sustainable economic development and provide an attractive environment to live for all" [2]. This indicates an increasing role of citizens in smart city projects as suggested by Berntzen and Johannessen [26].

In spite of this shift, Saunders and Baeck [14] report it is still common for smart city strategies to be void of meaningful engagement in the design of new energy and low carbon interventions. While policymakers and planners generally understand, and often aspire toward enabling more inclusive participatory strategic planning processes [27]. There is far less consensus as to how to make this a realisation even with the addition of digital tools Leyden et al. [28]. Indeed, even though citizens are theoretically the beneficiaries of smart city projects, traditionally they are rarely consulted about what they want and their ability to contribute [29], which Pham et al. [20] argue is often the fundamental flaw leading to failure. Expanding on this, there are numerous studies devoted to exploring the relationship between occupant behaviour and energy consumption in buildings, such as Yu et al. [30], who developed a methodology based on cluster analysis. Most studies fail to consider the role that different stakeholders can play in determining the type and extent of retrofit measures, or develop methodologies that integrate social, environmental, economic and technical concerns [31], leaving a gap for holistic, citizen-centric research. Israilidis et al. [32] also suggest that citizen-centric initiatives can be the vehicle for future smart city developments.

Sovacool [33] note three benefits to citizen engagement. Besides the obvious benefit of empowerment in decision-making processes, advantages are two-way when citizens add value as "nonexperts" with higher sensitivity to important ethical components, while also becoming increasingly likely to accept change, having been involved in its design [33]. Of course, the extent and nature of citizen engagement can vary markedly in different contexts. Bull et al. [34] argue that many of the new models of smart city shift the whole emphasis of engagement from an active choice that citizens have to make to an integrated one in which citizens are providing feedback. A useful typology for explaining the levels of citizen engagement is Arnstein's ladder of participation (Figure 1) [8] that has particular popularity in policymaking and planning [35]. It illustrates stages of involvement, ranging from the lowest category "manipulation", a form of nonparticipation which is top-down and one-way, up through increasingly meaningful forms of engagement. While "consultation" seeks opinions, it is still classed as "tokenism". The highest step is "citizen control", where participants not only influence outcomes but make decisions.
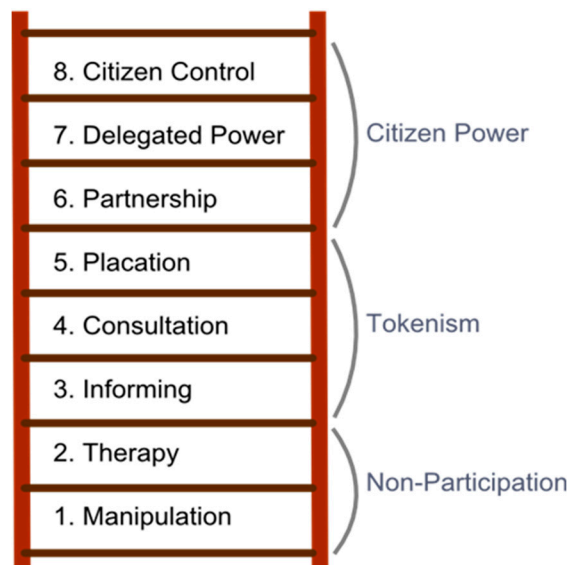
Figure 1. Arnstein's Ladder of Participation [8].

Looking more specifically to the topic of smart technology, Bull et al. [34] draw attention to the increasing inclusion of citizen engagement within the definition of "smart city" itself, as they discuss the phrase's evolution over time. The role citizens play within their smart city can range from using or giving feedback within integrated systems, so they effectively become a living data point [36], to playing a meaningful role in the design of new smart city development through a co-creation or co-design approach.

2.3. Co-Creation for Smart Cities

The term "co-creation", sometimes used interchangeably with "co-production", is the provision of services through regular, long-term relationships between professionalized service providers and service users or other members of the community, where all parties make substantial resource contributions [37]. Bovaird [37] argues that it transcends conventional engagement and participation by actively harnessing citizens' skills and experiences. Correspondingly, Granier and Kudo [23] regard citizen engagement not "simply as a way to stimulate participation in the public debate but as a process of social innovation which aims to allow citizens to co-produce Public Value", finding it to increase "the adoption and the sustainability of public services in line with (…) the smart city's strategic vision". Co-creation offers a solution to deliver sustainable long-term benefits for public service providers and users in cities [38]. Various models have been successfully implemented in the design of smart solutions. Examples include user driven innovation (UDI), a user-centric product development process where users contribute to creation and refinement [39,40] and user-centred-designed, which is "based upon an explicit understanding of users tasks and environments" and "driven and renewed by user-centred evaluation" characterised by a cyclical structure [41–43].

Depiné et al. [44] argue that Design Thinking, "an analytical and creative approach that focuses on the concerns, interests and values of the (…) citizen" plays into the vision of Human Smart Cities, which they state are the "new generation of smart cities", balancing "the hard technological infrastructure with soft factors such as social engagement and citizen empowerment". While publications around co-creation in the context of smart cities are significantly increasing in volume, there appears to be little exploration of creativity within co-creation. Few studies consider the fine details when it comes to the tools and techniques implemented during engagement sessions and how this might influence the quality of data and attitudes going forward. For example, Cellina et al. [21] launched a living laboratory for the co-creation of a mobility behaviour change app to trigger novel governance practices in cities. Granier and Kudo [23] argue that scholars have highlighted that little

research has focused on actual practices of citizen involvement in smart cities, so far indicating a gap in the literature. Furthermore, Morton et al. [22] are of the view that there are few empirical studies exploring how building user engagement can shape development of ICT-based energy efficiency interventions.

3. Research Methods

A qualitative approach was adopted for this study to enable deeper understanding of citizen engagement and its role in smart city development. The research strategy for this study was a comparative case study of two examples of engagement in Nottingham, England. A case study strategy involves an empirical investigation of a contemporary phenomenon within its real-life context using multiple sources of evidence [45,46]. Nottingham was selected as the case study because of its participation in two EU H2020 projects. It was recognized as a "Lighthouse City" in the REMOURBAN (REgeneration MOdel for accelerating the smart URBAN transformation) project and was a key partner in the eTEACHER Project (more details below). Primary data were collected by conducting semistructured interviews with senior and middle managers in the Nottingham City Council (NCC) and other stakeholder organisations such as Nottingham City Homes (NCH) and Nottingham Energy Partnership (NEP). All the interviewees were selected using the convenience sampling technique, as they are involved in citizen engagement and smart city projects in Nottingham. Project-related documents and deliverables were used as secondary data to support the analysis. One of the authors has been leading the delivery of eTEACHER's engagement strategy in Nottingham and, therefore, reflective practice is also used for analysis, which helps to reflect on actions for continuous learning. Table 1 presents a list of interviewees.

Table 1. List of the interviewees.

Interviewee No	Interviewee's Position	Organisation
1	Communications and marketing personnel	Nottingham City Council
2	Engagement and participation strategy personnel	Nottingham City Council
3	Project management personnel	Nottingham City Homes
4	Academic in digital engagement and smart cities	University in East Midlands
5	Senior member of the council	Nottingham City Council
6	Senior member of the energy team	Nottingham City Council
7	Senior member of the communications and marketing team	Nottingham City Council
8	Member of the housing team	Nottingham City Council
9	Member of the consultation team	Nottingham City Council
10	Member of the public health team	Nottingham City Council
11	Communications personnel	Nottingham City Homes
12	Member of the energy team	Nottingham City Homes
13	Staff member	Nottingham Energy Partnership

3.1. Nottingham as a Case Study

Nottingham has a distinguished position in the UK and globally when it comes to energy and decarbonization. Nottingham City Council (NCC) has set an ambition to become the first carbon neutral city in the UK by 2028 [47]. The core drivers for NCC's Energy Services team include combating fuel poverty, improving energy security through the district heating networks and solar PVs, and generating energy and cost savings. The city surpassed a carbon reduction target of 26% reduction by 2020 (as per 2005 baseline) four years early. The city has one of the largest district heating networks in the UK and

a dedicated company, Enviroenergy, to manage it. NCC has an arms' length management organisation, Nottingham City Homes (NCH), managing approximately 27,000 homes. NCH has retrofitted over 5000 domestic properties with solar PVs and has an ambitious retrofitting programme for the future. Households across Nottingham have taken up over 40,000 energy saving measures delivered by NCC, including 7000 external wall insulations.

Nottingham is building on its strong reputation and experience in decarbonisation to create a unique selling point for the city, leading to commercial opportunities, job creation and regeneration. It hosts two of the UKs leading universities for domestic energy research, while a good number of citizens are involved in the low carbon sector through work (over 900 businesses are classed as being in the clean technology sector), education or community groups.

3.2. A Tale of Two Projects

This study examines two different EU funded smart city research projects to illuminate practical lessons for citizen engagement to reduce energy consumption in low carbon smart cities. The REMOURBAN and eTEACHER case studies explore how citizens are engaged as co-creators at the community and building scale, respectively (Table 2).

Table 2. Overview of REMOURBAN and eTEACHER.

	REMOURBAN	**eTEACHER**
Project aim	Citizens central to urban transformation and active actors of the energy efficient retrofits to make cities smarter	Using information and communication technology (ICT) solutions to encourage and enable behaviour change towards energy efficiency
Sector	Domestic buildings	Nondomestic buildings
Scale of the project	Community	Buildings
Target audience	Residents	Building users (non-residents)
Smart city theme	Energy and carbon emissions	Energy and carbon emissions
Methods	Various online and face-to-face methods to communicate, such as website, social media and community meetings and events	Workshops and feedback forums
Timescale	2015–2019	2017–2020

4. Data Analysis and Results

4.1. Case Study 1—REMOURBAN

REMOURBAN was an EU Horizon 2020 smart city demonstrator project, tackling issues at the intersection of (i) transport, (ii) energy and (iii) ICT sectors. The project was a partnership between three EU "lighthouse" cities: Nottingham (UK), Valladolid (Spain) and Eskisehir (Turkey), and two further "follower" cities: Seraing (Belgium) and Miskolc (Hungary). Each lighthouse city aimed to develop novel solutions, according to its own needs, which were then shared across the follower cities to develop generic, replicable solutions. Engaging citizens is a key feature for successful implementation and sustainability of the REMOURBAN model. The project has three areas: sustainable urban mobility, integrated infrastructure and sustainable districts and the built environment (the focus of this paper). Citizen engagement took centre stage for a Nottingham demonstration area, Sneinton, where 463 residences were retrofitted. A citizen engagement strategy was developed based on the city's past processes together with new ideas using the principles outlined in Figure 2.

Figure 2. REMOURBAN model for citizen engagement [3].

Engagement maturity is categorised into three levels. Level three demonstrates the ultimate intention to empower and co-create smart city solutions with citizens, devolving decision-making on one or many parts of the process to align with the top tier of Arnstein's Ladder [8]. Engagement was broken down into six key steps (Table 3).

Table 3. Six steps for citizen engagement in Nottingham, adapted from [3].

1.	Analysis of the current situation	REMOURBAN team developed a list of citizen engagement activities for demonstration area and the whole city via a SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis. This included: • Direct mail to households and key local influencers such as Councillors, Member of Parliaments, tenant and community groups; • Local energy events; • Social media; • Press releases to local media.
2.	Definition of messages	REMOURBAN defines citizen engagement initiatives as processes by which public concerns, needs and values are incorporated into decision-making. Nottingham developed positive messages for all three levels of citizen engagement for demonstration and city area. However, there was a lack of clarity on how these messages were delivered. This may suggest that the messages were mainly developed for level 1, which is "Tokenism" on Arnstein's Ladder and therefore needs improvements to achieve more mature levels of engagement.
3.	Target audience and expected outreach	The target audience were landlords of privately rented homes, commercial businesses in the demonstrator area, city-wide citizens, community groups and politicians. The demonstration area was a relatively active community and had well-established community groups. This area had a high number of privately rented homes.
4.	Tools and mechanisms	A combination of online and offline citizen engagement activities was available including direct mail, one-to-one visit, community events, news channels, local newsletter, local noticeboards, community champions, social media, websites and local media, namely Notts TV, Nottingham Post and Radio Nottingham.

Table 3. *Cont.*

		Key actions for citizen engagement in REMOURBAN included: • Stakeholder Briefing Pack, Engage the City and Sneinton, Targeted Information for demo houses and Create Marketing Collateral. • Citizen engagement implementation plan for energy interventions was developed for the demonstration area.
5.	Action plan for citizen engagement	• 465 households were segmented into typology group (e.g., social and private households) to target consultation events and supporting materials to streamline the process. • Early meetings were planned to ensure that people can have their say in the development of the delivery plans. This included a set-by-step "process map", which details work programme, daily liaison control, regular local events, sign-off the completed work and customer satisfaction. Contact started early in the project, which continued throughout the design, tendering, implementation and monitoring/feedback.
6.	Description of resources	Communications and marketing personnel within the NCC's energy services team led on engagement activities. 15000 GBP (British Pound Sterling) was set to be spent on the local desk (Marketing Officer in the energy services team) placement and marketing collateral in the project. Beyond the project, there was a lack of funding to effectively implement citizen engagement projects.

4.1.1. Steps for Citizen Engagement

This REMOURBAN methodology provides cities with a model for developing citizen engagement for smart city transformation. The traditional face-to-face engagement model was predominantly used, which may have limited reach to all segments of communities. However, it may be that small-scale examples can offer insights into how citizens can engage with change at a local and city scale. For example, lessons on message tailoring from REMOURBAN align with previous experiences of NCC, who can look to upscale this kind of framing:

"If it is just an energy efficiency event, no one will come. Better to have a stand at existing events. In areas of deprivation it is about getting messaging right—about saving money; to be healthier; we made sure messaging was more around these predominant needs. There is opportunity once people are engaged in that message to follow up with messages about lower emissions and the city going greener". (I-1)

4.1.2. Citizen Engagement Strategy in Nottingham

The local desk in Nottingham coordinated efforts of the partners for the implementation of citizen engagement strategy. For the energy district interventions, NCC, NCH and NEP worked together to explain the REMOURBAN offer to demonstration-area households. A key aim of the citizen engagement strategy was to ensure that there was enough uptake from the demonstration area for the project to be viable. The strategy aimed to disseminate the benefits of a smart city approach through a citizen engagement framework with four areas:

1. Consult and engage.
2. Results.
3. Engagement throughout the operational cycle.
4. Knowledge dissemination and public outreach.

The REMOURBAN citizen engagement activities were built on existing partnerships built through previous energy efficiency programmes across the city. I-2 stated that NCC attempts to encourage and foster dialogue towards empowerment, which was in line with the Citizen Power (6: Partnership) in the Arnstein's Ladder.

"It is a conversation in which partners are equal and voices are respected and conditions for having that conversation are tended to, so we are aware of and create spaces in which people feel comfortable and empowered to share their ideas and concerns and also become more aware of what they are putting into. This needs to be more proactive not reactive". (I-2)

A coherent citizen engagement strategy evolved through householders' feedback to identify what types of engagement would contribute most to create a legacy going beyond the project's geographical boundaries and life cycle. NEP focused on finding how to ignite the interest for domestic energy efficiency solutions of the nonparticipating private sector households living in the project area. Throughout the project, NCC sought to build long-lasting awareness and engagement with energy efficiency messages for citizens, to reduce energy and carbon emissions whilst overcoming fuel poverty. I-6 expressed a wish to go further:

"We are probably not doing as much of it as we would like to, but we certainly have got those fuel poverty stats being the key thing and where we would like to target any interventions or support that we can. So, we understand areas within the city that are probably at most need". (I-6)

REMOURBAN engagement was mainly top-down and there appears to have been no initial engagement with residents for the design of solutions; rather, solutions were consulted on at a later stage, which qualifies as tokenism on Arnstein's ladder. However, citizen engagement process in REMOURBAN for the 2050 homes included the involvement of citizens in procurement and contracting, which is unique. Tenants had contact with the bidding process which means the dialogue happened at that stage when the tenants had opportunity to influence the final proposals. I-3 stated *"We had different events to get people engaged and tell them about plans. We had various workshops with contractors so that people could see products putting in, for example, district heating private wire"*, implying limited co-creation in comparison to eTEACHER. REMOURBAN beneficiaries may have a positive role to play in future engagement activities. I-2 stated that:

"Much of the research was done when I got involved moving into implementation phase for which need for participative form of engagement more around how to engage citizens to understand benefits of this programme and how do we share this information, rather than how do we engage citizens to co-create something based on their inputs, which is in eTEACHER—not same degree of citizen stakeholder engagement as I know it". (I-2)

However, residents did influence some design features according to I-3: *"Oh they definitely helped to shape it. In Energiesprong homes, they chose colour and two entry points to homes, back and front. Their idea was to put bell in, a bell with two sounds to know if it was the back or front—something as simple as that which really made difference"*.

4.1.3. Target Audience and Expected Outreach

Citizens in Demonstration Area

Participation within the demonstration area was vital for success. The data of this area provide a snapshot of the population and its characteristics that underpin NCC's citizen engagement strategy. It had a diverse community with a sizeable immigrant population. A high number of citizens work in lower managerial, administrative and professional occupations, followed by routine and semiroutine occupations. Messaging was focused on saving money and a warmer home to improve health and well-being, with the secondary message of energy efficiency. L-8 explained *"It's all about money isn't it? I mean let's be honest; it's about people's bills and people will be receptive if it's something that works for them"* (I-8). A significant barrier to engagement was disruption during retrofits. However, NCH experienced that the prospect of low energy bills and better health outcomes overcame any foreseen inconvenience from the delivery of the interventions. Value addition for the house was well-received, showing how tangible benefits can facilitate better citizen engagement. In REMOURBAN, cost savings has been an important driver for most of the residents, corroborated by I-8.

Landlords of Privately Rented Homes in the Demonstration Area

NEP led on the engagement in the 37% of properties in the demonstration area that were privately-owned; a challenge given that the ultimate decision-makers were not the occupiers, but their landlords. I-13 stated: *"We have focused on the private sector [as it] gets forgotten when it comes to energy"*. UK rental models are based on short-hold tenancies. The private renter is far more transient than social tenants and that of owner occupiers. NCC's messaging was aimed at incentivizing both landlords and tenants to invest in energy efficiency. Forty-nine properties signed up for the retrofit, which was only 5% of targeted households, in line with NEP's previous difficulties in signing people up on these types of schemes. It could be attributable to lack of interest and perceived cost implications. The level of deprivation in the area is high and the correlations between low income and low educational attainment were apparent. Private sector residents who owned homes may not have had the disposable income to afford the contribution.

Community Groups

NCC has teams of Neighbourhood Development Officers (NDOs) aiming to help build cohesive and empowered communities that have strong relationships with the Council. I-3 stated: *"Before we went, there was no community within that group and engagement helped bring the community together"*. The REMOURBAN area had two NDOs, providing support to residents, community associations and groups across the project area, including the Renewal Trust, Sneinton Tenants Outreach Programme Community Group, Muslim Community Organisation, Friends of Green's Mill, Friends of Windmill Park, Alchemy Group and Newark Crescent Woman's Group. NDOs had regular Local Issues Meetings in six locations across Sneinton for participation from each ward. A cross-section of residents attended, enabling local government professionals to access what participants describe as the "real problem". The NDOs were a source of local information and helped project officers establish links with the wider community. The community groups were engaged to support the launch of the retrofitting offers. NCH had a tenant liaison team that recruited Energy Champions for the Sneinton area in 2018, trained by their Fuel Poverty Officer.

4.1.4. Tools and Mechanisms

The tools and mechanisms applied in the citizen engagement framework represent a shift in citizen engagement philosophy. A more accessible framework with a variety of engagement points was developed that allows greater levels of participation in accordance with individual contact preference. Tools and mechanisms that were utilized to deliver engagement included:

- Direct mail;
- One-to-one visit;
- Community events;
- A blog trialled for The Courts households;
- Community "news" channels—newsletters, meeting points, noticeboards;
- Community champions;
- Local and project-wide websites;
- Local media—Notts TV, Nottingham Post, Radio Nottingham;
- Social media.

REMOURBAN often relied on more traditional methods of communication, including one-to-one discussions. I-3 stated: *"Although the community-based engagement got some success, a lot of tenants preferred 1:1 engagement"*, perhaps because some people felt uncomfortable leaving their homes. NEP also redeveloped their website to allow the project to have a lasting presence, with the aim of creating true sense of community for REMOURBAN beneficiaries, and to open opportunities to other interested

households in Sneinton and across the city. REMOURBAN thus combined traditional in-person citizen engagement with potentially innovative ICT-based tools and social media.

4.1.5. Resource Allocation

NCC had a "Local Desk", an individual responsible for communication and engagement. A communications taskforce was developed in Nottingham whose members supported the coordination of their organisations across the city. REMOURBAN allocated 16 months of resources to the Local Desk for planning, monitoring and reporting on citizen engagement. Each partner delivering an intervention had resources to allocate from the project deliverable budget to work with target citizens. All local partners liaised with the Local Desk to ensure that activities were correctly branded and fed into the narrative of Nottingham's REMOURBAN journey. The wider perceived shortfall of government support and funding proved to be major barriers. Planned engagement activities were often delayed; I-3 stated: *"Obviously there is pressure to complete in those timescales because in innovative projects, things don't go to plan".* Most of the interviewees indicated that financial pressures in recent years have taken their toll on public sector energy engagement:

> *"It's very difficult to get the funding to be able to do some projects. There are things that I really want to do, but I'm struggling to have the assets to be able to do that. I think we've just got to look out for funding".* (I-9)

Smart city projects have provided NCC with practical learning and their next step is to explore if these can be incorporated into future work.

> *"Our developmental step is to feel that we have more capacity (. . .) around a shared understanding of how to work in shared and dialogistic way. Engagement works best when there is a continuum in which the citizens you engage will move up a notch, but you don't stop empowering or enabling them".* (I-2)

In addition to REMOURBAN, NCC is continuing citizen engagement journey and building on its existing work, as I-1 stated:

> *"Conversation will still be happening. REMOURBAN will carry on in our mind as professionals, as a catalyst for doing things differently and will have legacies, but more with professionals rather than citizens".* (I-1)

4.2. Case Study 2—eTEACHER

The eTEACHER program is an EU funded Horizon 2020 project with partner organisations in six European countries and was adopted after REMOURBAN, incorporating its learning. The eTEACHER program uses ICT solutions to encourage and enable behaviour change of building users towards energy efficiency. Nottingham hosts two pilot buildings (Table 4) and aspires to co-create solutions with their users, many of whom are also Nottingham citizens.

Table 4. Pilot buildings in eTEACHER.

Building Name	Function	Date Constructed
The Council House	Council-owned historic building offering public services such as birth and death registrar, coroner hearings, weddings and other large events, alongside offices	1927
Djanogly City Academy (DCA)	Academy trust educating 11–18-year-olds	2005

4.2.1. Citizen Engagement Workshops

ICT engagement began with Workshop Ask sessions which consulted building users to gather data to feed Workshop Bridge, a single meeting attended by project partners who accordingly begin to establish recommendations for app design. Co-creation was thereby employed from the project's outset, seeking users' habits and needs in the predesign stage. It was seen as critical to *"to be at the start of the pipe with engagement thinking in order to build all the way down the line"* (I-2), which demonstrates a forward-thinking approach and a recognition that meaningful user input can only be achieved by frequently returning to users throughout a project's entirety. Advantageously, they were able to ensure the app's development was continually catering to their dynamic circumstances to increase the chance of ultimate uptake. This dialogistic process is, of course, two-way and therefore within the topmost third of Arnstein's ladder ("degrees of citizen power"). The approach ensured that all stages of the app development were grounded in the actual, not presumed, needs of its audience. Rather than *"helicoptering in smart city solutions, (we) put the citizen at the heart of the conversation, as it's their life we want the solutions to address"* (I-2). This indicates a deep-rooted interest in solving localized problems in a way that is framed by the users themselves, in addition to the broader, predetermined aims of the project. By sending the message that the project was *"willing to listen to what you need and try and fit that in with our design"* (I-4), users were encouraged to continue participating. Combined with the dedication to an active and persistent engagement program, this open attitude, again in line with the empowerment segment of Arnstein's ladder, appeared to help grow trust and familiarity with users to increase the chance of widespread and long-term cooperation.

Workshop Ask

Workshop Ask asked users about their ICT practices and opinions on different kinds of eTEACHER visions. It was delivered in all 12 pilot buildings using a uniform template to generate consistently formatted results, amenable to comparable analysis. The following section concentrates on the experience of Nottingham pilots. The session collected a large volume of information within a limited timeframe, yet minimised onerousness for users by means of varied, visual and interactive tasks (Table 5). Although basic focus groups have the advantage of logistical simplicity, weaving these conversations around practical activities enables the identification of quantitative trends for making helpful generalisations to guide design recommendations. Contextual information was regarded as very important to gauge *"how the tool would fit into their building, how eTEACHER could benefit them"* (I-2). In line with the "one-size-does-not-fit-all" philosophy to energy behaviour change interventions, there is clear acknowledgement of the need for hyperlocalised design tailored to the specific needs of users, born from two-way engagement, rather than a blanket solution, perhaps qualifying as tokenistic consultation on Arnstein's ladder, but falling short of empowerment. The activities' colour, tactility and mental stimulation makes for a more memorable experience and forms a positive association with the project in the mind of the user, boding well for future cooperation (Figure 3).

Table 5. Workshop Ask activity details.

| Activity	Task Description	Data
Activity 1	Identifying hardware devices from image sheet	Recognition rate
Activity 2	Sticking hardware devices to pyramid template	Hardware popularity
Activity 3	Sticking software devices to circle template	Software popularity
Activity 4	Listening to "ideas" pitch (different tools) and circling related preferences.	IT preferences
Activity 5	Rating eTEACHER ideas on template.	Feature popularity
Activity 6	Producing poster, evaluating favourite idea and creating a unique eTEACHER vision.	Motivations, barriers, improvements and creative ideas
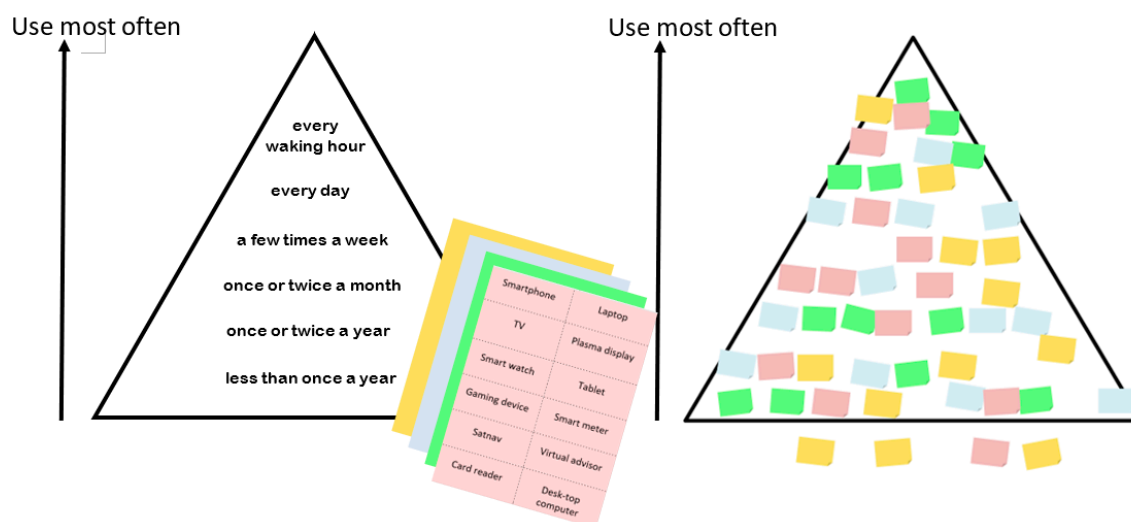
Figure 3. Schematic to show the configuration of Activity 3.

Throughout Workshop Ask, participants used sticker sheets in one assigned colour so answers could be traced back to their user role and demographic for trend identification. Facilitators recorded key points and quotations to capture extra insightful information. There were 10–12 participants in each session, with staff including teaching, administration, cleaning, kitchen, a councillor, and pupils in the school. The engagement lead explains that throughout eTEACHER, activities *"all energised and creatively engaged the subjects even though the people undertaking those were vastly different"* (I-2).

The heterogeneity creates challenges as users in a session *"don't have the same relationship with that building; they don't necessarily understand their own authority or own ability to make change (. . .). We'd have some users thinking "yes I can do this as a result of this", but others don't think they can do anything"* (I-2). There were also concerns about the representativeness of attendees. Given that users in these buildings had to sacrifice work or break times to partake, facilitators postulated that engagement was limited to *"participants who see the benefits of providing projects with feedback"* (I-4).

While the sessions were received well by users, arranging them in the first place was not without difficulty. The biggest issue was reportedly *"trying to facilitate these sessions through a key building actor who sometimes isn't necessarily as approachable as we might want them to be"* (I-4), which was overcome to a large degree by *"finding a person who will champion your project and building up a trust (. . .) to really show what the benefit of the project is and how it could benefit them in the long run"* (I-4).

Results Highlights

Figure 4 illustrates quantitative data gathered from the Workshop Ask sessions, which were supplemented by qualitative quotations from the discussions. By colour-coding participant answers according to role type, it was possible to identify user trends across building types (including other European pilots beyond Nottingham). This example shows that students across all buildings use smartphones least frequently and highlights that nearly 30% of cleaning and kitchen staff across all pilots have little access. Such information is important when designing an app that must cater to many types of people and could influence its login structure and setup. Accompanying quotations enriched the data, sometimes lending explanations to the numbers. In this case, a Council House (CH) employee described smartphone as their *"life-line"* and the *"gateway to (their) whole life"*.

Djanogly City Academy (DCA) participants particularly valued educational software. One student insisted they would be *"lost without BBC Bitesize"*. A teacher explained DCA was the top user of "General Certificate of Secondary Education (GCSE) pod" in the UK and uses "Forum", where students contribute to communally displayed news. Many participants expressed an aversion to games. A CH employee explained *"they never go near the games (because they) take up too much time"*. DCA students

and staff mentioned previous unsuccessful attempts to introduce games in an educational context. Some activities were more open-ended in nature, yielding entirely qualitative data. These parts offered scope for more creativity on the user's side. Generating original ideas issues more potential power to users than merely commenting on pre-existing concepts, as the project is processing new material from the users as well as projecting material to them, strengthening the "two-way" dynamic. Figure 5 presents written highlights from posters from which users were asked to create and illustrate what features would make a good energy app.
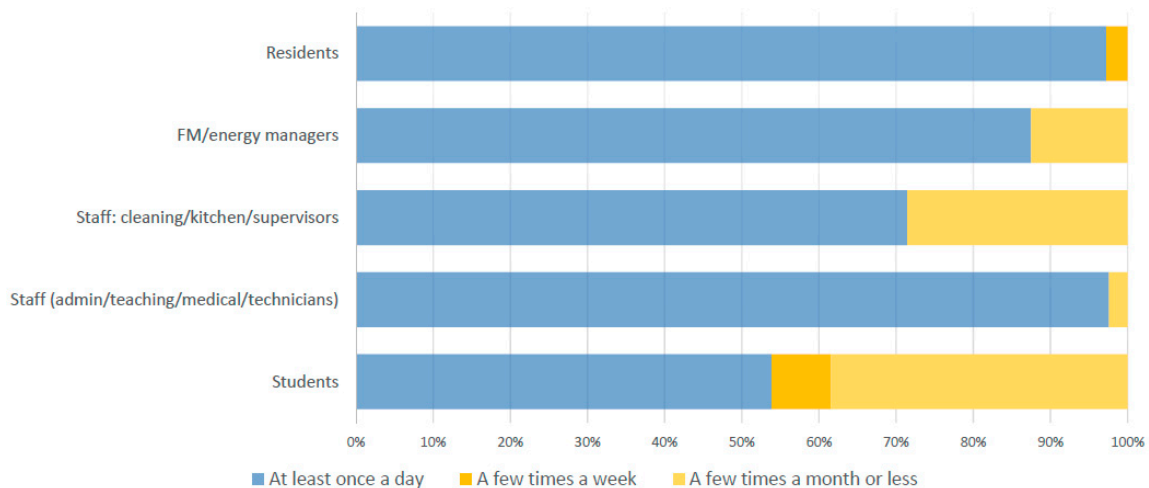
Figure 4. Smartphone usage by building user role.

Figure 5. Highlights from posters regarding the features of a good energy app.

There was said to be a *"very strong sense of participation from the eTEACHER project"* (I-2) and *"they were all happy to engage and give their honest opinion"* (I-4). Having a consistently comfortable atmosphere that promotes transparency on both sides is testament to the healthy and balanced relationships fostered through the engagement sessions. Referring to the Arnstein's ladder, these project conditions seem akin to "partnership" transcending the realm of tokenism. However, one of the challenges in eTEACHER was that users may not have the same relationship of ownership within the building,

which may have detrimental impact on engagement. For example, *"One of the challenges is that when talking to room full of people in building, they don't have same relationship with that building. They do not necessarily understand their own authority or own ability to make chance".* (I-2)

Feedback Forums

Workshop Ask was the first of several engagement sessions with building users. The project *"didn't want it just to be a collection of feedback and responses from users and then feed that back to developers who just go off and make something and then users see the final product"* (I-4). Thus, regular meetings were arranged with a workshop or focus group format. These were named Feedback Forums (detailed in Table 6) and continually sought the views of users, *"engaging them with current project progress [so the sessions are] used as a way of them becoming a sounding board"* (I-4). Feedback forums lend more evidence to eTEACHER's commitment to the balanced interchange between the project and its participants, so that app development may be fuelled by the aspirations of users all the way through to implementation. Bringing together users has proven advantageous in itself, as sessions have instigated the sharing of others' actions that others had not been previously aware of, and was therefore *"good for facilitating understanding building-wide issues and ways of getting around them, even though the tool itself hasn't been rolled out"* (I-4). Going beyond the project's scope, the engagement has started to lead to wider, unforeseen benefits even in early stages, possibly serving to create a community of invested building users, which in turn might strengthen the project and improve its chances of success.

Table 6. Feedback forums and project stages.

Feedback Forum	Description	Project Stage	Status
1	- Focus group format with slides. - Introduction to role of Feedback Forum. - Project summary. - Introduction to "Pulse" system—giving feedback on environmental indoor quality.	Before app design and rollout	Completed
2	- Slides and sticker/written activities. - Update on project progress. - Activities—asking what kind of hints users would find useful, preferred formats, app aesthetic and type of missions.	During app design, before rollout	Completed
3	- Hybrid of focus group and interactive activity session. - Feedback to aid initial tool design—pretest messages. - Discussion on app features and use; feedback on initial thoughts and expected use of app. - Discussion on rollout, asking what users want to know about and most appealing formats.	After initial app design, before official rollout	Planned

Table 6. *Cont.*

Feedback Forum	Description	Project Stage	Status
4	- Hybrid: focus group and interactive activity session. - Discussion of use and observed use of other, and changes in energy behaviours. - Evaluating app's effectiveness: strengths and potential improvements. - Collaboratively analyse factors influencing app engagement. - Interactive activity on use of app features, including hints and missions.	After app rollout	Planned
5	- Focus group format. - Describing use and behaviour change in selves and others. - Evaluating app's effectiveness. - Collaboratively analysing factors influencing app engagement.	After rollout, 5–6 months before project close	Planned

5. Discussion

This paper explored the role of effective citizen engagement for co-creating smart city solutions and offered lessons to be learnt. In practice, it is rare to get access and insight into two related but distinct examples of citizen engagement in a single municipality. Whilst there are potential limitations with exploring one city, the two EU projects allowed for a contrasting picture to emerge. The two interlinked case studies illustrate two very different experiences of trying to climb the ladder of participation in the context of sustainable and low carbon smart cities. It is, of course, recognized that cases are limited and cautious, but the findings and lessons learnt are relevant to both smart cities and citizen engagement debate and to the wider policy challenges of minimising energy and carbon emissions in cities. The study provides clear evidence that cities can go beyond a purely transactional relationship between citizen and service providers and get close to the partnership rung on Arnstein's ladder. This is significant, as it is about enabling and encouraging the citizens to become proactive and participative members of the community, as suggested by BIS [2]. The eTEACHER project in Nottingham suggests an approach of co-creating smart solutions can work, but there are limiting and enabling factors, notably the importance of skill in terms of actually being able to facilitate engagement well and secondly the time to do it. A notable and important difference between these two case studies was the audience. REMOURBAN was attempting to engage people in their own homes using predominantly traditional and face-to-face methods. This is in line with Johnson et al. [48] who found that most of the smart cities use traditional types of citizen engagement such as citizen meetings, round tables and workshops. The eTEACHER project was operating in a more formal context that enabled a structured approach with clear boundaries and digital engagement, the key differentiator in eTEACHER project. Morton et al. [22] state that improving and widening building user engagement by involving them in co-designing interventions has potential for greater acceptance and impact.

People, collaboration and governance are key components of smart city processes [21]. Both REMOURBAN and eTEACHER have the same governing structure in terms of a broad participation strategy in the city. NCC has a strapline for all of smart city line, "Smart because of You", a concept which was developed and it would be led by the intelligence of citizens, and it would be their input in terms of defining what would be important to them in their lives, understanding how they lived their lives in their neighbourhood, developing products/projects that would enhance their lives, where

we were imitating and supporting a smart cities research programme—wanted to be in response to their needs. Both projects had citizens, in theory, at heart of the conversation. But commitment is not enough. REMOURBAN, as its key actors noted, did not allow sufficient time in the lifecycle of the project to actually build the relationships and enable long-term sustained engagement. Much of this had to do with the funding restrictions, but also the team relied on traditional marketing and information provision approaches as the team involved were based in communication and marketing. In REMOURBAN, citizens participated in the procurement process to carry out energy efficient retrofit of homes, as they were the beneficiaries of the procurement output. This was an opportunity for them to influence contracting and the final proposals whilst enhancing communication between the city council and citizens, as suggested by Berner et al. [49]. Hossain et al. [50] state that citizen engagement in public procurement can help develop transparency and accountability in the process along with ensuring high quality of public service delivery. In contrast, eTEACHER had written into its proposal document and a concerted programme of the workshops and engagement tools for co-creation with a whole year of sustained engagement before the ICT tools would be implemented. A dedicated person was responsible for this process and was able to be trained and upskilled in these approaches. There was an honest period of reflection from the energy team who had witnessed some of the challenges of REMOURBAN. Finally, as noted above, the context of a school and a local authority building in eTEACHER project meant that the roles and processes could be more easily managed.

Arnstein's Ladder is utilised as a heuristic tool [8]. Whilst useful, there are questions on the efficacy of Arnstein's Ladder in that it does not seem to offer an appreciation of the dynamic nature of citizen engagement, especially across different audience types (household residents versus employees for example). Collins and Ison [51] argue that the form, meaning and purpose of participation is now diversified; they suggest the phenomenon of social learning rather than participation more accurately embodies the new kinds of roles, relationships and sense of purpose that will be required to progress complex, messy issues such as energy and smart city. Further research is then required in terms of how this model could be adapted and applied to a range of organisational contexts, especially ones in which delegated power and control may not be realistic or desirable.

Nottingham demonstrates the practice, challenges and scale in organising digital and face-to-face citizen engagement for buildings and communities. Although there is not a one-size-fits-all approach for citizen engagement [3,19], Nottingham's experience and lessons can help facilitate citizen engagement and co-creation of low carbon smart solutions. Lessons were learnt across the two smart city projects and learning from REMOURBAN informed eTEACHER Citizen engagement activities were defined as a key determinant of REMOURBAN, yet for the reasons outlined it never quite reached its potential. Practical lessons were learnt and eTEACHER presents a more mature and to some extent better executed vision of the same aspiration. These activities ensure that the smart city model is co-created and accepted by citizens, therefore, enhancing success and replicability. Less clear is how cities empower citizens in co-creating services and products and this study offers some insights and lessons learned.

6. Conclusions and Recommendations

This paper offered evidence based on how citizen engagement can be embedded to deliver smart city activities of municipalities. Based on the case study analysis of two EU funded projects, the study argued that citizen engagement needs to be at the forefront for co-creating low carbon smart cities. Both REMOURBAN and eTEACHER projects offered novel insights into their citizen engagement activities at both building and neighbourhood scale. The projects used a variety of digital and face-to-face engagement methods to engage a demographically diverse audience, which can help support co-creation in the context of smart cities. This study offered novel contribution to literature and practice by building the evidence base of how citizen engagement can be practically embedded in smart city activities. The lessons learnt need to be shared with practitioners so that citizen engagement is beyond a tick box exercise, as Israilidis et al. [32] and Selada [52] suggest is the key to developing knowledge sharing and learning capabilities for smart city success.

The study offers recommendations arising from the empirical research. Firstly, citizens are usually involved too late in the process of smart city development, mainly invited to verify requirements, designs and prototypes that have already been produced or used as sensors or data collectors. This needs to change. Firstly, an improved approach should consider citizens as active agents (actors) within the development process of smart cities. Citizens can collaborate in co-creating smart cities together with the private sector, governments and knowledge institutes following the quadruple helix approach [52]. Secondly, citizens can bring value to the table when they are part of the design and innovation process in smart cities, but this takes skilful facilitation. Thirdly, it takes time to allow innovative initiatives to develop. Finally, it requires significant personal challenge and commitment on behalf of those from a managerial point of view; this translates as proactively and routinely embedding multifaceted citizen engagement efforts in every stage of smart city projects. Therefore, engagement strategies must not sit separately from smart city project plans but be intertwined so that citizens are continuously influencing the work's direction and development. Critically, an iterative approach must be taken so that managers are open to significant changes in course according to citizen needs, even if that means deviating from the core elements stated in original plans. The transition to more sustainable energy systems has set about redefining the social roles and responsibilities of citizens [53].

For low carbon smart city research to reach its full potential, more work is needed in understanding other cities and local authorities and how different organisations respond to citizen engagement to inform behaviour change in the context of smart and sustainable cities. Further exploration of what works and what does not is required to inform future smart city practice not only in the UK and Europe, but beyond as cities globally appear to be facing common sustainability challenges. This can be carried out as part of future research agenda. The focus of the paper is energy and low carbon smart cities, but it outlines some principles of how to undertake effective engagement in other contexts. This paper concludes that local authorities and stakeholder organisations in cities should develop flexible and context-specific approaches for promoting co-creation for smart city development, rather than implementing "one-size-fits-all" approach for citizen engagement.

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