Mapping technical and social capabilities in a smart and fair neighbourhood (Rose Hill)

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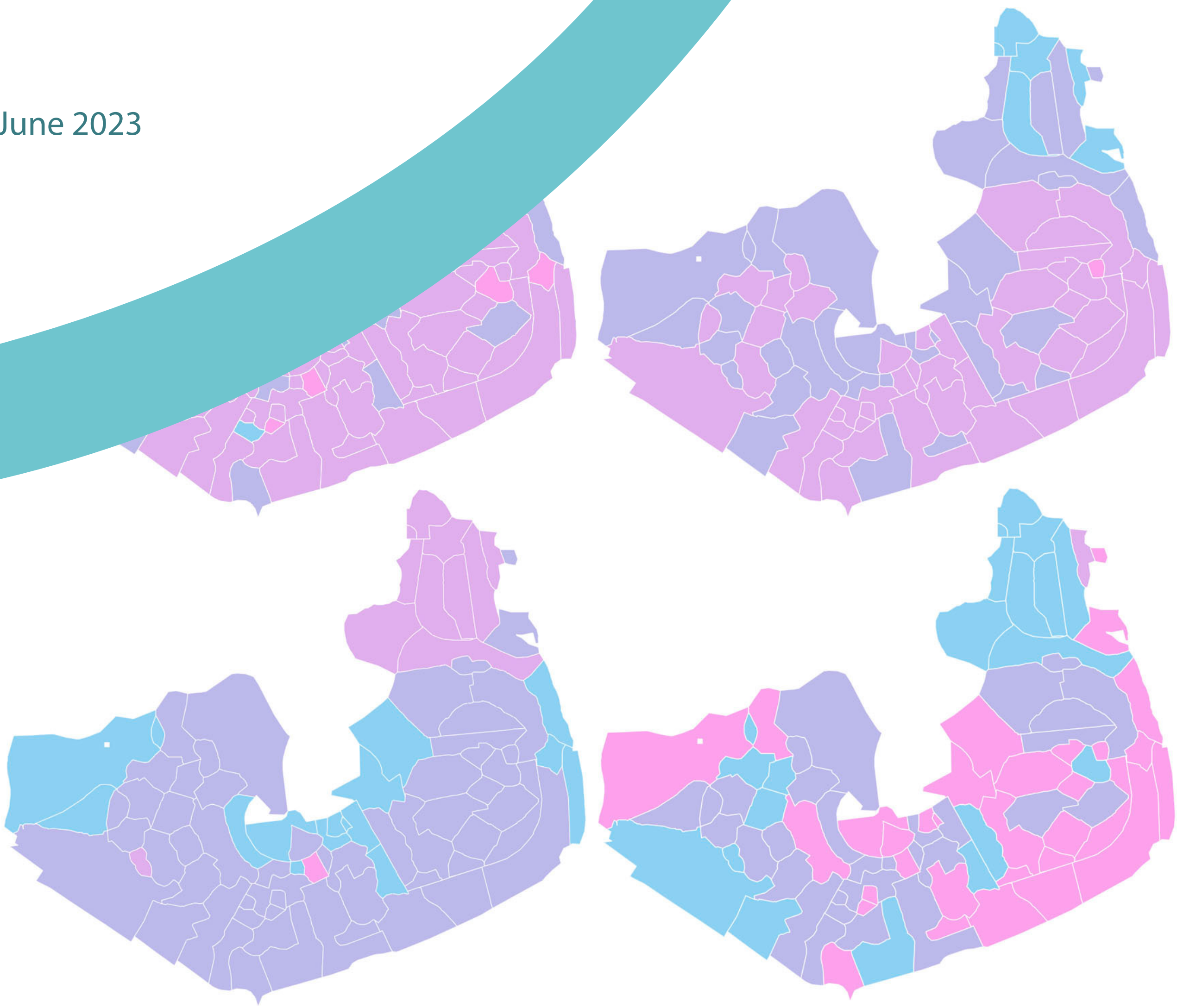

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Contents

Summary

This report used a local area energy mapping approach (LEMAP) to undertake capability assessment of a smart and fair neighbourhood in Oxford, as part of Project LEO. The capability assessment used technical and socioeconomic data to identify how likely households are to adopt different low carbon technologies (LCTs) and those who may be left behind based on socio/technical characteristics. The capability assessment analysed four categories (technical, digital, financial, and social). Each category was divided into four levels to evaluate and grade each household. A little over 50% of the dwellings in the area were considered at least partially technically and financially capable of taking up LCTs; however, several other dwellings needed significant fabric improvement first and were low income. The most populated category in the neighbourhood was digitally capability (either High-tech users or tech. savvy). This suggests that householders are more accepting of technological solutions to energy and climate challenges. Social was however the weakest category; 52% were considered 'sceptical'. The mapping of these capabilities is intended to help stakeholders such as community energy project developers, local authorities, and local community groups to plan for localised smart and fair energy initiatives in neighbourhoods.

Introduction

This report presents the use of a local area energy mapping approach (LEMAP) to map technical and social capabilities in a smart and fair neighbourhood (SFN). LEMAP was developed to provide spatial analysis and communication of baseline energy use, energy resources and potential for take-up of low carbon technologies (LCT) at property, postcode, and neighbourhood level. The intent was to help stakeholders such as community energy project developers, local authorities, and local community groups to plan for localised smart and fair energy initiatives in the focal neighbourhoods. The findings are also useful for the district network operator in energy system planning.

Project LEO – Smart and fair neighbourhoods approach

As the UK Government has legislated net zero by 2050, decarbonisation will place more demand on the electricity network. The need for technology and the ability to balance demand on the network at different periods provides opportunities for new markets to be created, and new demand to be accommodated through a smarter, secure, and more flexible network. Project Local Energy Oxfordshire (LEO) seeks to model the network of the future to better understand decentralised relationships and grow an evidence base that can inform how we manage the transition to a smarter electricity system.

LEO is a holistic smart grid trial with the intent to improve understanding and maximise opportunities from the transition to smarter, flexible electricity system for the benefit of communities, their businesses, and households. At the community level, the increase in small-scale renewables and low-carbon technologies (LCTs) is creating opportunities for consumers to generate and sell electricity, store electricity using batteries, and integrate the use of electric vehicles to alleviate demand on the electricity system.

Project LEO brings together an exceptional group of stakeholders as Partners to deliver a common goal of creating a sustainable local energy system. This partnership represents the entire energy value chain in a compact and focused consortium and is further enhanced through global leading energy systems research brought by the University of Oxford and Oxford Brookes University consolidating multiple data sources and analysis tools to deliver a model for future local energy system mapping across all energy vectors.

Local area energy planning approach: LEMAP tool

LEMAP is a versatile mapping tool designed to be at the heart of a Local Area Energy Planning approach for Project LEO. The ultimate purpose of LEMAP is to present the domestic energy related findings in a geographical / visual way so that stakeholders can visualize and target key areas for immediate action.

LEMAP brings together public, private, and crowd-sourced data on energy demand, energy resources, building attributes, socio-demographics, fuel poverty and electricity networks within a geographical information system (GIS) platform. The analyses of these data were mapped at relevant scales (e.g., dwelling, postcode, LSOA (lower layer super output area)) in LEMAP and organized around four technical divisions of GIS presentation. These are:

- **Baselining** – presents current energy related aspects of a specific area including fuel poverty statistics, recorded electricity and gas consumption, and local energy resources.
- **Targeting** – presents surveyed data on interest in, and suitability for LCTs (specifically photovoltaics, heat pumps, batteries, electric vehicles).
- **Forecasting** – presents modelled projections of consumption and production for the targeted LCTs.
- **Capability profile** – presents socio-economic and technical data on the capability of households to adopt LCTs. The capability profile assessment is the specific focus of this briefing report.

In addition to these, LEMAP also includes three user engagement elements. These are Participatory mapping to allow residents to visualise modelled energy demand profiles showing energy demand patterns during a typical day in heating and non-heating seasons, Storymap for creating blogs on local energy flows, and Forum to enable discussion amongst users of LEMAP and project stakeholders.

Capability assessment

Capability provides a type of social analysis through which we can assess the ability of a person or group to comprehend, accept, adopt, afford, and utilize something. Stakeholder participation in smart local energy system development requires capability to receive the benefits available to them (Banks and Darby 2021). The LEMAP assessment of capability categorises how likely households are to adopt different LCTs and those who may be left behind based on their socioeconomic characteristics. The capability approach is also helpful in identifying policy and regulatory change that needs to take place to successfully implement smart and fair change to the local energy system (Banks and Darby 2021). The LEMAP capability assessment covers technical suitability, economic circumstances, and social and digital characteristics of the household.

Rose Hill case study

The Rose Hill SFN is a 0.74km2 area located in the south of Oxford (Oxfordshire). The SFN falls within the Rose Hill & Iffley Ward and the Rose Hill & Littlemore Division administrative boundaries. Rose Hill covers four LSOA, 79 postcodes and includes approximately 3,400 people living and working in 1,846 domestic properties (majority from the interwar period) and 69 non-domestic buildings (figure 1).

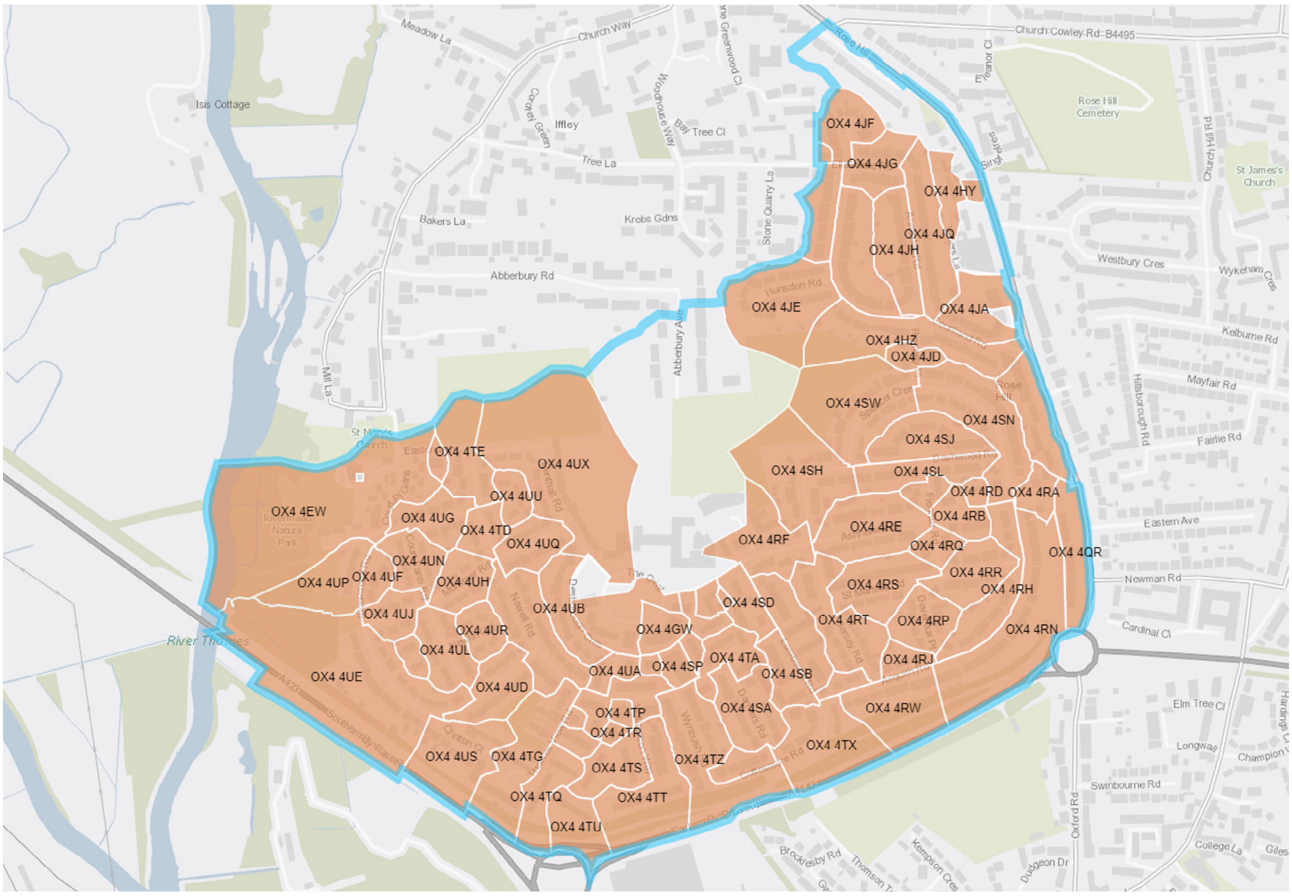

Figure 1: Rose Hill SFN Postcodes and border.

Social rent houses make up 50% of the Rose Hill SFN. This type of rent (e.g., council housing) is linked to the local income and provides affordable housing bellow the private rent-pricing scheme. This indicates, along with the high unemployment of the area, a low economic income of the area's inhabitants. The percentage of fuel poor households for the area is at 12%. This is above the national average of 10%. The distribution of fuel poverty, however, is not even among the four LSOAs as one contains 7% and another 20%.

The average age of the area's inhabitants is 35-64 years (33%), commonly referred to as the working-age group. The second-highest age group were young adults: 16-34 age group (30%). The working-age group's predominance was validated by the area's employability, with 56% of the population employed in either part-time or full-time work activities. However, the unemployment percentage of the area (7%) population is 2.2 times higher than the UK's national average, which has averaged about 4% since 2018.

Education and social grade play an essential role in the adoption of innovations/new technologies. The predominant social grade in the SFN is DE, with 46% of the population. The DE social grade, as BEIS defines, indicates that the population is a semi-skilled or unskilled manual worker, unemployed or work in the lowest grade occupations. This clustering of DE social grade is relatively high, as only 26% of the UK population is identified with this social grade. This unskilled employment is confirmed by the SFN population's qualifications, as 34% have no qualifications.

The Energy Performance Certificates (EPC) database shows that 53% of the properties had a domestic EPC rating of D or below, while 47% had a rating of C or above, highlighting the low energy efficiency of domestic properties in the SFN. The D rating is common in houses from the interwar age due to the thermal performance of the building fabric.

From 2015-2019 Rose Hill has maintained a medium-high annual electricity consumption (Ofgem classification which is between 2,900 kWh and 4,300 kWh per property); however, the total mean has been declining steadily over this period. Currently the mean domestic electricity consumption for the area is around 3,200 kWh. From 2015-2019 Rose Hill has maintained a medium annual gas consumption (Ofgem classification which is between 8,000 kWh and 17,000 kWh of per property); the total mean has been increasing slightly over this period. Currently the mean domestic gas consumption for the area is around 11,800 kWh.

Method for capability assessment

Capability assessment is based on the capability lens approach developed by the Centre for Sustainable Energy (CSE). The assessment helps identify how likely households are to adopt different LCTs and those who may be left behind based on their socioeconomic characteristics. The capability assessment for Rose Hill was analysed and displayed (mapped) in four categories. Each category was divided into four levels to evaluate and grade each household related to their capability profile. The capability categories are described in more detail below; however, in summary:

Table 1: Capability weights

No.	Technical	Digital	Financial	Social
1	Full potential	High tech user	Happy investor	Fully convinced
2	Partial potential	Tech. savvy	Venturers	Motivated
3	Need improvement	Training required	Penny savers	Sceptical
4	Unsuitable	Other priorities	Deprived	Not interested

Technical capability

The grades for technical capability are:

- **Full potential** – Fully capable of adopting multiple low carbon technologies (LCTs)
- **Partial potential** – capable of adopting some low carbon technologies.
- **Need improvement** – capable of adopting technologies if relevant improvements are made to the dwellings.
- **Unsuitable** – dwellings unsuitable for low carbon technologies, such as listed buildings.

The technical capability grade was calculated based on LCT suitability for each dwelling (including ground source heat pump (GSHP), air source heat pump (ASHP), photovoltaics (PV), battery, and electric vehicle (EV)). The more LCTs that were technically suitable for installation in the dwelling, the higher the grade. LCT suitability were calculated in the targeting phase and were mostly based on EPC data.

Digital capability

The grades for digital capability are:

- **Hi-tech users** – households with cutting-edge hardware immersed in digital technology.
- **Tech savvy** – households composed of avid users of social media and smartphones that aspire to obtain cutting-edge hardware.
- **Training required** – households that only use digital technology for entertainment, shopping or practical purposes.
- **Other priorities** – households with limited, little or no interest in digital technology, preference given to non-digital approaches.

The digital capability grade was calculated based on the Experian's Mosaic digital group classification of households. The Mosaic digital group has 11 types ranging from 'Capital connections' to 'Tentative elders'. Table 2 indicates the alignment of Experian's types to LEMAP's digital capability grades.

Table 2: Alignment of Mosaic's digital groups and LEMAP

No.	Mosaic digital groups	LEMAP Digital capability grades
1	Capital Connections, Digital Frontier, Mobile City	High tech user
2	First-gen Parents, Aspirant Frontier, Online Escapists	Tech. savvy
3	Upmarket Browsers, Savvy Switchers, Cyber Commuters	Training required
4	Beyond broadband, Tentative elders	Other priorities

Financial capability

The grades for financial capability are:

- **Happy investors** – households with ability to invest in LCTs without looking for a financial return.
- **Venturers** – households with access capital or funding to acquire LCTs and expect some economic payback or delay of payments.
- **Penny savers** – households that depend on loans, grants, or programmes to implement LCTs or change life patterns towards energy flexibility.
- **Deprived** – socially or economically deprived households with priorities beyond LCTs.

The financial capability grade is an average of Mosaic's affluence rating and equivalised household income band grouping. Mosaic's affluence uses several variables such as income, property value, council tax, outstanding mortgage, etc., to arrive at 20 bands. In addition, there are nine equivalised household income bands ranging from >£65,000 to <£10,000. Table 3 indicates the alignment of Experian's financial groups to LEMAP's financial capability grades.

Table 3: Alignment of Mosaic's financial groups and LEMAP

No.	Mosaic Affluence Groups	Mosaic Equivalised household income groups	LEMAP Financial capability grades
1	Bands 17-20	>£50,000	Happy investor
2	Band 16	£30,000 – 49,999	Venturers
3	Bands 5-15	£20,000 – 29,999	Penny savers
4	Bands 1-4	<£20,000	Deprived

Social capability

The grades for social capability are:

- **Fully convinced** – households that prioritise activities towards the environment.
- **Motivated** – households with some interest and knowledge on the effect of flexible and LCTs on the environment.
- **Sceptical** – Households that need to be trained or guided to understand the benefits of implementing LCTs or making changes in their lifestyle to flexible energy patterns.
- **Not interested** – households with lifestyles that do not align with using low carbon technologies.

The social capability scale brought together EPC and Mosaic data combining consideration for existing LCTs as indicated by EPC assessments and Mosaic's consumer behaviour types labelled Financial Strategy Segments.

Table 4: Alignment of EPC, Mosaic's social groups and LEMAP			
No.	**EPC LCTs**	**Mosaic Financial strategy segment groups**	**LEMAP Financial capability grades**
1	At least one preexisting LCT (wind turbine, PV, solar hot water)	Money makers, Established investors	Fully convinced
2	No preexisting LCT	Earning potential, Growth phase, Deal seekers, Career experience, Mutual resources, Respectable reserves, Golden age	Motivated
3	No preexisting LCT	Family pressures, Small-scale savers, Single earners, Home-equity elders, Declining years	Sceptical
4	No preexisting LCT	Cash economy	Not interested

Capability assessment results

The results of the capability assessment are described below for each type. Maps are provided below showing the capability grade at both a dwelling and postcode scale for Rose Hill.

Technical capability

Over the past couple of decades there has been much effort in upgrading the building stock through government programmes like the Energy Efficiency Commitment (EEC) and the Energy Company Obligation (ECO) (Rosenow 2012). These resulted in improved insulation and glazing in many dwellings through the years, though there is still much to do. This effort can be seen here as over 50% of the dwellings, though constructed during the interwar period, are considered to have full or partial technical capability. Figure 2 provides the mapped results for direct targeting and Table 5 shows the per cent of dwellings in Rose Hill attributed to LCT suitability and technical capability. The map indicates that there is a wide distribution of capability suggesting that the previous efficiency campaigns have been more individualised and less localised. As a result, the 'need improvement' and 'unsuitable' areas are key areas on which to focus greater fabric improvement.

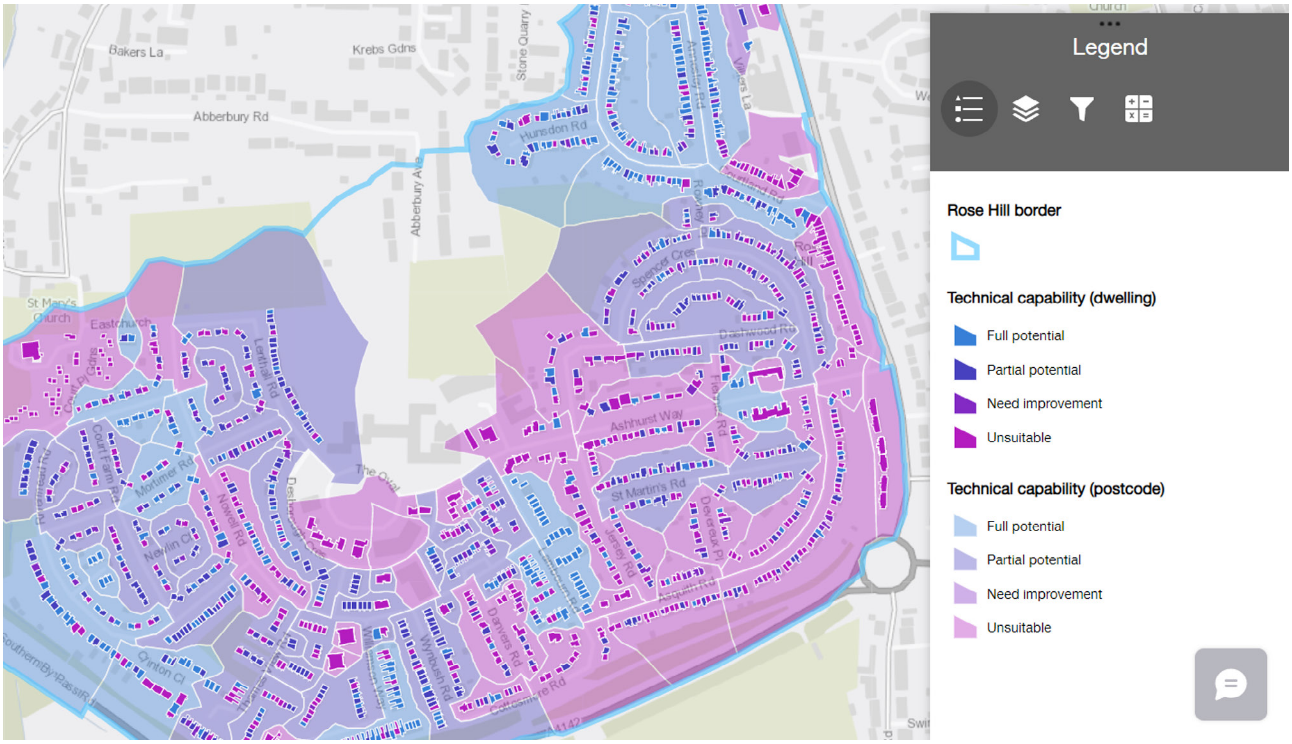

Figure 2: Technical capability map

Table 5: LCT suitability and technical capability percentages

LCT Suitability				
PV	**ASHP**	**GSHP**	**EV charger**	**Battery**
55%	44%	40%	55%	35%

Technical capability			
Full potential	**Partial potential**	**Needs improvement**	**Unsuitable**
24%	30%	9%	37%

Digital capability

An even greater number of households are considered digitally capable (either High-tech users or tech. savvy). These classifications would suggest that householders are more accepting of technological solutions to energy and climate challenges. There should also be less of a challenge to training and informing these householders on the interconnectedness of solutions and their management. Figure 3 provides the mapped results for direct targeting and Table 6 shows the per cent of dwellings in Rose Hill attributed to digital capability. The map indicates that on a postcode scale, the tech. savvy group is amassed through the centre of the local area.

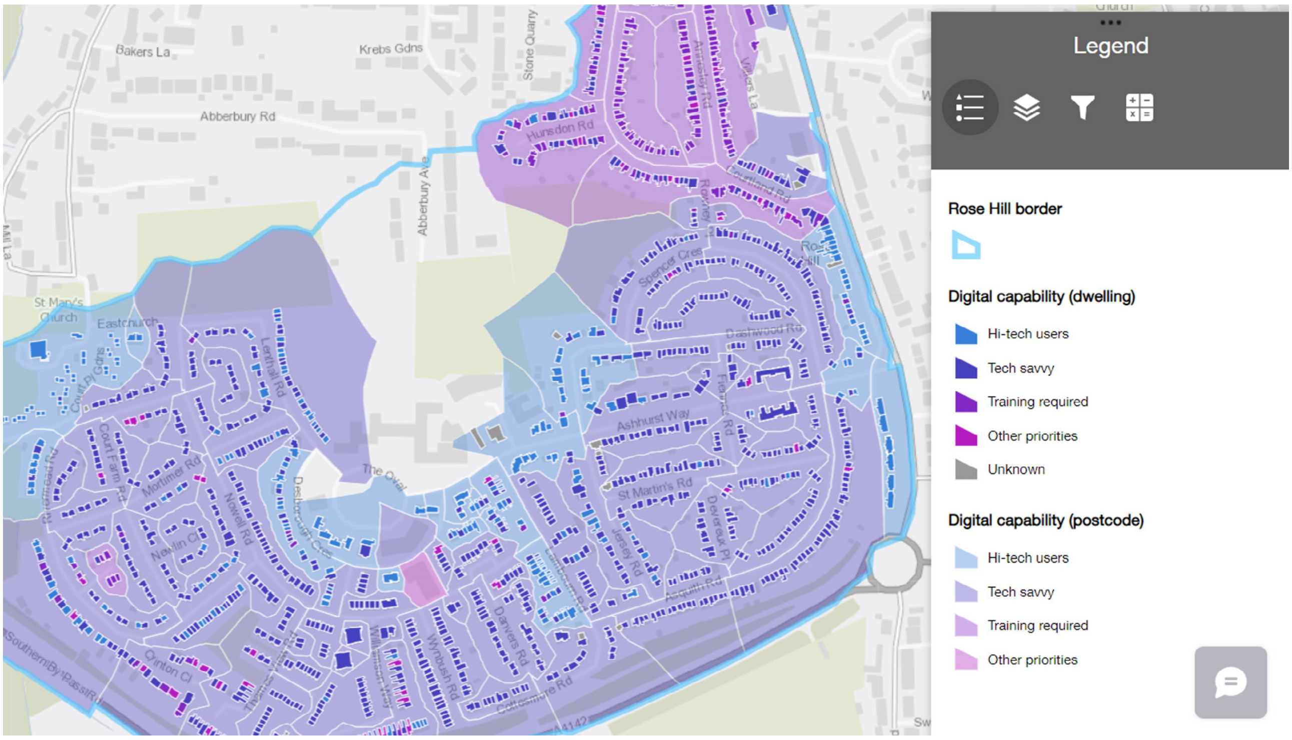

Figure 3: Digital capability map

Table 6: Digital capability percentages			
Digital capability			
High tech user	**Tech. savvy**	**Training required**	**Other priorities**
16%	66%	14%	4%

Financial capability

A borderline majority of households in Rose Hill are financially capable, i.e., happy investors or venturers. However, a significant number of households are considered 'penny savers' (with equivalised annual income between £20,000 – 29,999). Figure 4 provides the mapped results for direct targeting and Table 7 shows the per cent of dwellings in Rose Hill attributed to financial capability. The map is notably quite segmented on a postcode scale. Financial capability is particularly helpful whether seeking able to pay households or households qualified for income-based grants. Furthermore, fuel poverty can also be addressed using financial capability data.

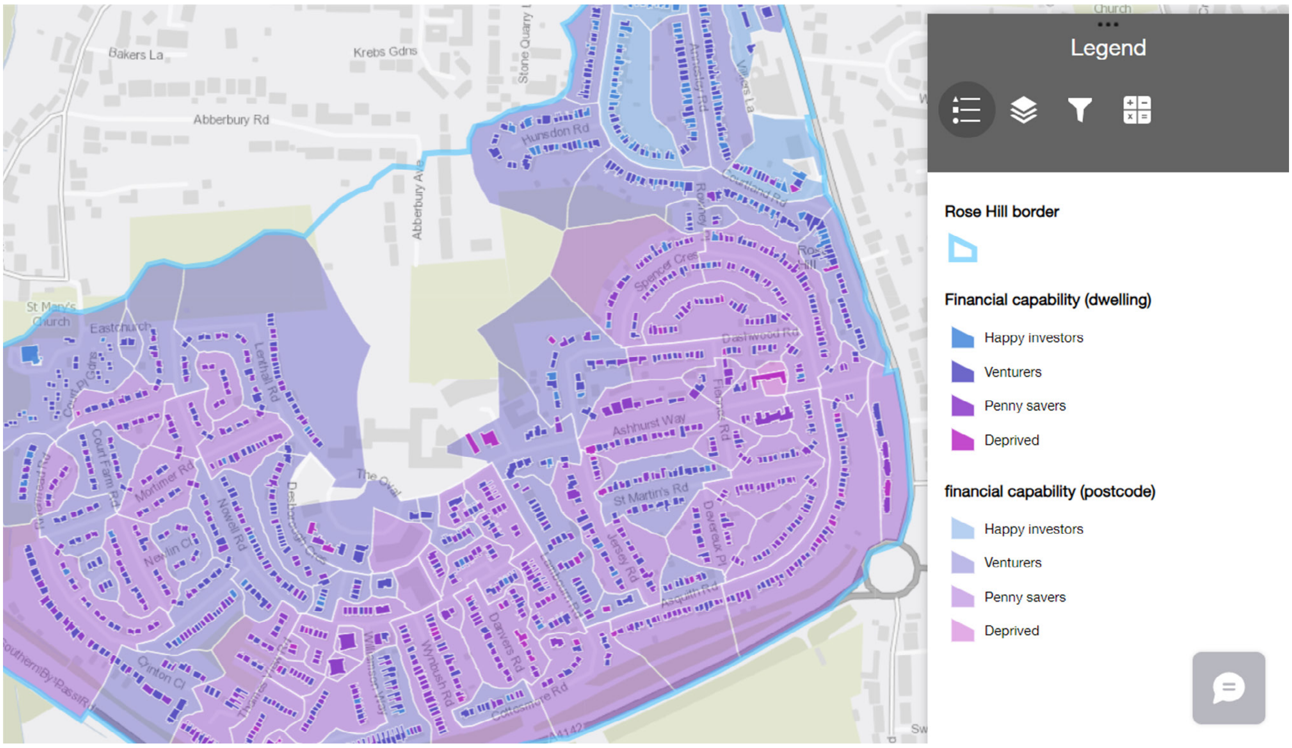

Figure 4: Financial capability map

Table 7: Financial capability percentages			
Financial capability			
Happy investor	**Venturers**	**Penny savers**	**Deprived**
10%	46%	41%	3%

Social capability

The category with the lowest numbers of capability in Rose Hill is social. Both fully convinced and motivated make up only 35% of the households; 52% are considered sceptical. Social capability, however, is likely the most speculative assessment as it does not include a direct survey to the householders regarding LCTs or energy and climate issues but uses broad categories based on national financial strategy segment groups – a view of UK consumer financial behaviour. Figure 5 provides the mapped results for direct targeting and Table 8 shows the per cent of dwellings in Rose Hill attributed to social capability.

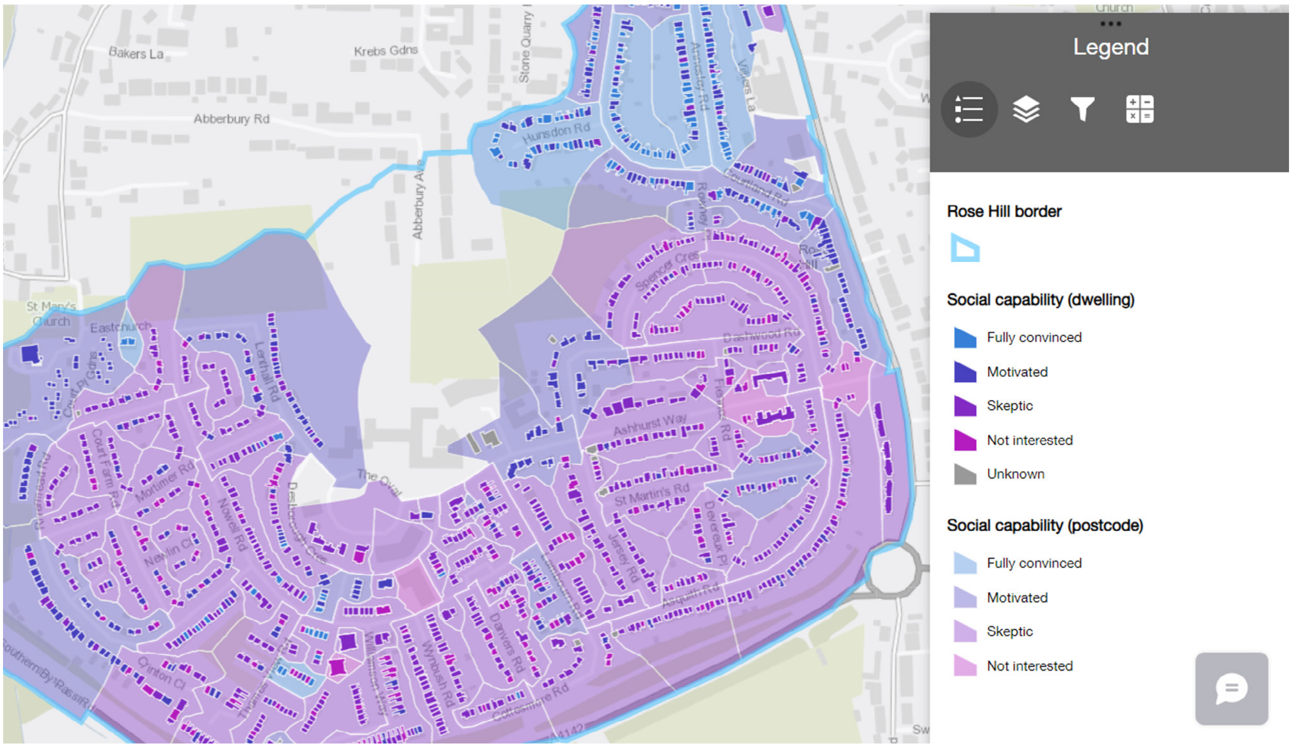

Figure 5: Social capability map

Table 8: Social capability percentages			
Social capability			
Fully convinced	**Motivated**	**Sceptical**	**Not interested**
10%	25%	52%	13%

Potential for low carbon technologies

Stakeholders can align the data in these capability categories to seek households fit for LCT installation. Potential for LCT installation does not only consider suitability but also capability. As an example, 55% of dwellings in Rose Hill are suitable for PV installation because they have an EPC rating of 'D' or higher and have a roof that is suitable. However, depending on policy support, the goal may be to target those that can afford and are willing to pay or to provide equitable opportunities to others that may be digitally and social capable but not financially capable.

Most dwellings suitable for PV were built between 1918 and 1945 and are semi-detached in form. The semi-detached dwellings were also able to accommodate the greatest number of panels and had access to the highest mean solar irradiance. Most of the suitable dwellings had an EPC energy efficiency rating (EER) of 'D'. An additional four per cent of dwellings could be suitable for PV if EPCs were improved as suggested. Using the data regarding these homes could initiate fabric improvement and LCT installation packages. Thirty-five per cent of dwellings were suitable for batteries. Only 29% could accommodate PV and batteries together. Fifty-five per cent of dwellings were suitable for EV charging; it is recommended that these align with dwellings that have PV.

Around 45% of dwellings were suitable for heat pumps, slightly less for GSHP given the need for appropriately sized garden space. Most dwellings suitable for heat pumps were built between 1918 and 1945 and are semi-detached in form. Most of the suitable dwellings had an EPC energy efficiency rating (EER) of 'D'.

Recommendations

The capability assessment approach has shown that where a householder or community do not have the capabilities considered necessary to participate in a smart and fair energy system, the appropriate approach would first necessitate increasing capability. The interventions include either adjusting the capability to enable participation or change the expectation of the smart energy solution to meet and work with the communities' capabilities (Banks and Darby 2021). Ideally, the solution would include both meeting current capabilities and improving capabilities in the process. Examples of improving capabilities include reducing costs (e.g., support, grants, etc.), ensuring households are maximizing financial benefits, providing the appropriate training and support for technological solutions, socially – providing examples of neighbours' benefits, successes from installed technologies. As noted in the assessment, several dwellings needed fabric upgrades to be technically capable for certain LCTs. There will need to be continued effort in both low carbon technological solutions and energy efficiency through fabric upgrades to maximise the benefits of each.

Addressing the climate crisis and meeting national targets will require a smart, secure, and more flexible network that addresses local social and economic problems. The capability assessment combines socio-economic and technical data to support a fair and equitable approach to upscaling a local area for a low carbon future. Though inequity is often inevitable due to uneven distribution of capabilities (Banks 2022), the mapping of capabilities provide a powerful was to identify the vulnerable spots and focus on these to deliver a smart and fair energy transition. The mapping of these capabilities is intended to help stakeholders such as community energy project developers, local authorities, and local community groups to plan for localised smart and fair energy initiatives in neighbourhoods.

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About EnergyREV

EnergyREV was established in 2018 (December) under the UK's Industrial Strategy Challenge Fund Prospering from the Energy Revolution programme. It brings together a team of over 50 people across 22 UK universities to help drive forward research and innovation in Smart Local Energy Systems.

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