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Towards achieving net zero by 2050 in the UK – Stakeholder perspectives in integrated urban planning

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ABSTRACT

In light of severe risks of extreme conditions arising out of global warming, the push towards sustainable development and management of our resources has been a topic of immense interest globally. The UK's recent promise of reducing all greenhouse gas emissions to Net Zero by 2050 is a highly challenging and ambitious one, that involves radically changing how urban environments are planned, managed and developed. This paper is a first attempt at understanding how major cities in the UK are currently prepared at addressing this challenge. We report on findings based on interviews with seven local authorities, highlight some of the key challenges and barriers and offer recommendations.

1. Introduction

'Net Zero' or achieving an overall balance between greenhouse emissions produced and emissions taken out of the atmosphere is a highly discussed topic in recent times. In practical terms, Net Zero implies any emissions will need to be balanced by schemes (e.g., trees, afforestation, carbon capture and storage) that can offset an equivalent amount of greenhouse gasses from the atmosphere. While the UK has made significant progress in balancing economic growth with reduction in emissions, much is to be done. As such, in June 2019 (Walker et al., 2019), following recommendations by the Committee on Climate Change, the UK became the first major economy in the world to pass laws to end its contribution to global warming by 2050. Much debate exists on how far Net Zero targets can realistically help in limiting temperature increase to 1.5 °C above pre-industrial levels (as per the Paris Agreement goals), as much of the climate change is inevitable, due to the amount of man-made carbon dioxide that is already in the atmosphere. It is, however, important to note the increasing pressures on governments and local authorities in setting and delivering net-zero targets on a variety of sectors (Martin, 2019). Urban planning attempts to manage and determine competing uses for land and local authorities play a fundamental role as key custodians of local environments (Cullingworth & Nadin, 2006). Sustainable planning requires an in-depth understanding of a variety of factors that can directly or indirectly impact the trajectory of carbon emission targets. To this end, the Committee of Climate Change highlighted the urgency at hand as well as proposed several technologies and behaviours across multiple sectors that might help the UK achieve Net Zero targets. For example, societal choices on diets, electrification, developing a

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hydrogen economy, carbon capture and storage technologies and so on (Stark et al., 2019). Much of this urgency is extended to local authorities, given their responsibilities on the well-being of people and places in their respective administrative areas. Their responsibilities also extend to climate change, energy and sustainability (Gudde et al., 2021) and therefore, local authorities are under increased pressure to take informed decisions that can not only help in achieving their carbon targets, but also meet the economic, social, environmental, health needs of local communities and citizens. As such, until the time of writing this paper, over 300 local authorities in the UK have already declared climate emergencies (Climate Change Committee, 2020), with many local authorities setting ambitious targets to achieve by 2030.

With these increased challenges, it is important to understand how well-placed local authorities are not only in achieving their targets, but also to tackle barriers and challenges at an early stage. At the same time, the planning process is in urgent need of reform, where traditional approaches are struggling to scale up to increasing demands. In discussing the move towards radically transforming planning ("tear it down and start again"), the 'Planning for the Future' consultation document by the UK Government highlights the central role digital solutions and data are proposed to play in the future (MHCLG, 2020). We are likely to observe immense changes in the planning landscape over the next few years including the adoption of data-driven decision-making, paving the way for using AI-driven approaches in local government (Allard et al., 2018; Mergel, 2016). With this move toward an increased adoption of AI in public administration (Agarwal, 2018), it is possible to expect new models of governance that combine people, computational intelligence, machine-readable data exchange in a seamless and efficient manner (Vogl et al., 2020). In fact, as of June 2021, new digital tools in the planning process are already being tested across ten councils (MHCLG, 2021). As we move closer to Net Zero targets with an increasing focus on AI-driven future, it is important to understand how local authorities will adapt to new processes and demanding targets, while at the same time, continue to serve their local communities, businesses and residents. Therefore, we aim to answer the following research questions: "How well prepared are local authorities in the UK in developing interventions for achieving their Net Zero targets?".

In this paper, we report on our research conducted as a part of a collaboration between the Universities of Bradford (the second author's previous affiliation), Sheffield and the Connected Places Catapult over a period of a month, during which the project explored state of the art in digital solutions, surveyed open and proprietary datasets and conducted a series of interviews with stakeholders in local authorities. Understandably, our research question is a highly complex and broad one, that requires a multi-dimensional view over a variety of factors, some of which are beyond the scope of this paper or will have greater clarity in the future. At this point, it is also necessary to acknowledge the role that imaginaries can play in potentially shaping our Net Zero futures. Existing understandings of technology and related barriers, as perceived by decision-makers, often shapes, or constrains future choices between different technology pathways (Cherry et al., 2017). An in-depth study of Net Zero imaginaries of key stakeholders and urban planners is beyond the scope of this paper, however, is crucially needed. As such, we restrict the scope of this question to understanding the digital and data perspectives that local authorities are currently challenged with or likely to be challenged by in the future. To simplify our research, we break down our question to four sub-questions:

- RQ1: How are local authorities currently planning to achieve their Net Zero targets?
- RQ2: What digital or data solutions do local authorities rely on while monitoring emissions?
- RQ3: What challenges do local authorities currently encounter in planning for Net Zero?
- RQ4: How can digital solutions support local authorities in better preparing for a Net Zero pathway?

In this paper, we attempt to take a first step in understanding the complexities and challenges for local authorities in achieving their Net Zero targets. We report on our research that involved an initial desk-based study and a series of interviews with stakeholders in seven local authorities in the UK. The paper is structured as follows: we initially explore the literature in understanding the different urban planning interventions by local authorities for reducing carbon emissions and the digital landscape that can support local authorities in decision-making for Net Zero. We then discuss our methodology of interviewing stakeholders in local authorities and present our key findings. Finally, we discuss the implications of our findings and offer recommendations, before concluding the paper.

2. Net zero imaginaries and urban planning interventions

Net Zero socio-technical imaginaries (Jasanoff & Kim, 2015) offer an insight into how local authorities and stakeholders envision Net Zero futures (Booth, 2021). The social as well as technical perspectives of these imaginaries are critical to understand not only how stakeholders perceive new technologies, but also the elements in daily life (e.g., work practice, social interactions) a Net Zero future would offer. This is more important since we are at a critical juncture where these imaginaries shape or constrain what is determined to be feasible in the future. A range of different imaginaries of Net Zero have emerged, which offer interesting prospects of how researchers imagined technological development, policy reforms and evolved practices. These sociotechnical imaginaries (Jasanoff & Kim, 2015) can help align actual reconfigurations of socio-technical systems with their envisaged forms, drawing out knowledge and power dynamics that shape these, and different imageries portray, understand and envision the future in different ways (Booth, 2021). Imaginaries are also helpful to capture the wider perspectives of who are the imaginaries for and who are doing the imagining, and, in understanding the different relationships within stakeholders can help tease out tensions, knowledge and practice boundaries, sociotechnical infrastructure and resource flows (Pollard, 2019).

Within the energy sector, sociotechnical imaginaries have received significant attention (Ballo, 2015; Cherry, Jasanoff & Kim et al., 2017, 2009; Jasanoff & Kim, 2013; Mutter, 2019). Some of these imaginaries seek to understand or represent the lives of people, public, users or communities (Strengers et al., 2022), although limited attention has been paid on imaginaries from popular culture and

digital technologies (Jasanoff, 2015). Tozer and Klenk (2018) identify a range of imaginaries around the wider themes of carbon neutrality (around climate neutrality, clean, renewable, fossil-fuel free), new economy of carbon control (around new or green economic development goals), the city as a laboratory (around innovation labs, piloting and learning, green laboratory), technological fixes and modern city (around constructing energy efficient and renewable energy powered cities), and citizens that are empowered to be 'good' (around citizens being potential agents of change). Genus et al. (2021) compare two energy policy imaginaries representing different worldviews, technological and behaviour change (around identifying the best technological and behavioural change solutions that can contribute to reducing carbon emissions) and practices and cultural change (achieving changes in energy-related practices and "bottom-up" governance). A range of imaginaries have also been proposed for specific sectors such as agriculture (Booth, 2021), energy (Tozer & Klenk, 2018), housing (Cherry et al., 2017), transport (Mutter, 2021), which offers interesting insights into how researchers and practitioners envision their Net Zero futures.

These imaginaries are helpful and offer a glimpse into what stakeholders and researchers perceive to be possible, and potentially shape or constrain representations of the future. It is also important to understand the (data and digital) challenges that authorities and stakeholders are currently encountering in achieving their Net Zero targets. Before discussing the literature on specific interventions and initiatives that can support local authorities in their Net Zero goals, we discuss the complexities in the UK planning landscape.

The planning process in the UK is a complex one, typically initiated by local authorities, citizens, communities, or developers by establishing a specific need within a region. This need is further devised as a physical intervention in urban space. UK land use planning is driven by legislation that requires local authorities to establish plans for development within their areas and keep them up to date. The Legislative framework is defined by: Town and Country Planning Act 1990 for England and Wales, the Town and Country Planning (Scotland) Act 1997 and the Planning (Scotland) Act 2006 and the Planning Act (Northern Ireland) 2011; Planning and Compulsory Purchase Act 2004; Planning Act 2008, and Localism Act 2011. Interventions can be redevelopment, regeneration or a new development, each involving a range of complex exercises and a variety of stakeholders. As such, planning may often require multiple iterations to ensure the views, opinions and perspectives of different stakeholder communities can be considered and accommodated. In addition to understanding stakeholders, a considerable amount of research and investigation is also necessary to assess potential impacts of interventions, to help decision-makers take informed decisions. As legislated, local authorities in the UK follow statutory procedures for decision making with respect to planning applications, although minor variations exist based on legislative differences in the different geographies' authorities belong to.

Reform of the planning process is a key part of the UK's Net Zero ambitions as it is buildings that account for around a third of UK carbon dioxide emissions (BEIS, 2021) and, in general, the current energy performance of the UK's housing is poor (Piddington et al., 2020). The urban planning process, therefore, is a critical aspect of reaching Net Zero. Within the planning process, carbon emissions can be measured and evaluated at key points, for example, at the planning application stage to understand the proposed carbon footprint and impact on the environment, during the development of the build to ensure compliance with standards and once the build is complete, to measure ongoing emissions. The central UK government launched two consultations in August 2020 with proposed changes to the current planning process, these were the "Planning for the Future"[1] white paper and the "Changes to the Current Planning System"[2] consultation. While these changes were not only focused on climate change, it was, however, acknowledged that the planning system is one of the tools that can be used to achieve Net Zero goals, including proposals for Net Zero homes. In response to the proposed changes to the planning process, there was mixed support, with concerns raised by the Local Government Association (LGA) that any standardisation of methodology needs to account for local needs and geography and not constrain local authorities (LGA, 2020). Following consultation, the Planning Bill introduced in 2021,[3] set out the government's ambitions to streamline and modernise the planning process with greater focus on digital tools that will increase public engagement with planning.

Local authorities play a central role in developing and implementing planning reform (Martiskainen & Kivimaa, 2018; Gudde et al., 2021). It is expected that they will also play an important role in achieving Net Zero ambitions, with around three quarters of local authorities having already declared climate emergencies, following Bristol City Council in November 2018 and setting out plans to reduce emissions. However, local authorities are taking a wide variety of approaches in their efforts to reduce carbon emissions, both technological and social interventions (Fudge et al., 2016). While many local authorities have set goals for reaching Net Zero in their local area and have produced plans which are publicly available, there is no common approach taken or a standard set of interventions. This variability extends to planning reform for new builds and retrofitting of older properties. In a review of interventions by 31 local authorities, 6 different models were identified ranging from building in-house solutions to supporting local enterprises and commercial collaboration and within each model, differences between local authorities (Tingey et al., 2021).

Some local authorities have committed to building new homes that meet new environmental standards, such as net-zero houses or Passivhaus Standard, for example Birmingham council aims to build by 2031, 7000 units of social housing that meet these standards.[4] These standards, however, may not be consistent across local authorities. Manchester, for example, developed its own Low Carbon Build Standard to apply to new builds and retrofit projects. The lack of clear standards for planning and development and a lack of clearly defined measures of carbon emissions is an issue for local councils working towards low or zero carbon buildings (Bishop &

[1] Gov.UK Consultation Outcome – Planning for the future, available at https://www.gov.uk/government/consultations/planning-for-the-future

[2] Gov.UK Consultation Outcome – Changes to the current planning system, available at https://www.gov.uk/government/consultations/changes-to-the-current-planning-system

[3] Gov.UK Speech – Queen's Speech 2021, available at https://www.gov.uk/government/speeches/queens-speech-2021

[4] Adopted Birmingham Development Plan 2031, Birmigham City Council, Available at: https://www.birmingham.gov.uk/downloads/file/5433/adopted_birmingham_development_plan_2031

Brand, 2013; Wade et al., 2020). Other local authorities have introduced reform into their local planning process, for example, Bromsgrove District Council plans to introduce a positive bias into their planning application system that will promote low carbon builds[5] and Blaby council has introduced requirements for planning applications to meet standards in line with the Carbon Neutral target.[6] Adur and Worthing Borough Council proposed a shared climate and nature plan, in collaboration with wider communities towards developing a more sustainable future, focussing on ten key areas including reducing carbon emissions, clean energy, waste reduction, and so on.[7] In fact, a large number of local authorities have shared plans and strategies on addressing Net Zero targets. A sample of these are presented in the Table 1.

As can be noted from the sample presented in Table 1, it is important to acknowledge the wide range of efforts and initiatives already being organised by the different local authorities in the UK. This, in addition to demonstrating the interest and motivations of decision-makers, also serve to showcase the range of initiatives being undertaken towards achieving Net Zero targets.

The Planning for the Future consultation, published in 2020, highlighted the need to include more digital tools into the planning process and move towards a system based more on data driven decision making. It aims to move to digital systems and in June 2021, a £ 1.1 billion fund was distributed to 10 local councils to test digital tools within the planning process,[8] with the aim to understand how to implement digital solutions to make the process faster and engage with the local community more. Furthermore, in October 2021, the PropTech Engagement Fund provided funding to 13 local authorities to test digital interventions in the planning process. This included using interactive maps to help the public visualise planning proposals in London Borough of Hounslow.

There is, in general, a push for more digital and data interventions within local government (Allard et al., 2018; Mergel, 2016). Data analytics can offer opportunities for more evidence driven decision making for those involved in the planning process (Zhou et al., 2016). For modelling and reducing greenhouse gas emissions, SCATTER has been developed in partnership with local authorities and Antithesis. At the time of writing this paper, the tool is currently used by Greater Manchester, Oxford, Bath, North East Somerset and Birmingham, with Nottingham city council involved in testing and evaluating new features. Another tool developed by Connected Places Catapult in collaboration with Greater Manchester is Growth-Planner which brings together data to give decision makers quick access to information that provides an overview of the process of development.[9] The tool has been taken up by commercial companies who are developing similar applications for the planning process.

However, with local authorities at different levels of digital maturity in terms of technical skills and capabilities, there must be training provided to council staff, something which Birmingham council acknowledges (see Adopted Birmingham Development Plan 2031). A key challenge faced by local authorities is associated with data management, a lack of standardised data and lack of data skills (Giest, 2017). A lack of opportunity to develop expertise was raised as an issue in interviews carried out by Wade et al. (2020) with those working in local authorities in Scotland suggesting that projects to reduce emissions tending to be short term and based on convenience which prevent the development of knowledge about what works and how long-term solutions can be implemented. Without supporting local authorities to develop the digital skills to manage and analyse data, it is difficult to translate this into knowledge that can be used to make decisions (Giest, 2017; Falke, 2002).

The role of data and digital technologies in transforming the planning system is well acknowledged, and a wide range of tools are currently being developed and deployed. In fact, in the Planning for the Future whitepaper by the MHCLG (2021), we note an imaginary that is empowered by technology, driven by open data, offering efficiencies, inclusiveness and consistency in planning services to support decision-making. However, for such technologies to be adopted at scale, to enable a transformation toward a technology driven Net Zero imaginary, it is important to understand stakeholder perspectives in how local authorities currently experience challenges in practice.

3. Methodology

While the literature offers a wide variety of interventions designed by local authorities and potential digital solutions, it is important to understand the complex challenges with Net Zero targets and an evolving planning process. As such, a first-hand account of stakeholders involved in digital planning is critical to establish how local authorities are currently managing planning processes aimed at meeting their Net Zero targets. At the same time, stakeholders can offer an insight into the challenges local authorities are struggling with. With the need to understand the context of urban planning, we invited stakeholders from a variety of UK local authorities to a semi-structured interview session.

3.1. Participants

As a part of the research project, a set of key individuals at several local authorities were initially identified by the Connected Places

[5] Climate Emergency, Bromsgrove Council, Available at: https://www.bromsgrove.gov.uk/council/policy-and-strategy/climate-emergency.aspx

[6] Carbon Neutral Action Plan, Blaby District Council, Available at: https://www.blaby.gov.uk/media/4538/blaby-district-council-carbon-neutral-action-plan-2020.pdf

[7] Sustainable AW, Adur and Worthing Borough Council, Available at: https://www.adur-worthing.gov.uk/sustainable-aw/

[8] Press Release - Government announces 10 councils to test the use of digital tools in planning process, Available at: https://www.gov.uk/government/news/government-announces-10-councils-to-test-the-use-of-digital-tools-in-planning-process

[9] Connected Places Catapult – Digital Urban Planning: GrowthPlanner, Available at: https://cp.catapult.org.uk/project/the-latest-digital-urban-planning-system-growthplanner/

Table 1
A sample of local authority initiatives available.

Local Authority	Initiatives	URL
Basildon Borough Council	Investment in new homes that can contribute to Net Zero targets	https://www.basildon.gov.uk/article/8622/In-the-news-Councillors-commit-to-100million-investment-in-Basildon-estates-and-new-homes
Manchester City Council	New low carbon build standard (reduce, re-use and renewables) for all projects by/for MCC	https://moderngov.cheshireeast.gov.uk/ecminutes/documents/s91587/Appendix%201%20-%20Manchester%20Low%20Carbon%20Build%20Standard.pdf
City of York Council	Ambition to plant 50,000 trees by 2023 (York Community Woodland)	https://www.york.gov.uk/YorkCommunityWoodland
Hampshire County Council	190 EVs to replace diesel and petrol vehicles in the council's fleet	https://transportandenergy.com/2021/04/12/hampshire-cc-commits-to-zero-emission-electric-vehicle-fleet/
Wychavon District Council	Intelligently Green Plan 2020–2030	https://www.wychavon.gov.uk/community-and-living/intelligently-green/intelligentlygreenplan?start= 1#itemtext

Catapult team, from professional networks, prior contacts and engagement events. Stakeholders were senior employees in local authorities primarily identified based on their expertise and knowledge of planning processes. A list of potential participants was created, most of whom were previously informed of the scope of the project. The following lists the inclusion criteria for the stakeholder interviews: (1) An employee of a local authority; (2) at a senior-level; (3) with knowledge (as a policymaker or planner) or oversight of planning processes; (4) with insight of digital services (data, tools, models, infrastructure) with-in the organisation and beyond. The primary need was to ensure that stakeholders would have either hands-on or management experience with digital planning and decision-making.

The authors initially contacted all stakeholders with a brief overview of the project and the scope of discussions, together with an information sheet and consent forms. Stakeholders from the same organisation were contacted together, with a request to extend the invitation to other colleagues they might deem relevant for the discussion based on the information supplied. Meeting date-times were decided over email, and a meeting request was sent to all participants of the meeting, using a preferred option of video conferencing (Zoom, Microsoft Teams or Google Meets) depending on organisations. To maximise the quality of the discussion, and to preserve organisational contexts and practices, each meeting was specific to a local authority.

In total, over a period of three weeks in November and December 2020, seven online meetings were organised, with the opportunity to extend to other local authorities if necessary. Following the seven interviews, we agreed that this was not required. A total of 14 stakeholders were involved in our interviews, with some local authority meetings involving single participants, while some involved up to 4 participants. All interviewees were informed that none of them will be named and all identifying information in the data and reporting will be anonymised. Whilst we report on the interview findings anonymously, it may help to note that the seven local authorities are from three Metropolitan district councils, one combined authority, one London Borough and two Non-Metropolitan districts. As such, having interviewed local authorities from seven of the nine English administrative regions, we believe the findings of the interviews could be generalised to wider regions.

3.2. The interview process

The interviews were scheduled as a one-hour slot, with an initial (15 min) introductory session (including a few minutes for set up) planned where each interview session initially introduced the project members with a brief description of their research interests. This was then followed by stakeholders taking turns in describing their roles and experience in relation to urban planning. The interview session then started with a brief introduction to the project and project goals, followed by a narrative of what to expect during the interview, and what are the expected outcomes of the interview. The interviews were recorded, with the recordings and transcripts stored in a secured cloud folder. During the interviews, the authors were also taking notes of conversations, highlighting topics of interest, questions to be asked in future, and additional talking points. Interview recordings and transcripts are confidential and are only accessible to project partners.

Each interview was facilitated by the two authors, each taking turns in initiating a specific topic of discussion. The interviews were semi-structured, whereby the participants were guided through an initial set of specific probing questions, with the flexibility of expanding on a specific topic if the need arose. Discussions centred around the following topics (inviting participants to discuss specific examples):

- Setting the context of integrated planning – how their organisations function with relation to integrated planning.
- Setting the context of Net Zero –how their roles interact with Net Zero from either a policy or operational level. Interviewees were also invited to discuss about their personal interest on Net Zero.
- Understanding emissions factors in Integrated Planning – what are the key factors that are considered when approving or reviewing planning applications. Participants were asked about specific challenges they encounter in the process.
- Standard approaches in assessment and monitoring– if they follow specific assessment guidance that are open to members of the public. Participants were also invited to discuss about the data and models (digital tools) that are currently being used to monitor progress towards achieving Net Zero goals.
- Interventions – what are the long- and short-term interventions that are being considered to help achieving Net Zero targets.

- Key challenges in integrated urban planning – what are the technical and operational challenges in integrating Net Zero with other development policies.
- Datasets and models – what datasets and models are currently (or could potentially be) used by local authorities for Net Zero decision-making.

3.3. Analysis of interviews

Following the interviews, participants were invited to send any further thoughts or ideas if they hadn't been discussed during the interview. One participant followed up later with some details on specific datasets being used. The interview recordings, transcripts and interviewer notes were analysed following the interviews during the first and second week of December 2020. We conducted thematic analysis to identify the most important themes of the discussion, based on the topics of the interviews - participant organisations' current approach toward integrated planning and Net Zero; factors considered when approving or reviewing planning applications; long and short-term interventions considered; key challenges in urban planning that hinder progress toward Net Zero; datasets, models and technologies used by local authorities for Net Zero related decision-making.

4. Results

In line with the topics of the interviews, the themes identified were current practices in local authorities, planning processes, adaptation to Net Zero, use of technologies, and issues in planning. Given the wide variety of issues discussed, our thematic analysis further analysed themes in this topic, categorising them into digital challenges, human challenges and dilemmas. We discuss these themes in more detail in this section.

4.1. Current practice in planning

While planning evaluation follows statutory processes for decision making across local authorities, some minor variations due to legislative differences in geographies do exist. As a part of our interviews, it was expected that some of these variations would be noted. However, in addition to this, we identified considerable differences across local authorities when it comes to dealing with data. Our interviews established the critical need for a standard approach to providing information related to the carbon impact of developments. As a part of planning applications, applicants often highlight carbon footprint of proposed developments where there is a requirement specified in local plans or supplementary planning documents. In addition to providing carbon emission estimates, applicants often detail measures that will be taken to reduce carbon footprint. For example, using renewable energy sources, sustainable building materials or improving energy efficiency. While planning applications mostly contain information about these measures and carbon footprint, there is a lack of standardised approach towards reporting this – submissions typically contain a variety of formats, narratives and often without hard data. Interestingly, larger applications tend to have more robust reporting of estimates and presenting data. This is particularly so for applications that involve external consultancies or have specialist in-house teams for assessing carbon impacts of potential developments.

Our interviews also highlighted the need for greater understanding (and standardisation) of how applications are prepared at different levels. Some authorities, for example, mentioned the pre-preparation stages (commonly referred to as 'pre-app') of plans where developers and local authorities engage in informal discussions and negotiations on carbon offsetting measures or penalties before the preparation of formal applications. Whilst these discussions and negotiations at such early stages of application is important, the informal nature of the discussions itself makes it difficult to maintain standardisation. It is therefore unclear how such negotiations in the pre-app stages can be standardised particularly in determining offsetting measures and/or penalties, and how at the same time, the informal nature of the discussions can be preserved.

4.2. Adaptation to net zero

All local authorities interviewed had strong commitments to carbon reduction and achieving Net Zero targets, with ambitious plans toward Net Zero futures, albeit with different timescales (e.g., some had set targets by 2028, while some by 2038). It is important to analyse how these local authorities represent their Net Zero goals. We observed commonalities in terms of a bottom-up approach where all local authorities note relying on their existing targets and policies in building regulations, sustainability, energy management, carbon reduction and emissions, with a view that these targets will eventually align with Net Zero targets. As such, all local authorities are in the process of either adapting or developing frameworks and policies for sustainability and carbon reduction. Depending on their local regional contexts, local authorities prioritise policies – for example, a local authority might be more focussed toward interventions on improving sustainable transport over increasing green spaces. This is done through a formal process for developing, consulting and adopting planning policy which is ultimately adopted by the members of the authority as part of the democratic input into the process. Local authorities highlighted the need for a robust set of centralised guidelines and policies, specifically for Net Zero. However, it is important to frame/adapt these guidelines in the context of the local priorities of authorities.

In terms of key priorities that are linked to their work on Net Zero, they place special emphasis on the use of planning application process in ensuring compliance with emissions, sustainability and energy policies. Planning applications provide an opportunity to ensure that new developments are designed and built in a way that minimises their environmental impact. Local authorities can use the planning application process to require developers to meet certain emissions, sustainability, and energy standards. For example, they

can require developers to use sustainable materials, to install energy-efficient appliances, and to connect new developments to renewable energy sources. They also highlight the challenge in meeting this key priority. Following the completion of developments, there is a critical need for continued monitoring of compliance, particularly in understanding how the development can support carbon reduction. All authorities also noted the critical need for consistent, authoritative, accessible and trustworthy data that can continually capture emissions information far beyond the completion of a project. This is an essential aspect that needs to be considered, given the need to understand the true impact of developments compared to environmental and sustainability assessments submitted as a part of planning application. From this perspective, it is also important to note the challenges arising out of the nuances and complexities of informal and unstructured nature of pre-app stages. We believe there are immense opportunities for standardised processes, open data sharing and flexible, extensible and scalable methods to completely transform how carbon outputs can be robustly and consistently quantified and monitored.

The factors being monitored for carbon reduction and Net Zero are also varied across local authorities. For example, some of the local authorities mentioned that owing to various factors (lack of data being one), they only monitored carbon emissions for their own buildings and vehicular fleets, while others had a more comprehensive strategy for monitoring carbon emissions, energy usage and land use. The disparity in approaches across different local authorities needs to be urgently resolved as it can lead to data gaps in large regions across the UK. A more consistent approach across different regions in the UK would bring enormous opportunities in better estimating how Net Zero targets can be achieved.

4.3. Technology

We noted a high variability in the use of technology across the different local authorities. Most authorities mentioned using standard tools like Idox[10] that they use to manage planning applications. However, the tools that are used after planning applications have been received vary – tools for data visualisation, analysis and modelling are different across local authorities. Some local authorities rely on complex modelling tools for setting emission reduction targets like Scatter, while others use their own custom Excel workbooks or simple web applications for carbon calculations. While most authorities are aware of the complex tools like Scatter, a reason for not choosing these tools is either preference toward an in-house solution, uncertainty about the quality of underlying data, or inability to add new and custom datasets. We also note the high variance in how local authorities currently use data for carbon related decision-making. Some local authorities use generic datasets (e.g., housing numbers, employment statistics, transport and mobility estimates, health profiles, education, mortality, morbidity etc.) to gain an insight into the local contexts of residents. Some local authorities have deployed a range of sensors across their local areas to measure a variety of parameters like air quality, traffic, particulate pollutants, temperature etc. Other local authorities mention their approach of using proxies to estimate carbon footprints (such as energy bills, water bills, building usage, vehicle usage etc.).

Many local authorities also highlighted their commitment towards open data and making datasets available to members of the public and businesses, depending on their local contexts and needs of communities. We noted a range of levels of maturity in public facing information systems and data portals – some local authorities do not have any open data applications, while others have a matured and robust data sharing and analysis portals that are publicly available. These data portals are developed as web-based GIS tools, allowing public to select and download layers of data they are interested in. All local authorities surveyed had comprehensive plans for further applications of technology. These plans varied across the local authorities – for example, developing a digital twin application for a new development where smart buildings and connected devices will help sense and model large number of factors to improve delivery of services and better understand liveability conditions. Some local authorities mentioned their plans of using 3D visualisations for visualising urban environments and conduct scenario based ‘what-if’ analyses.

4.4. Issues and challenges

As mentioned in Section 3, our interviews attempted to capture the variety of issues local authorities are challenged with. While we appreciate understanding challenges require a much deeper and longer-term investigation, we believe highlighting these challenges at a very early are important. More importantly, we believe that addressing some of these challenges may influence aspects of the practice at a stage when planning processes are undergoing radical transformations. The below also showcase forms of technologies/decision support they identified for them to plan how to achieve Net Zero targets.

4.4.1. Digital challenges

While the term ‘digital’ captures many more aspects, in this paper, we note the issues arising out of the use of (or the difficulty of using) data, tools and models as ‘digital challenges. Data was highlighted as a critical pain-point for most local authorities. Even authorities that curate and share open data via matured and robust data portals highlighted issues with data. While some authorities mention the difficulty in dealing with large scale data constantly being generated, other authorities would welcome a lot more data to support their decision-making processes. Authorities also highlighted issues around the availability of the data within the organisation – often awareness of and access to new data is difficult and non-standard across departments in an organisation. As a result, decision-makers are not always aware of the full potential of the data that is available within the organisation. This raises issues around ‘data

[10] Idox, https://www.idoxgroup.com/

silos' and complexities in understanding what is available within the organisation. Our stakeholders mentioned often discovering new datasets or analyses far too late, which could have been highly beneficial if discovered earlier. This raises interesting questions around how such lost opportunities can be avoided.

In our interviews, concerns around granularity and resolution of data were also highlighted. High spatial and temporal granularity of data is highly desired and sought after, however, this raise concerns around security and privacy. This is particularly an issue when using open datasets – most local authorities expressed difficulty in identifying data that is highly granular and open datasets often provide aggregate statistics, making it difficult for local authorities to effectively use them.

Questions around data quality, validity and trustworthiness were also raised by local authorities. When asked how local authorities would assess the quality of a datasets, one participant mentioned that the data "should be able to stand up to public enquiries" to be deemed a sufficiently high quality. Furthermore, several local authorities and developers rely on research and data analysis conducted by external consultancies. This brings additional actors and data providers, which can potentially impact data quality and standards.

As highlighted earlier, there are large variations in technology adoption and maturity of data and tools being used by local authorities, which is often because of local contexts and community needs. However, this raises interesting issues around consistency when assessing carbon goals across multiple local authorities. Our interviews highlighted the use of simple models and carbon footprint calculators for some local authorities, measurement of proxy indicators (water usage, bills, building occupancy, financial data), the use of complex domain specific models like transport models to estimate carbon emissions. While participants may model carbon outputs from different perspectives (e.g., transport, housing, energy), our interviews did not identify the use of a unified model that brings models from different domains together.

Within the umbrella of smart cities, a large number of vendors exist who offer integrated solutions for sensing urban environments, managing workflows, conducting analyses, as well as predicting scenarios. However, participants noted difficulties around practicalities of bringing external data (from other vendors or business units), where different formats and standards are used. Participants also highlighted issues around sharing data across multiple tools. Tools and frameworks are often promised as a solution that can help resolve the most challenging issues that local authorities face. As such, tools are often overly ambitious and result in considerable loss of time and effort in customising to local contexts. However, there is a risk of losing specialist knowledge when experts leave the organisation or new tools are procured to replace existing ones. Often, the process of introducing a new tool can be expensive and, at times, a frustrating one. Finally, many local authorities noted that a risk with such vendors is being locked-in to proprietary solutions over multiple years.

4.4.2. Human challenges

With increasing use of digital solutions in planning, users and experts at the interface also struggle with challenges. While we acknowledge that many other challenges that relate to humans in the decision-making process exist, we refer to 'human challenges' as issues encountered by local authorities as users of the technology being used. A critical challenge noted by most local authorities is the severe constraints around resources that they must operate in. This has significantly impacted on how local authorities can address the digital challenges – increasing volumes of data involve a lot more data required to be cleaned, pre-processed, stored, analysed, processed etc. All these processes require significant effort and specific expertise. At the same time, the issues around discovery of datasets and analyses raise interesting questions about how data can be shared more widely around organisations, while adhering to privacy and security protocols. Often however, expertise around an organisation is not available or prioritised for other activities, leading to further delays in exploiting newly discovered datasets.

4.4.3. Dilemmas in planning

The planning process is a complex one, often requiring understanding of multiple aspects of applications, eventually leading to making critical decisions on land use. Planning and development are expensive and does not only involve consideration of financial and economical perspectives, but also social, environmental, health and liveability factors. Most of the participants expressed concerns around efforts in regeneration and redevelopment of brownfield sites. These sites typically consist derelict and disused buildings, often unsafe and can often require extensive remediation before being redeveloped. Increasing pressures on land make the prospect of regeneration and redevelopment of these areas increasingly attractive, however such decisions need to be made with a lot of care. As such, these decisions need to be managed appropriately, given the risks to closures, environmental and public health impacts.

Our participants also noted their concerns around difficulty in adhering to Net Zero targets from their existing built environment. While new developments are planned for the future and are built based on existing standards (building regulations, sustainability, energy efficiency, renewables etc.), existing developments are often tricky and contribute to a significant proportion of emissions. Retrofitting will be an essential component of enabling local authorities to reach Net-Zero. The mechanisms through which retrofitting can be achieved at scale are unclear but planning and standards will play a vital role in enabling the roll-out of retrofit programmes within Local Authorities.

Often planning applications are rejected based on certain criteria in the region (e.g., high Nitrogen Dioxide levels) at the time. However, a resubmitted plan or a very similar one could still be approved if the environmental conditions in the region change. As such, authorities noted the influence of external contexts in impacting the outcome of a planning application and often these are varied over time.

5. Key findings and recommendations

In light of our observations and interviews with key stakeholders, we believe several aspects in Net Zero planning are key to

highlight at this very early stage. This finding showcases the collective thinking of a key stakeholder group on how they see the need for the future legislation, policies, processes/practices and tools/systems. We discuss these in six themes:

5.1. Monitoring adherence to net zero

As described earlier, there are considerable differences among local authorities in technological capability, practices and approaches to monitoring environmental conformance. Most local authorities have their own policy-making processes for meeting NetZero targets. Most of the organisations interviewed mentioned their continued activities in developing policies and frameworks for NetZero, whilst also expressed how sustainability, building regulations and environmental policies are already well aligned with the vision of carbon reduction and achieving Net Zero emissions targets. We also note different practices exist across local authorities in submitting data, analyses and estimates and the processes followed are non-standard across planning applications as well as authorities. Furthermore, monitoring compliance with Net Zero targets following the implementation of a proposed project is not a standard process. As a result, whilst planning applications often seek to incorporate carbon efficient and energy efficient processes by design, how successfully these elements can contribute toward achieving Net Zero is uncertain. We believe this is a gap which needs to be urgently addressed. Monitoring how well planning interventions continue to contribute toward carbon reduction well beyond the implementation of the project is essential, while at the same time, standardising the process of submission of hard data as a part of standard planning applications can help in developing more effective models that can be used in forecasting carbon emissions. To this end, the Connected Places Catapult's recommended approach of submission of structured, machine readable data following common standards can offer some insights into how the process of data collection can be standardised (See Transforming the Digital Architecture of Planning whitepaper[11]).

5.2. Integrated planning for net zero

As mentioned earlier, planning process across local authorities is often varied based on regions. As local populations, contexts and needs are diverse across the local authorities, processes and policies are developed to serve local needs appropriately. For example, authorities with larger open spaces, greenbelt lands or unbuilt up areas might have different policies compared with authorities with greater built-up areas. Authorities with large commercial areas will need to serve different interests as compared to rural residential areas. Local authorities might also have different strategic priorities compared to others. For example, some authorities might have a stronger focus on transport while others on housing or environment. Authorities might also have differences in work practices and technological maturity as well as their approach towards data. All of this can often lead to a diverse set of approaches towards planning for NetZero. While many of these concerns are, to some extent difficult to address (for example, different local priorities or strategies), most local authorities highlighted the need for more support and guidance from central government on standardised frameworks that can be applied across local authorities.

5.3. Technical and digital gaps

A significant barrier to developing standards and data sharing is the considerable differences between authorities in technical and digital maturity (Giest, 2017). Different levels of digital adoption were also reflected in the breadth and depth of public open datasets available in the different regions. At the same time, our survey of datasets highlighted many open datasets that were aggregate statistics, while local level datasets available from council data portals may have higher resolution and granularity. This however is not standardised across local authorities. For example, portals like Mapping GM and Birmingham's Open Data Portal offer rich granular datasets to the public. However, large number of authorities within the UK do not have similar data portals making data accessible. The differences in local authorities in making data accessible owing to a variety of factors (for e.g., cost of maintenance of portals, data capture and processing, strategic priorities etc.) can however result in a large number of data gaps across the UK, consistent with previous findings (Wade et al., 2020) The availability of such datasets could be crucial to developing effective and accurate local, regional and national models. We believe developing a standard framework for releasing open datasets across local authorities could significantly help in planning for NetZero.

5.4. Third party data

The role of external data providers and specialist consultancies is key for many local authorities. For example, for specific topics such as sustainability for example, often in-house expertise isn't available. In such scenarios, inviting external experts or consultants for validation of assessments is a common process. External parties can also be involved in the monitoring of different parameters within local authorities such as traffic, air quality or emissions. The data generated by external partners may often be compiled into reports and text for local authorities, resulting in the loss of hard data, which is often not made available as open data. As a result, with the involvement of external parties too, there is a need for standardisation, while at the same time preserving existing processes on sharing analyses and results with local authorities.

[11] Transforming the digital architecture of planning whitepaper, available at: https://cp.catapult.org.uk/news/transforming-the-digital-architecture-of-planning-white-paper-published-by-connected-places-catapult/

5.5. Knowledge sharing and peer learning

Our discussions highlighted the considerable challenges each local authorities had to deal with related to planning for Net Zero. While challenges were often based on local contexts and strategic priorities, a common thread emerged where it was important to understand how other local authorities are addressing the challenges they face. All local authorities expressed their interest in this research, particularly in developing a greater sense of how other authorities are innovating and developing unique solutions for their local contexts. This raised a need for a sharing space that can facilitate knowledge sharing and peer-learning as we move closer to Net Zero targets, consistent with findings from previous research conducted by Argyriou et al. (2012). We believe that there is much value in establishing multiple communities of practice (aligned strongly with different strategic foci) where local authorities can share their experiences and reflect on their practices.

6. Discussions and conclusions

The UK's target of achieving Net Zero is an ambitious one that requires a considerable shift in how local authorities can plan for the future. While we are at a nascent stage in the journey towards Net Zero targets, it is important to explore how authorities are dealing with existing challenges. With enormous changes in the planning process itself, it is even more important to engage in understanding how a framework can be established that can help local authorities in their transition to low carbon futures. Understanding existing challenges, pain points and barriers within existing practice, while exploring directions of future development is an important first point. In our study, we set out to answer several research questions on the UK's trajectory to Net Zero and, via a series of semi-structured interviews, engaged with stakeholders who are engaged in the process of planning. We address our research questions as follows:

6.1. RQ1: How are local authorities currently planning to achieve their net zero targets?

Our interviews identified a range of approaches followed by local authorities, often aligned with the strategic priorities of their local contexts. The approaches are also derived from existing sustainability and carbon commitments. We also observed a considerable need for centralised guidance. Several local authorities also mentioned actively developing and operationalising NetZero specific plans. Several initiatives over the last three decades have influenced UK local authorities' response to carbon reduction, starting from the RIO Earth summit in 1992 till more recently, the UK 100 and regional energy strategies (Gudde et al., 2021). We also noted that most of the local authorities interviewed are in the process of developing Net Zero specific strategies, while also mentioning that their existing building regulations and sustainability commitments are in-line with achieving Net Zero goals. In their analysis of a sample of local authorities in the climate emergency database, as of April 2020, Gudde et al., (2021) identified only 2 % (7) of the local authorities that had stated publishing a delivery plan to directly address their Net Zero commitments.

6.2. RQ2: What digital or data solutions do local authorities rely on while monitoring emissions?

Authorities currently rely on a set of tools developed over several years, ranging in complexity as well as coverage of data. All the tools used are designed for specific purposes and aimed at addressing specific needs of local authorities. These solutions range from custom online calculators and estimators to complex modelling software. We haven't encountered a large-scale adoption of integrated planning tools, and we note a need for greater adoption of such tools. As Zheng et al. (2019) notes, it is important to highlight that the adoption of intelligent apps using big data, IoT and AI can make public institutions more effective and economical, however, there are risks in broadening the digital gap in e-governance if internet infrastructure is unable to support them. The varied approaches to data, software and digital solutions across the UK local authorities may bring additional challenges to data sharing.

6.3. RQ3: What challenges do local authorities currently encounter in planning for net zero?

We note considerable challenges in planning for Net Zero – the varied availability of accessible datasets is a significant challenge mentioned by many local authorities. While some local authorities benefit from rich datasets available via open data portals, several authorities note the lack of standardised data collection mechanisms. Data is also not standardised across regions – the different levels of spatial and temporal granularity brings significant challenges in processing and analysis. Large scale integration of such datasets across different regions is an enormous technical challenge. Challenges also emerged when discussing the role of external parties in data collection and planning assessments. At this stage, third parties provide summary assessments, and the richness of raw data is often lost. Authorities also mentioned the challenges of operating with constrained resources and personnel as well as the constraints around vendor lock-ins for proprietary solutions restricting the flexibility of quickly shifting to new tools. From a planning process perspective, authorities mentioned several dilemmas that they often struggle with in terms of taking decisions on monitoring already built developments as well as how brownfield sites can be regenerated. Finally, we note the desire of local authorities to learn how other authorities are coping with these challenges. In shaping a vision for the application of AI in local government, Vogl (2021) argues for certain measures to address some of the technical and data challenges. For example, setting data standards and dedicated resources for data quality and AI development. He also argues for the need to ensure avoiding vendor lock-ins, and that projects are well aligned with local contexts.

6.4. RQ4: How can digital solutions support local authorities in better preparing for a net zero pathway?

The complexities that local authorities are operating are challenging and we note the need for a longer-term approach. Local authorities mentioned the need to learn from each other and we note how (digital) communities of practice could help create a space for sharing best practices, lessons learned and suggestions. These sharing spaces could be invaluable to learn how different types of tools have helped authorities in different contexts. There is also a need to explore how digital data standards can be more widely adopted and used. In fact, Vogl (2021) argues for the need to develop a formal mechanism for collaboration across local authorities and third sector. He also argues for the development of a platform for all information about IT projects across local authorities. Several standards already exist within this space such as BIM, CityGML, GeoJSON, Future Homes standard and it is important to explore the applicability (and possibly, extension) of existing standards within this area. It is encouraging that local authorities appreciate the need for adoption of data standards and the practice of employing data standards is increasing. In their 2019 survey of urban application domain practitioners in multiple sectors, Kavisha et al. (2019) noted the increased use of GIS tools, with a significant importance on GIS standards. While their study focussed on 3D GIS practitioners, it is encouraging to note the increased acceptance of employing data standards. This need for data standards is equally voiced for specific areas of urban planning such as mobility (Willberg et al., 2021), air quality (Davies, 2020) and building energy modelling (Chen et al., 2019). While limited options already exist in integrated urban planning modelling software, there is a need for complex tools and frameworks. However, to ensure greater adoption of these complex tools, there is a need for information sessions for stakeholders.

Our study of the existing initiatives, datasets and tools, and subsequent interviews highlighted a strong willingness among local authorities in achieving their Net Zero targets. We identified a range of approaches that local authorities take in dealing with integrated planning, and ambitions towards Net Zero targets, which are often tailored to individual contexts of the local authorities. Local authorities identified a need for some guidance around how to meet Net Zero targets, and a strong need for learning from other authorities. Some of the important challenges highlighted around data and digital was on capturing data and monitoring progress towards targets, challenges in sharing information and the different levels of data and technical maturity among local authorities. Based on these findings, our future work will involve co-designing technical prototypes of how local authorities envision their integrated planning approaches working towards monitoring Net Zero adherence. We also aim to involve local communities together with local authorities to develop different Net Zero imaginaries that can help demonstrate different needs of stakeholders.

Declaration of Competing Interest

None.

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