BURO HAPPOLD

Brighton & Hove Decarbonisation Pathways

Final Report

XXXX-BHE-XX-XX-XX-X-XXXX

058534

21 August 2024

Revision P04

Revision	Description	Issued by	Date	Checked
P01	Draft report	AC	20/05/2024	BW
P02	Final draft report	AC	10/07/2024	BW
P03	Issued report	AC	09/08/2024	AC
P04	Issued report with appendices	AC	21/08/2024	AC

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Contents

Glossary

Term/acronym	Definition
AHC	After Housing Costs
AONB	Areas of Outstanding Natural Beauty
ASHP	Air Source Heat Pump
BEES	Building Energy Efficiency Survey
BHCC	Brighton & Hove City Council
BUS	Boiler Upgrade Scheme
CCC	Committee for Climate Change
DESNZ	Department for Energy Security and Net Zero
DFES	Distributed Future Energy Scenarios
DfT	Department for Transport
Diversity	Diversity refers to natural differences in demand. This accounts for the fact that not everyone in Brighton & Hove will be using all of their appliances at once, for example, every household charging an EV, having a shower, cooking a meal, using the tumble dryer and having the heating on full at the same time.
DNO	Distribution Network Operator
DSO	Distribution Service Operator
EPC	Energy Performance Certificate
EV	Electric vehicle
EVI	Electric vehicle infrastructure – generally refers to charge points
EWI	External Wall Insulation
FPEER	Fuel Poverty Energy Efficiency Ratings
Fabric retrofit	Refers to energy efficiency improvements to the fabric of the building (rather than energy consuming elements like heating systems). Typical fabric retrofit measures include loft insulation or improved glazing.
Flexibility	Flexibility refers to the ability to change generation or consumption/demand patterns to support the electricity network. In fossil fuel-based energy systems, with the ability to easily dispatch additional generation to match demand there has traditionally been relatively little need for demand to be flexible.
GBIS	Great Britain Insulation Scheme
GSHP	Ground Source Heat Pump
HN	Heat Network
HUG2	Home Upgrade Grant 2
IMD	Index of Multiple Deprivation
IWI	Internal Wall Insulation
JSNA	Joint Strategic Need Assessment
LAEP	Local Area Energy Planning
LBC	Listed Building Consent
LEVI	Local EV Infrastructure
LILEE	Low Income Low Energy Efficiency
LNRs	Local Nature Reserves
LSOA	Lower Super Output Area
LTP	Local Transport Plan
MEES	Minimum Energy Efficiency Standard
NEVIS	National Electric Vehicle Insight and Support
NNRs	National Nature Reserves
ONS	Office of National Statistics
ORCS	On-Street Residential Charge point
QCR	Quantifiable Carbon Reduction
SACs	Special Areas of Conservation
SGN	Southern Gas Networks
SHDS	Social Housing Decarbonisation Scheme
SLES	Smart Local Energy Systems
SPAs	Special Protection Areas
SSSI	Sites of Special Scientific Interest
UKPN	UK Power Networks

0. Executive summary

Brighton & Hove City Council (BHCC) declared a climate emergency in 2018, aiming to be a carbon neutral city by 2030. The energy system (including transport) is the single largest contributor to these greenhouse gas emissions (henceforth referred to as “emissions” or “carbon emissions” in this report) and is the focus of this decarbonisation pathways study.

In the 2023 assessment of the former Government’s climate policies, the UK Climate Change Committee (CCC)[1] concluded that “approximately half of the emissions reduction required to meet the [national] 2030 target[2] is at risk or has insufficient plans” and that “emissions reduction outside the electricity sector now must accelerate four-fold to reduce UK emissions by 68% by 2030 relative to 1990 levels.” Inadequate progress towards national climate targets to date means that action at all levels must accelerate to reduce the worst impacts of climate change.

In the context of constrained local authority budgets and lack of devolved powers to decarbonise the city’s energy system, the council has, in recent years, focused largely on decarbonising its own estate. It will continue to aim for a 2030 target for maximising decarbonisation on its own estate. However, a more realistic decarbonisation target of 2040 has been used in this study to model decarbonisation scenarios or 'pathways' for the city as a whole.

This is a technically led document but includes consideration of communities, accounting for factors such as fuel poverty and deprivation. It was developed by Buro Happold with extensive input from BHCC and looks ahead to Regional Strategic Energy Planning. The Decarbonisation Pathways analysis helps establish a broad strategy for the energy system to help achieve carbon neutrality, and more immediate actions and identification of an initial pipeline of early opportunity projects to explore.

The current energy system in Brighton & Hove

The current carbon emissions for Brighton & Hove are 768 ktCO_2[3], the vast majority of which is related to the energy sector. A breakdown of these emissions is provided by sector and fuel type in Figure 0—1.

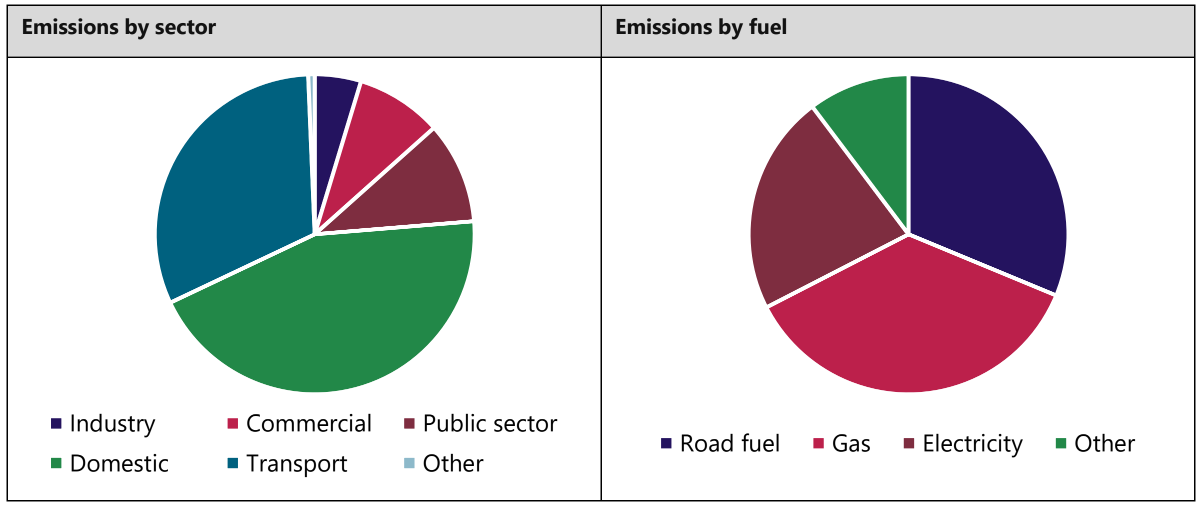


Figure 0—1 Breakdown of carbon emissions by sector

The domestic sector is the largest single source of territorial emissions, caused by the dominance of gas boilers for heating properties. The main mechanism in this plan for emissions reduction from all sectors is electrification, or the replacement of technologies or processes that use fossil fuels, such as internal combustion engines and gas boilers, with electrically powered equivalents, such as electric vehicles or heat pumps. However, the most recent emissions data from central government shows that electricity is still a major emitter. The decarbonisation of the electricity network at a national and regional level is thus vital to achieve any of the net zero pathways presented in this report. This is just one example of where regional and national action is required for local decarbonisation.

Scenario modelling

The analysis explored different decarbonisation scenarios based on the UK Power Networks (UKPN) Distributed Future Energy Scenarios published in 2023. These are a localised set of four energy system scenarios, based on the National Grid Future Energy Scenarios (which cover the whole of the UK). These scenarios help inform UKPN’s spending plans. Context from other decarbonisation pathways, notably the Climate Change Committee’s Sixth Carbon Budget, are used to provide additional insights and wider framing of the modelling. The four scenarios are “Falling Short”, “Consumer Transformation”, “System Transformation” and “Leading the Way”. These scenarios are discussed further in section 0.

The “Leading the Way” scenario, or pathway with the most accelerated action by government, communities, and industry, as well as individual households was considered to align best with a fast decarbonisation ambition for Brighton & Hove. In this scenario, only ~30 ktCO_2 remains to be offset in 2040.

Because of its close alignment with local ambition, the Leading the Way scenario is used to estimate the number of decarbonisation measures and their associated costs and carbon savings. These estimates are reported relative to estimates from the “Falling Short” scenario, or the ‘business-as-usual’ pathway which fails to hit the carbon reduction targets, but which provides useful context.

The key characteristics of the Leading the Way scenario are:

- high levels of heat pump in houses (domestic properties that are not flats)
- high heat network deployment, particularly in the denser city centre areas, and large deployment of communal heat pumps in flats
- a large amount of fabric improvement
- high levels of electric vehicle uptake with early carbon reduction supported by mode shift away from personal vehicle use
- 86% increase in electricity demand due to the electrification of heating and transport
- extensive renewable energy deployment (focusing on rooftop PV) with linked battery storage will meet 10% of new electricity demand
- significant investment in grid upgrades to accommodate additional electricity demand (the exact level depends on the next point)
- outside heat network zones, whole property decarbonisation (bundling fabric improvements, heat pump, solar pv and battery storage) maximises financial return on investment and minimise the requirement for grid upgrades, improving the efficiency (cost and time) of the local energy transition

The speed and extent of action requires the council, businesses, communities and individuals to all play their part. The council can take early actions to act as a pathfinder for some solutions, with good opportunities for some technologies (e.g. heat networks) in the BHCC estate; however, wider action is required. A summary of the different actions required is provided in Table 0—1. Many of the numbers are given as a property count; for reference, 10,000 domestic properties translates to ~7% of the Brighton & Hove total, whilst 1000 non-domestic properties is nearly 9%.

[1] Independent, statutory body established under the Climate Change Act 2008 to advise the UK and devolved governments on emissions targets and to report to Parliament on progress made in reducing greenhouse gas emissions and preparing for and adapting to the impacts of climate change.

[2] The ’2030 target’ is the Nationally Determined Contribution (NDC) which is to reduce emissions by 68% by 2030 relative to 1990 levels.

[3] From the Department for Energy Security and Net Zero - https://www.gov.uk/government/statistics/uk-local-authority-and-regional-greenhouse-gas-emissions-national-statistics-2005-to-2021

Table 0—1 Summary of key technology installations and actions to achieve the decarbonisation pathway. Numbers are cumulative for the length of the scenario.

Item	Current status/context	Requirement 2027	Requirement 2030	Requirement 2035	Requirement 2040
Domestic fabric improvement	35,000 properties with some single glazing, 40,000 properties with uninsulated cavity walls, up to 72,000 with uninsulated roofs and 56,000 uninsulated solid walls (not a priority).	Retrofit up to ~14,300 properties (~21 GWh/yr heat saving)	Retrofit up to ~44,700 properties (~62 GWh/yr heat saving)	Retrofit up to ~95,500 properties (~138 GWh/yr heat saving)	Retrofit up to ~105,000 properties (~152 GWh/yr heat saving)
		~2,400 of which are on land in BHCC ownership.	*~6,100 of which are on land in BHCC ownership.*	*~6,700 of which are on land in BHCC ownership.*	*~6,700 of which are on land in BHCC ownership.*
Non-domestic fabric improvement	3,300 properties with an EPC of D and 3,600 properties with an EPC of E-G	Retrofit saving up to 5 GWh/yr heat demand (~1% of non-dom gas demand)	Retrofit saving up to 17 GWh/yr heat demand (~4% of non-dom gas demand)	Retrofit saving up to 37 GWh/yr heat demand (~9% of non-dom gas demand)	Retrofit saving up to 42 GWh/yr heat demand (~10% of non-dom gas demand)
		4 GWh/yr saving from properties on land in BHCC ownership.	*11 GWh/yr saving from properties on land in BHCC ownership.*	*12 GWh/yr saving from properties on land in BHCC ownership.*	*12 GWh/yr saving from properties on land in BHCC ownership.*
Property level heat pumps	Currently 360-1,100 domestic heat pumps in Brighton & Hove. Limited information for non-domestic.	Total of ~8,000 additional property level heat pumps installed.	Total of ~28,000 additional property level heat pumps installed.	Total of ~49,000 additional property level heat pumps installed.	Total of ~73,000 additional property level heat pumps installed.
		~2,500 of which are on land in BHCC ownership.	*~7,000 of which are on land in BHCC ownership.*	*~7,000 of which are on land in BHCC ownership.*	*~7,000 of which are on land in BHCC ownership.*
Communal and district heat networks	The large heat network at the University of Sussex and 1280 domestic properties connected to communal systems or small heat networks.	Total of ~1,300 additional properties connected.	Total of ~4,700 additional properties connected.	Total of ~23,800 additional properties connected.	Total of ~44,000 additional properties connected.
		~800 of which are on land in BHCC ownership.	*~3,800 of which are on land in BHCC ownership.*	*~8,500 of which are on land in BHCC ownership.*	*~8,500 of which are on land in BHCC ownership.*
Electric vehicle infrastructure	430 publicly available EV charge points currently installed.	Total of 1,200 additional publicly available EV charge points.	Total of 3,530 additional publicly available EV charge points.	Total of 6640 additional publicly available EV charge points.	Total of 9,730 additional publicly available EV charge points.
Solar PV installation	~15 MW of current PV capacity	Minimum of 14MW of total additional PV capacity installed.	Minimum of 33 MW of total additional PV capacity installed.	Minimum of 56.5 MW of total additional PV capacity installed.	Minimum of 66.5 MW of total additional PV capacity installed.
		At least 5.5 MW is on land in BHCC ownership.	*At least 15.5 MW is on land in BHCC ownership.*	*At least 26.5 MW is on land in BHCC ownership.*	*At least 26.5 MW is on land in BHCC ownership.*

These different technologies have different impacts on carbon saving. Fabric retrofit yields limited carbon saving when considered in isolation but is a key enabler of low-carbon heating technologies – which present the largest total potential savings. The emissions impact of different factors is explored in Figure 0—2.

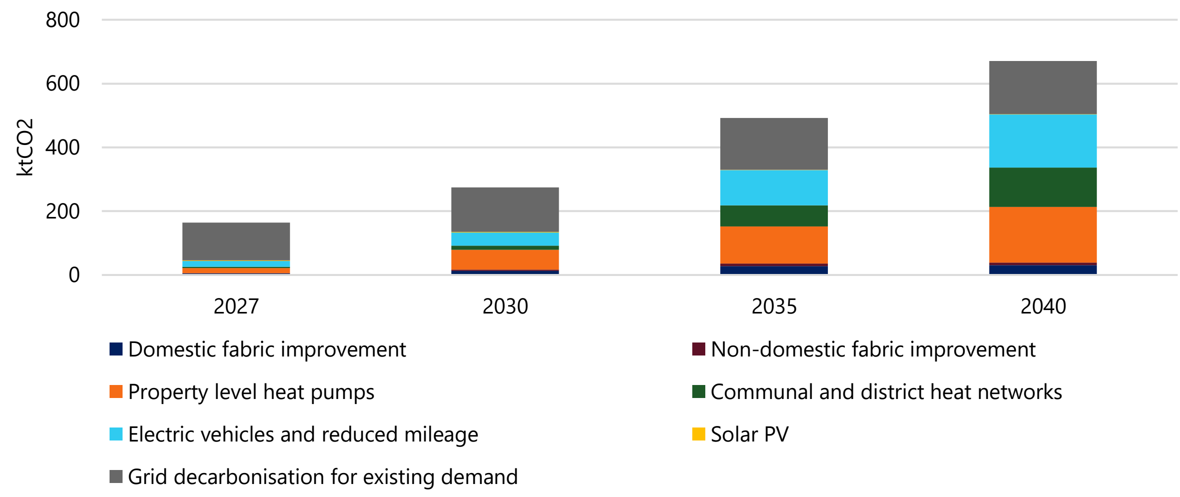


Figure 0—2 A summary of how different items contribute to carbon savings against a 2021 base reporting year for emissions.

As with fabric retrofit, solar PV makes a limited *direct* contribution to carbon savings. The impact of solar PV on carbon savings is greatest in early years, with the decarbonisation of the wider grid already yielding significant carbon savings by 2027. This means Brighton & Hove will see the most benefit from early deployment of solar PV. However, like fabric retrofit, solar PV is a key enabler of the Leading the Way pathway. 66.5MW of additional solar pv capacity installed by 2040 would meet 10% of the additional electricity demand modelled in this scenario. Moreover, solar PV will play an important role in minimising the cost of the transition for residents and businesses, both directly through lower energy bills, and indirectly by reducing socialised costs associated with grid upgrades.

Investment and operational costs

To achieve this decarbonisation pathway substantial investment is required. The different levels of investment required for up until 2040 are provided for the Leading the Way and Falling Short scenarios in Figure 0—3. For extra context the total spend on BHCC assets is also included for the Falling Short scenario.

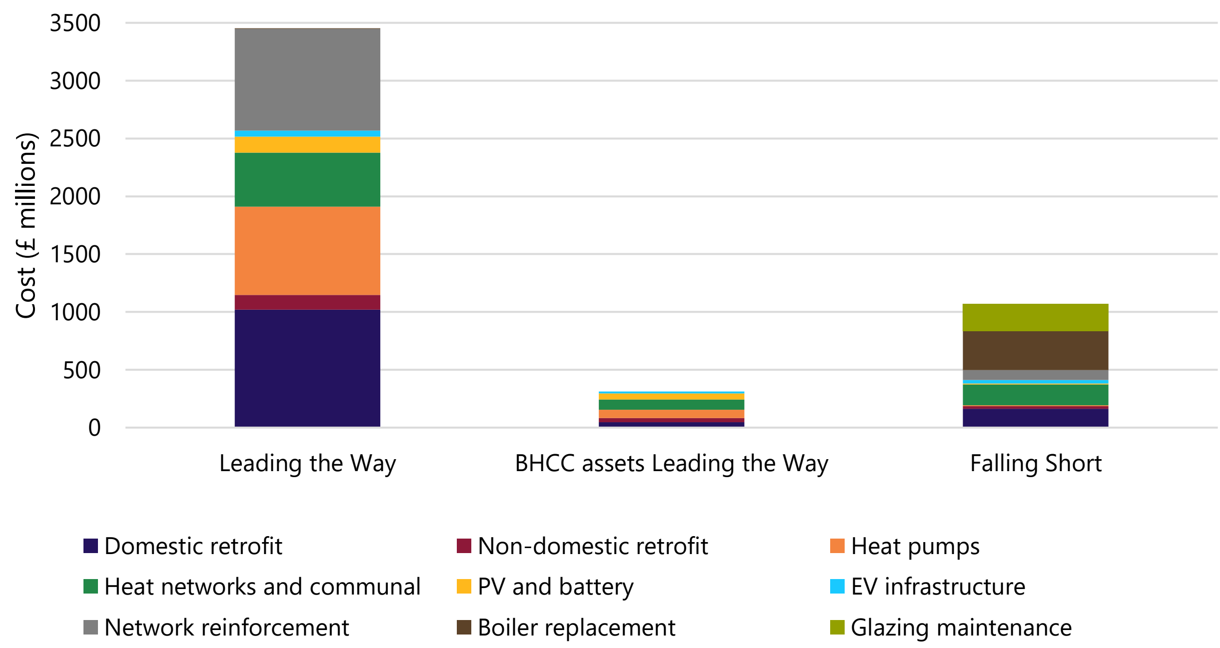


Figure 0—3 Capital investment required to 2040 for the Leading the way scenario, the Brighton & Hove City Council assets for the Leading the Way, and Falling Short.

In the Falling Short scenario, the cost of “glazing maintenance” (replacement of windows at their end-of-life with double glaze windows) and “boiler replacement” (replacement of boilers at their end-of-life with more efficient boilers) is included in the Falling Short scenario in Figure 0—3 to give a fairer cost comparison.

Relative to the Falling Short pathway, £2.3 billion of additional capital investment is needed in the Leading the Way pathway to achieve net zero by 2040. Property owners in Brighton & Hove will need to contribute part of the overall investment for most costed measures (e.g. domestic retrofit, PV and battery, and heat pump installation). However, a significant portion of investment would come from other sources, such as government grants and subsidies, and private investment in energy service companies that take on the upfront capital cost of installations. This is especially important to unlock capital intensive “Whole property decarbonisation” where solar pv and battery storage systems are installed at the same time as heat pumps to maximise the value and financial return of low-carbon technologies.

Due to the high prevalence of heat networks and communal heating systems in the Leading the Way scenario, much of the investment in heat decarbonisation would need to come from the public and private sectors, where many of the upfront costs would likely be met by a central provider.

The “Network Reinforcement” costs, account for about a quarter of the total capital investment in the Leading the Way scenario. Network reinforcement can also significantly delay the installation of low-carbon technologies. Taken together, these two points highlight the importance of the local electricity grid. It is a vital enabler for the decarbonisation pathway selected and, as such, requires substantial investment. Much of the upgrade cost would be socialised, meaning the majority of the cost burden would not fall directly on Brighton & Hove residents.

The socialised cost and delays introduced by network reinforcement can vary widely depending on the uptake of other measures. Whole property decarbonisation is crucial for minimising network reinforcement costs, as the co-installation of these measures diversifies and reduces a building’s electricity demand from the grid . The same is true for co-locating solar canopies and EV charging infrastructure, touched upon in Section 7.5.3.

Likewise, heat networks improve the diversity of demand, minimizing the need for costly grid reinforcements. They also benefit from economies of scale often associated with larger low carbon heating technology. For these two reasons, centralised heating solutions in Leading the Way represent a total cost saving of ~£220 million compared to Consumer Transformation.

Cost savings between the Leading the Way and Falling Short scenarios help to offset some of the capital investment that is required to achieve net zero. However, the estimated savings in fuel costs only amount to £210 million between 2025 and 2040. This is due to the high cost of electricity compared to gas (electricity is ~3.4 times the gas price in the UK Government Greenbook – which is used to derive fuel prices). Increased flexibility and smart management of demand should help to reduce the gap in price between gas and electricity. The fuel and carbon costs in the final year of the pathway is provided in Figure 0—4.

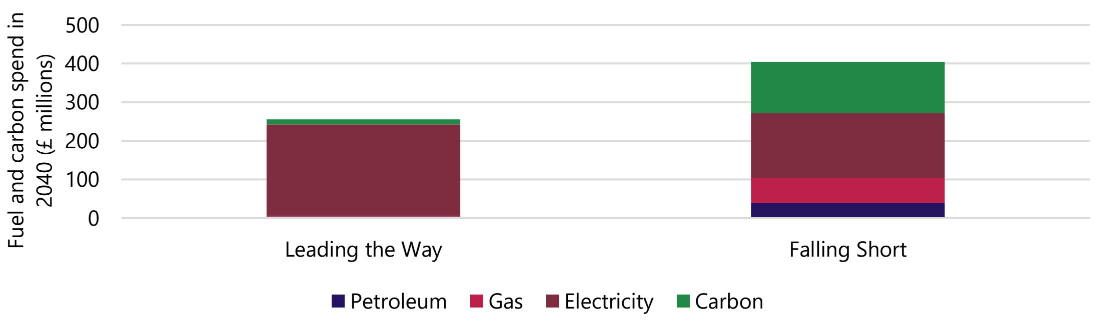


Figure 0—4 Fuel and carbon costs for Leading the way and Falling Short in 2040.

Total cost savings between 2025 and 2040 increase to £1275 million when including “carbon cost” savings. The “cost of carbon” refers not to the social cost of carbon, but rather to the unit cost levied by existing policy frameworks such as the EU Emissions Trading Scheme and carbon tariffs. The unit cost of carbon used to calculate pathway costs in this analysis and Figure 0—4 is from the HM Treasury’s Green Book (set at £343/tCO_2 in 2040 at the time this study was carried out). The unit cost will need to rise further if the world is to meet the Paris Agreement’s net-zero targets. If and when the unit price increases, the gap in cost savings between the two scenarios is likely to increase, improving the economic case for decarbonisation.

Conclusions and recommendations

This section draws out seven key conclusions pathways analysis – linked to partnered next steps. A high-level summary, including a map of the Leading the Way decarbonisation pathway for Brighton & Hove is provided at the end of the section in Figure 0—5.

Conclusions

1. The transition to net zero can only be achieved if the measures listed above are taken up by all actors: public, private, households and communities, with an ambitious Government policy mix to drive their adoption.
2. Brighton & Hove City Council, despite limited influence in some areas, have a key role to play in steering, monitoring and reporting city wide progress.
3. Timing is key, with early deployment meaning greater cumulative carbon reduction and a higher impact from certain technologies.
4. There is need for a transparent process for engagement and information sharing to support democratic input to energy system planning and targeted network investment. The just transition requires a coordinated effort and clear communication is a key component of this.
5. Brighton & Hove benefits from having many active stakeholders. Stakeholders can identify shared opportunities and objectives to unlock value. Community groups such as BHESCo and Brighton Energy Co-op have successfully delivered projects across all themes considered in the pathways analysis. Effectively engaging them with a pipeline of work (based on the priority projects) could be a mechanism to help deliver early decarbonisation. It is also key to gaining a better understanding of future legislation, particularly relating to community-led projects that can accelerate the city’s path to net zero.
6. The majority of measures will be commissioned by individual businesses and householders, for example:
   - 95% of fabric improvements will need to take place in privately owned homes and 70% in privately owned non-domestic buildings
   - 90% of heat pumps will be installed in private sector properties (i.e. privately owned or rented homes and commercial properties)
   - 80% of communal or heat network connections will be to private sector properties

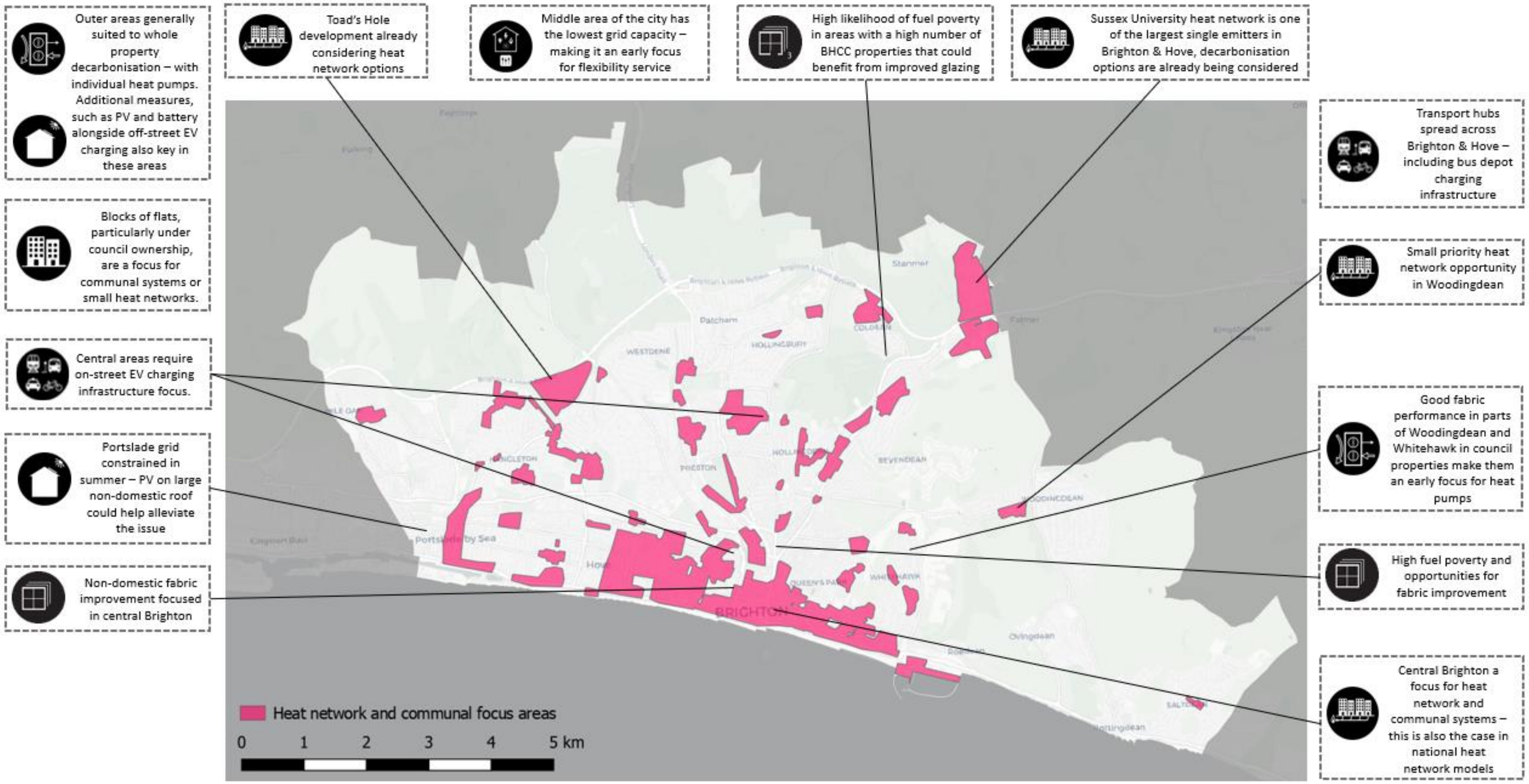
   Engagement with businesses and the public is key to reaching the private sector – particularly given the current lack of central government legislation. Alongside this messaging, trust building is key. Targeting earlier decarbonisation of public sector buildings allows leveraging of assets to demonstrate viability of technology choices, and to build supply chains and capacity.
7. Demand reduction and more active, flexible, engagement with the energy system is required to reduce the need for grid reinforcement with the electrification of heat and transport.

Recommendations

1. Use the report and associated data as an evidence base to influence central government to provide the support and policy needed for wider action outside BHCCs own assets. Engage with Government on existing and developing policy frameworks, a key example being Heat Network Zoning (described in more detail in section

2.6) and the creation of a Zone Coordinator to take forward heat networks in Brighton & Hove. This role will be key to driving forward parts of the pathway and to develop an action plan.

2. Identify a lead within BHCC to own the decarbonisation pathways and to lead on stakeholder engagement for the development of a city-wide decarbonisation action plan. The lead should be responsible for monitoring and reporting progress to the appropriate oversight committee and to continue engagement with key stakeholders.
3. Develop a city-wide energy decarbonisation action plan that takes into account detailed recommendations provided in section 9.2 of this report. This includes consideration of 110 priority projects identified for initial focus. These should be reviewed, and a preferred pipeline for action created, including consideration of funding mechanisms. These should be a mix of projects that can be achieved in the near term, such as replacement of communal boilers with heat pumps at end of life, and longer lead-in projects, such as wider district heating projects that require a feasibility stage and large-scale investment.
4. Engage with a wide range of stakeholders, from the distribution network operator to residents experiencing fuel poverty. Ensure their views, knowledge and experiences feed into the planning process to speed up delivery, reduce costs and maximise social benefit. Promote visibility of the plan and strategies with local residents, businesses, communities and third sector organisations, and keep key stakeholders updated on progress
5. Consult with community energy groups to understand how they can most effectively engage with the plan and opportunities identified.
6. Demonstrate the viability and communicate the co-benefits of low-carbon technologies to local residents and businesses.
7. In the near term, examine opportunities for flexibility in the council's own assets based on UKPN published flexibility opportunities. More widely, there should be engagement relating to the benefits of being a more active participant in the energy system and the benefits this can bring – including reduced fuel costs. Engagement should also relate to the opportunities and enabling technologies (such as smart meters) needed for this active participation. This engagement could come from a combination of BHCC, community groups and UKPN.



Domestic fabric improvement	Non-domestic fabric improvement	Property level heat pumps	Communal and district heat networks	Electric vehicles and reduced mileage	Solar PV	Flexibility
Retrofit up to ~105,000 properties.	Retrofit saving up to 42 GWh/yr heat demand	Total of ~73,000 additional property level heat pumps installed.	Total of ~44,000 additional properties connected to communal systems or heat networks.	Total of 9,730 additional publicly available EV charge points.	Minimum of 66.5 MW of total additional PV capacity installed.	Not treated as a standalone technology but considered alongside other technologies
30,700 tCO_2e saved in 2040 compared to present	8,400 tCO_2e saved in 2040 compared to present	174,250 tCO_2e saved in 2040 compared to present	122,900 tCO_2e saved in 2040 compared to present	167,130 tCO_2e saved in 2040 compared to present	1,120 tCO_2e saved in 2040 compared to present	Allows for deployment of other technologies

Figure 0—5 Summary of some key elements of the selected decarbonisation pathway.

Introduction

This document examines decarbonisation pathways for the energy system of Brighton & Hove. This is a technically led report developed by Buro Happold in conjunction with Brighton & Hove City Council (BHCC). The focus of the decarbonisation pathways is scope 1 and 2 emissions (nominally from, direct use of electricity, natural gas and petroleum products), this aligns with many annually published national and regional energy system decarbonisation pathways. With the overall aim being identification of a pathway to reach as close to zero carbon emissions associated with energy by 2040, maximising public sector decarbonisation by 2030. This recognises that although BHCC declared a climate and biodiversity emergency in 2018, with the aim of being carbon neutral by 2030, the existing infrastructure, supply chain and national policy is not in place to support this transition (more details about determining the aims of decarbonisation pathways is provided in section 0.

Scale of the challenge

In the last year emissions data was reported at a local authority level (2021) the total carbon dioxide emissions associated with Brighton & Hove was 768 kt[4]. The split of these emissions by major sectors is shown in Figure 0—1.

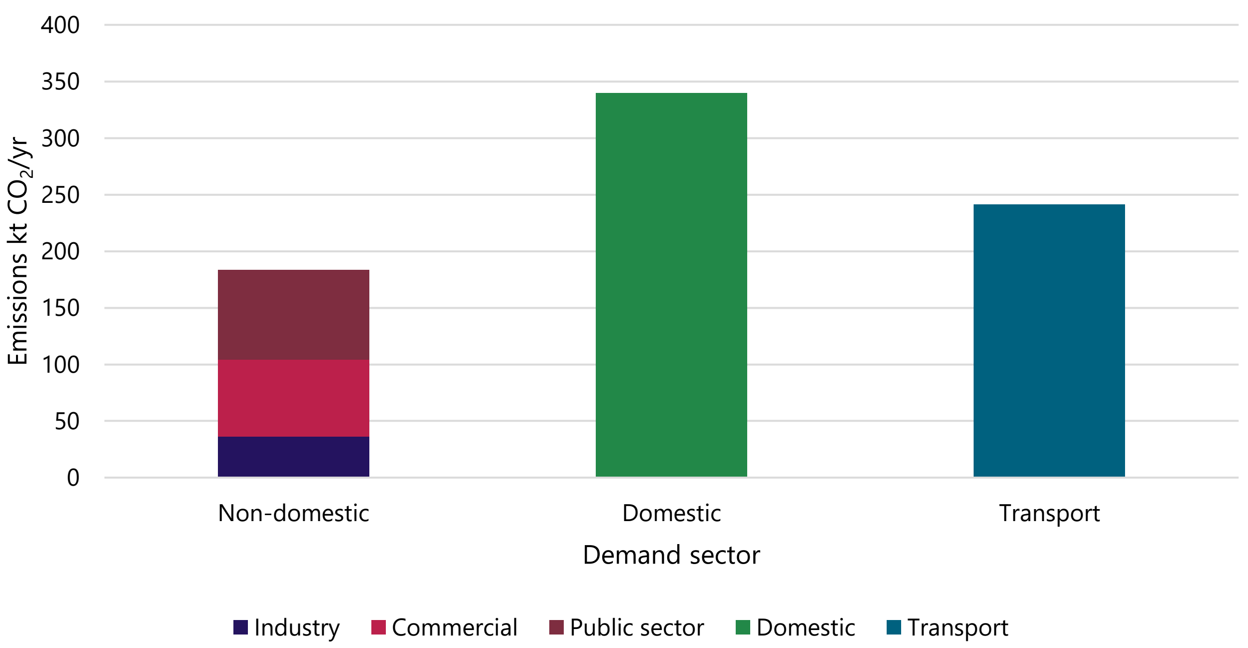


Figure 0—1 Carbon dioxide emissions by key demand sectors in the energy sector in 2021.

The domestic and transport sectors make the largest contribution to carbon emissions in Brighton & Hove, highlighting that the role of individuals in achieving behaviour change will be critical to any decarbonisation pathway. From a strategic perspective the relatively large contribution of the public sector (this includes large emitters like the NHS as well as BHCCs own emissions) to overall non-domestic emissions does show there will be some opportunities for decarbonisation over which BHCC and national policy has greater influence.

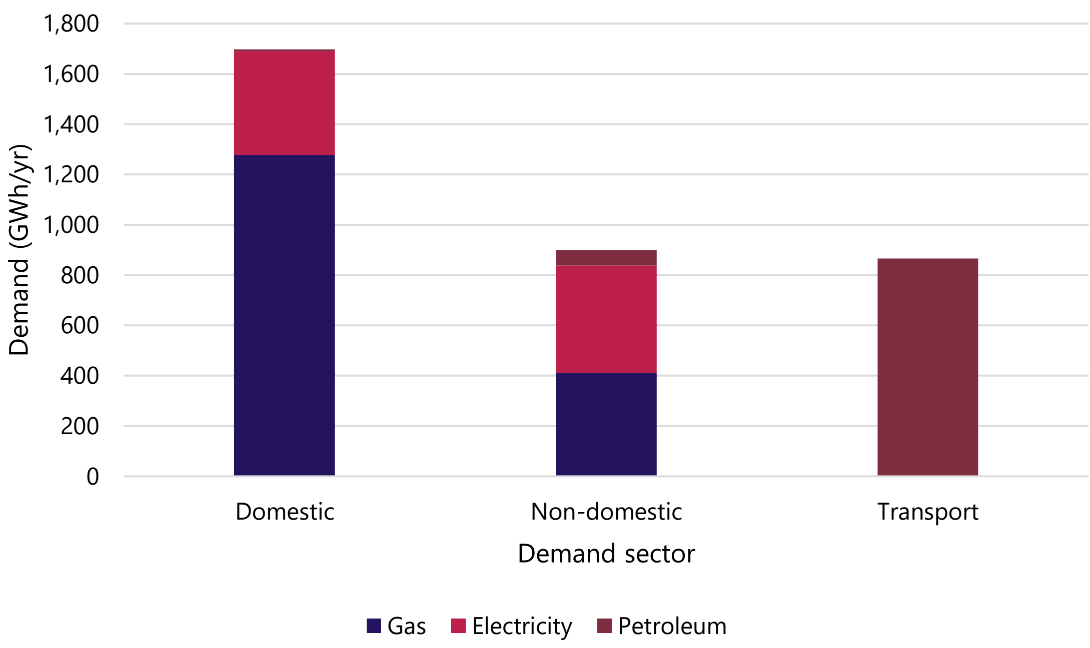


Figure 0—2 Demands for different energy vectors by demand sector in 2021.

Emissions associated with electricity consumption will naturally reduce overtime, based on national projections, making electricity the demand of lowest concern. In general, the aim of most decarbonisation pathways will be to reduce overall energy demand and to shift the petroleum and gas demands to electricity.

Again, the energy demand figures highlight the importance of the domestic sector in the pathway to decarbonisation, with gas based domestic heating being the single largest energy demand and source of carbon emissions. This highlights the scale of the challenge of decarbonising the energy system of Brighton & Hove, with a large number of private home and vehicle owners needing to make active decisions to switch to net zero technology.

Scope

The main objectives of this pathways analysis are:

- to explore different options for energy system decarbonisation and focus on the reporting of one proposed pathways
- through examination of the pathways identify priority decarbonisation projects
- use the pathways analysis and identified priority projects to establish an action plan

Core context to all of these objectives is consideration of at-risk communities, such as those in fuel poverty. This forms a key part of the analysis and modelling approaches considered.

To carry out this pathways analysis an adapted form of Local Area Energy Plan (LAEP) modelling was used. An overview of the LAEP process, which was initially developed by Energy Systems Catapult, is provided in Figure 0—3.

[4] This focuses purely on the energy sector (excludes waste and agriculture given their very small contribution to overall emissions) carbon emissions all major greenhouse gas emissions 812 ktCO_2e in 2021. Data taken from https://www.gov.uk/government/statistics/uk-local-authority-and-regional-greenhouse-gas-emissions-national-statistics-2005-to-2021

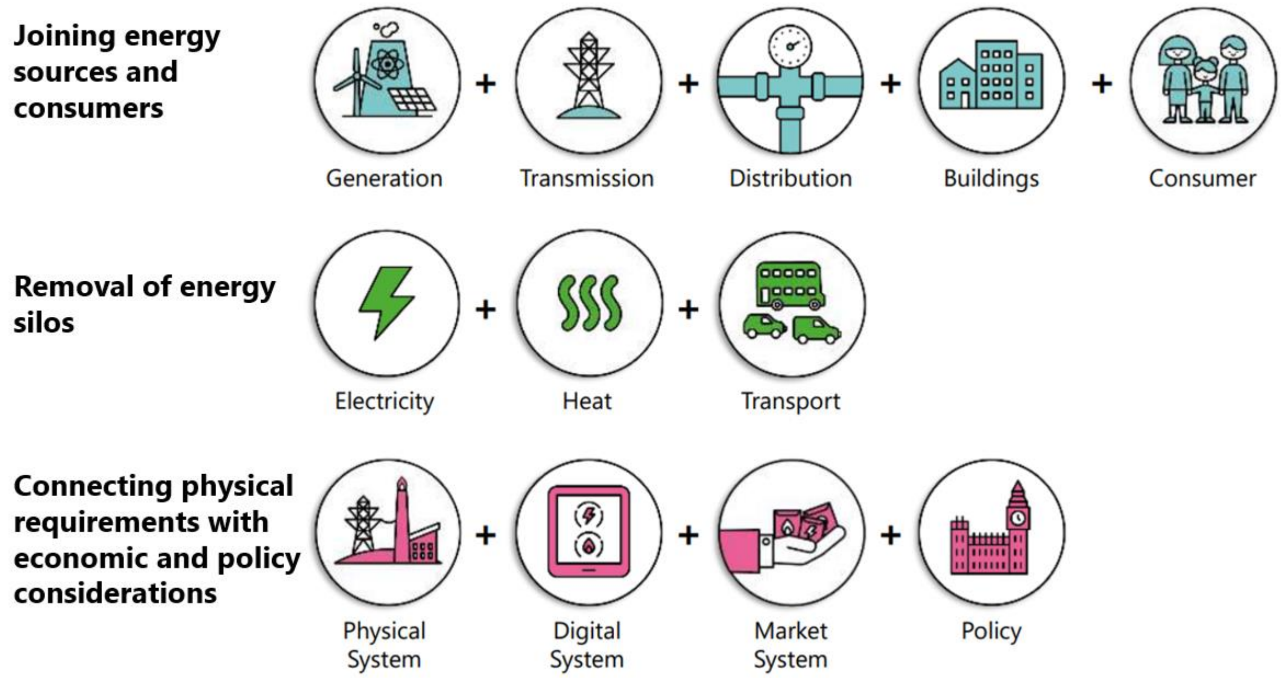


Figure 0—3 Illustration of key characteristics of the LAEP process[5].

The LAEP process takes a holistic view of the energy system examining multiple scales and aspects of the energy system. This is key, because as previously mentioned, decarbonisation will often result in electrification of demands – meaning traditional siloing of different aspects of the energy system is no longer viable.

Core to the LAEP modelling philosophy used in this analysis is modelling at fine detail. This means every property is considered in the modelling approach.

Whilst the analysis captures the whole energy system there are significant emissions out of scope, this includes scope 3 emissions[6]. Transport in particular presents challenges with emissions, with large HGVs as well as commuters and tourist traffic contributing significantly to overall transport emissions in Brighton & Hove. Whilst these emissions and demands cannot always be easily extracted the focus of the transport decarbonisation is on the demands associated with Brighton & Hove residents and non-domestic activity within the city.

The approach is not based on carbon budgeting but energy system decarbonisation. Thus, it is more similar to a Brighton & Hove specific version of the National Grid Future Energy Scenarios or the Distributed Future Energy Scenarios produced by UK Power Networks (UKPN) than a carbon budget like that produced in the Committee of Climate Change's (CCC) Sixth Carbon Budget. Recommendations in the CCC's Sixth Carbon Budget are based on the UK's legally binding interim target of 78% reduction in carbon emissions by 2035 relative to 1990 level. In the nearer term the UK's nationally determined contribution under Article 4 of the Paris Treaty stipulates "reducing economy-wide greenhouse gas emissions by at least 68% by 2030, compared to 1990 levels." As noted by the UN Framework Convention on Climate Change[7] hitting near term targets is most crucial for limiting global warming, which is one of the reasons this report focuses on near term actions and opportunities.

According to the CCC, behaviour change (for example, shifting from private vehicle travel to public transport and active travel) plays a significant role in limiting UK net emissions of GHGs and achieving interim targets during the early stages of technology adoption (for example, electric vehicle uptake and rollout of charging infrastructure). Behaviour change thus plays a greater role in CCC scenarios and recommendations than in DFES scenarios, which focus on decarbonising the energy system by 2050. These different approaches to decarbonisation strategies are explored further in sections 0 and 0.

Reporting scales

The LAEP approach produces large volumes of detailed data, including every property in Brighton & Hove. Reporting at property level has challenges such as GDPR and commercial sensitivity but alongside this the volume of data makes it hard to form a strategy or prioritisation of actions. At the local authority level reporting headline values is useful but there is not enough detail for a project-based strategy. Multiple scales between these two extremes were considered and are used in this reporting, an illustration of this is provided in Figure 0—4.

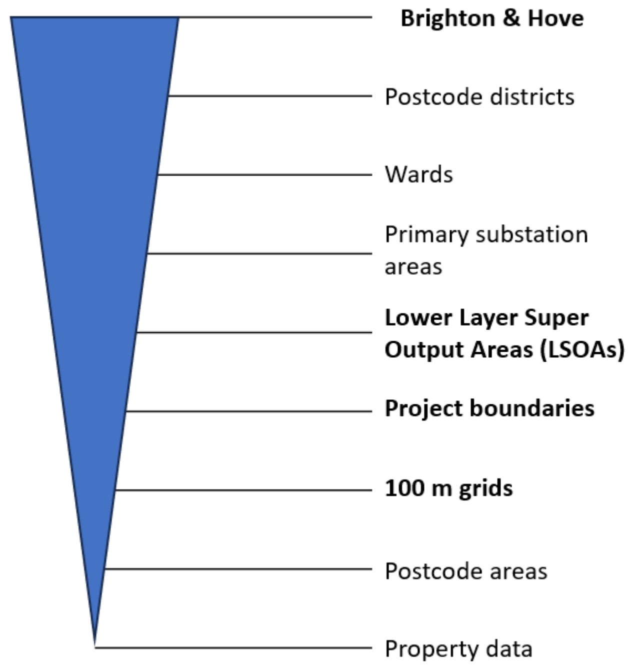


Figure 0—4 Different scales considered for data presentation in reporting.

The scales marked in bold are key reporting scales used in this report but many of the others are also used in specific contexts. The three bold marked scales near the middle perform different roles:

- LSOA is a standard reporting area used in many national publications, from census data to national energy scenarios. This means it is useful to align with multiple national datasets, such as fuel poverty and indices of multiple deprivation. In Brighton & Hove there are 166 LSOAs. This means they provide a good level of detail whilst being suitable for mapping – this is the geographic scale most commonly used in this report.
- The 100 m grid provides a summary of characteristics in 100 m grid squares. This is far more detailed than the LSOA level (~8300 grid squares in Brighton & Hove), allowing insight into clusters of properties within an LSOA.
- The project boundaries are either an output of precise analysis, such as heat network modelling or based on a combination of the 100 m grid, property data and LSOA information. These projects are not of uniform size and can cross multiple LSOAs or fall within a couple of the 100 m grid squares.

In general the Brighton & Hove level and LSOA levels are concerned with strategy and direction of travel, whilst the project boundaries and grid squares are concerned with precise delivery.

[5] Image adapted from Energy Systems Catapult, available from https://erpuk.org/wp-content/uploads/2019/11/Grant_Tuff.pdf
[6] Scope 3 includes all indirect emissions that occur upstream of Brighton & Hove – for example this would include purchased goods such as electric vehicles.
[7] UK NDC ICTU 2022.pdf (unfccc.int)

Report structure

The structure of the report has four key elements:

- Section 0 examines key characteristics of Brighton & Hove, its current energy systems (demand, generation, fuel mix, and emissions) and how different groups interact with it. Alongside this broad context some specific information is provided in later sections.
- Section 0 is concerned with scenario definition. These scenarios are used to shape the decarbonisation pathways considered for Brighton & Hove.
- Sections 0 to 8 form the bulk of the report and explore low carbon interventions and changes from the pathways analysis:
    - Section 4 is fabric retrofit –and examines fabric improvement measures for both domestic and non-domestic properties.
    - Section 5 is heating systems – analyses the different heating system options.
    - Section 6 is local power generation – identifies opportunities for renewable power generation, this is primarily focused on rooftop solar but also considers ground mounted solar and wind power.
    - Section 7 examines transport decarbonisation, with the focus being on electric vehicle (EV) infrastructure and EV roll out.
    - Section 8 is a short examination of the current energy networks in Brighton & Hove (electricity and gas). It briefly considers the impacts of the pathways outlined in sections 4-7 on these networks as well as enabling technologies like grid flexibility to help deliver the pathways.
- Section 9 provides the decarbonisation pathways summary. This includes a summary of progress required from present to 2040 and the associated emissions reductions. Alongside these it gives an indication of the capital costs associated with the core decarbonisation pathway, comparing it to a baseline scenario. The final section also provides an action plan summary based on priority projects identified in other sections as well as the overall pathway, with consideration of key stakeholders and funding schemes to help deliver the pathway.

Context

This section provides a broad overview of some key contextual factors for Brighton & Hove. These factors are common across all or multiple elements of the energy system and pathways analysis. Alongside more specific elements detailed in other sections this forms the baseline reporting aspect of the pathways analysis.

Brighton & Hove characterisation

Brighton & Hove is a city and unitary authority located on the southern coast of England. It covers area of ~83 km^2 with approximately 277,200 population (based on the latest census data of 2021). Whilst it is characterised as an urban and coastal area it does extend to the surrounding downland, with the Council 's own rural estate falling in the South Downs National Park. It covers an area of over 5,200 hectares comprising of farmland, nature reserve, and recreational space. In collaboration with residents, farmers, community groups, and other stakeholders, the Council has developed the City Downland Estate Plan[8] which aims to protect and improve the downland estate. These rural areas have very limited associated energy use and are thus not a focus of the pathways analysis. However, these areas are hugely important to the biodiversity aspect of the climate and biodiversity emergency declared in 2018. The areas can also contribute somewhat to any residual carbon emissions, helping to sequestrate them if effectively managed. However, the protected status does limit the scale of deployment of some low carbon technologies, like ground-mounted renewables.

As well as the National Park there are other areas that have planning protection in Brighton & Hove, including 34 conservation areas. These areas are designated based on their special architectural or historic interest, with a focus on preserving or enhancing their character and appearance. Within conservation areas, planning controls are stricter. However, the level of control varies depending on the type of building, whether it is a listed building, a single-family dwelling, a commercial structure, or flats. Figure 2-1 visually highlights the distribution of conservation areas and listed buildings across the city.

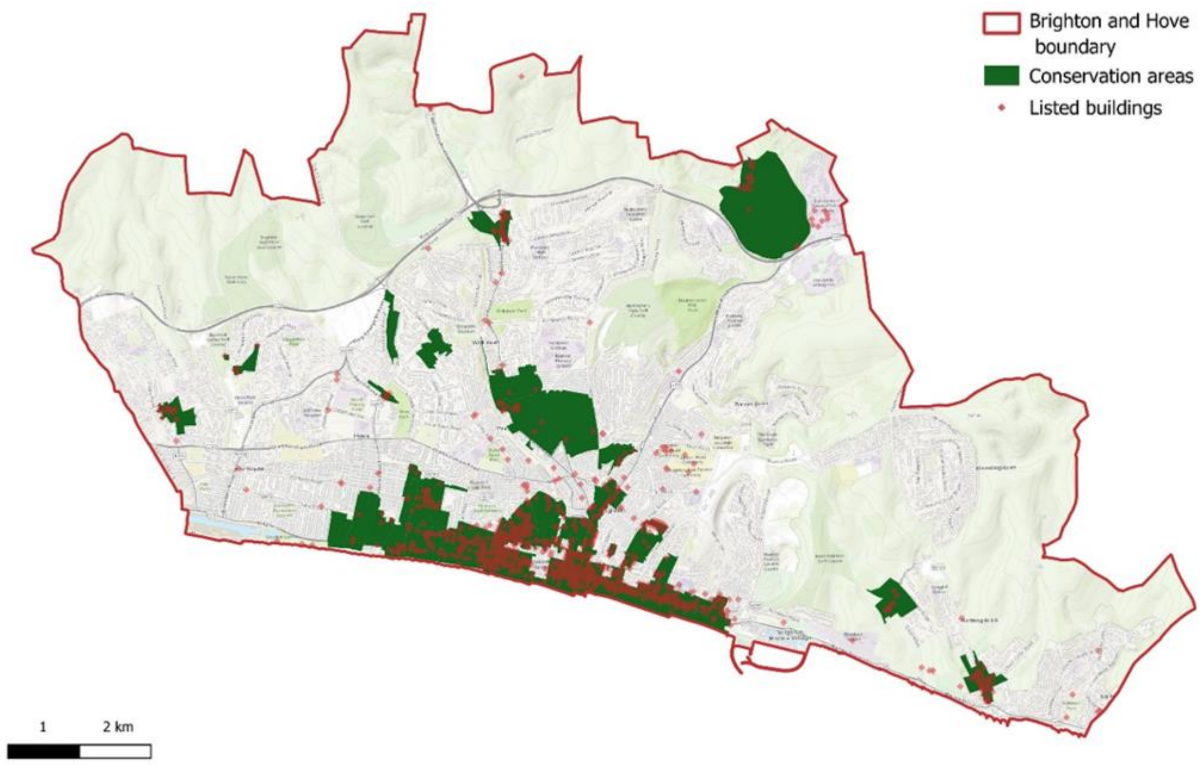


Figure 0—1 Map of conservation areas and listed buildings in Brighton & Hove

[8] https://www.brighton-hove.gov.uk/planning/planning-policy/our-city-downland-estate-plan

There are over 3,400 listed buildings in Brighton & Hove. The listed buildings are considered to be of national architectural significance due to their architectural or historical value. Listed buildings face additional constraints related to external wall insulation, window replacement, and the deployment of low-carbon technologies such as heat pumps and solar PV. On top of typical planning permissions, a listed building consent (LBC) is also required for solar panels or any other works affecting its special architectural or historic interest.

The focus of these planning constraints is within central Brighton and along the coastal part of the city. Although, there are some other localised concentrations – such as Rottingdean.

Stakeholder mapping

Although, this pathways work did not include extensive stakeholder engagement, due to various constraints, some initial stakeholder mapping was undertaken. This initial mapping helps provide context for reporting and can help inform the next steps in the action plan stemming from the scenarios. BHCC helped map some of the key stakeholders identified for the city, this is summarised in Figure 0—2.

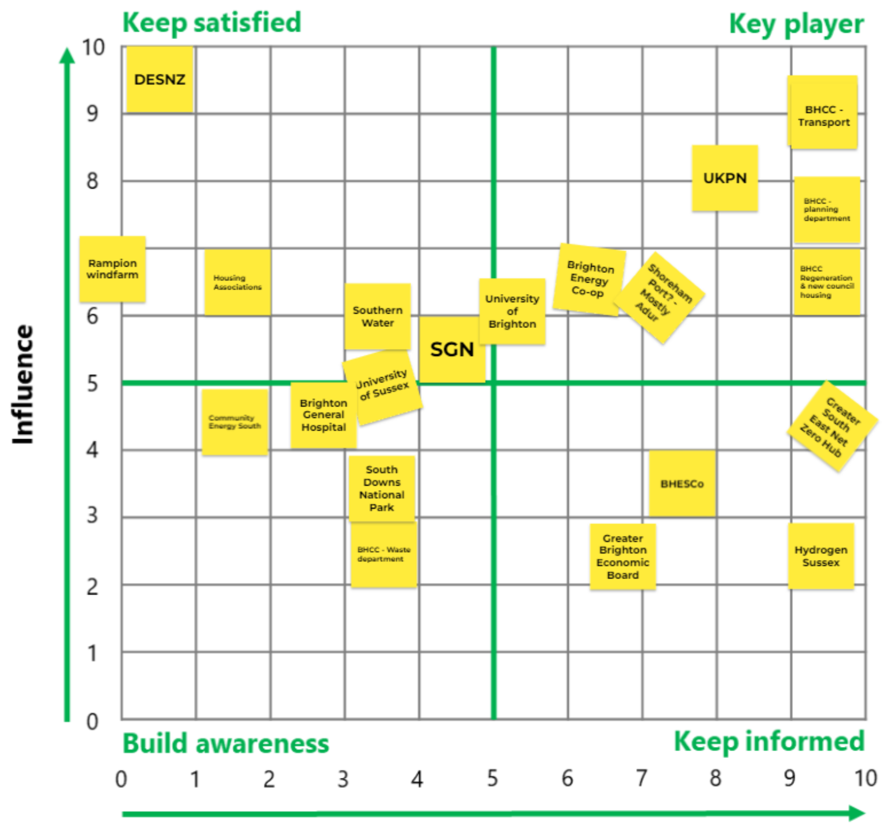


Figure 0—2 Summary of stakeholder mapping based on BHCC input.

Alongside the council the stakeholder mapping highlighted that Brighton & Hove is in the fortunate position, from an energy transition perspective, of having a highly engaged set of relevant stakeholders.

This includes a high number of community energy groups, who have an appetite for and are delivering decarbonisation projects already. Linked to this is a highly engaged population, which is probably the most important single element of the energy transition, given the scale of action needed.

Alongside these, other factors include two highly active universities in the city and Brighton & Hove Buses which are one of the leading bus companies for decarbonisation in England.

Energy usage and building stock overview

To estimate the heat and electricity demand, two core datasets were utilised. These are Parity Projects[9] data for the domestic sector and Non-Domestic Analytics for the non-domestic sector (provided by Energy Savings Trust[10]). To validate the gas and electricity consumptions and calibrate the estimated heat demand at each individual property, UK Government LSOA level gas[11] and electricity[12] consumptions were used for domestic sector and for non-domestic the local authority level gas and electricity consumptions[13] were used. These resulted in some adjustments to the property level demands (where modelling approaches and unreliable base data like EPCs can lead to errors), which is important to ensure the consumption is as accurate as possible and aligns with carbon emissions.

The current count of properties and their relevant energy consumptions (heat demand and gas and electricity consumptions) are listed in Table 0—1 which highlights that the largest energy demand is linked to the domestic sector in Brighton a& Hove. Figure 0—3 also indicates the share of gas and electricity consumption between domestic and non-domestic properties.

Table 0—1 Overview of heat demand and energy consumption in Brighton & Hove Boundary

Typology	No of properties	Heat demand GWh	Electricity demand GWh	Gas consumption GWh
Domestic	136635	1184	422	1291
Non-domestic	11267	487	435	412

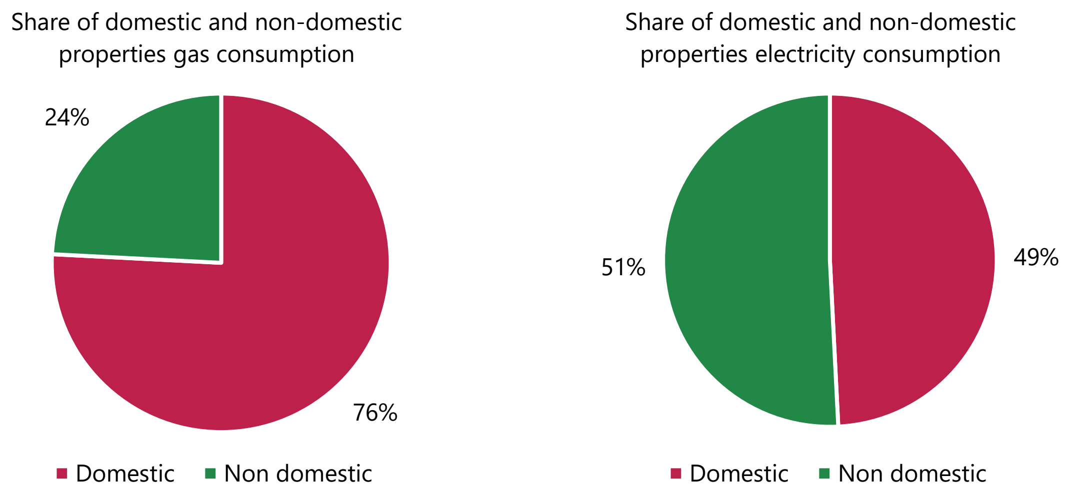


Figure 0—3 Share of gas and electricity consumptions in domestic and non-domestic properties in Brighton & Hove

Domestic

There are over 136000 domestic properties in Brighton & Hove. The housing stock is in Brighton & Hove is relatively old with around 30% of the domestic properties built pre-1900 and 29% between 1900 and 1950. Figure 0—4 provides an overview of age distribution in domestic properties in Brighton & Hove.

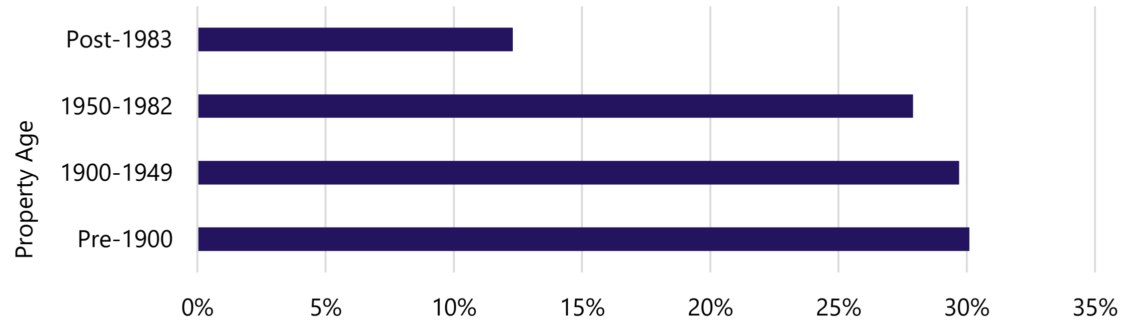


Figure 0—4 Age distribution among domestic properties in Brighton & Hove

Figure 0—5 shows the distribution of domestic stock types in Brighton & Hove. Flats are the most dominant properties, accounting for 54% of the stock, followed by 21% of terraced houses and 16% of semi-detached. The geographic distribution of these different domestic property types 100m x 100m grid level is shown in Figure 0—6 showing flats (low rise) are largely dominants property types in the city centre area. The majority of detached properties are in the area to the left side of the train station (along Dyke road and similar streets) and in the southeast of the local authority (with a focus in Rottingdean).

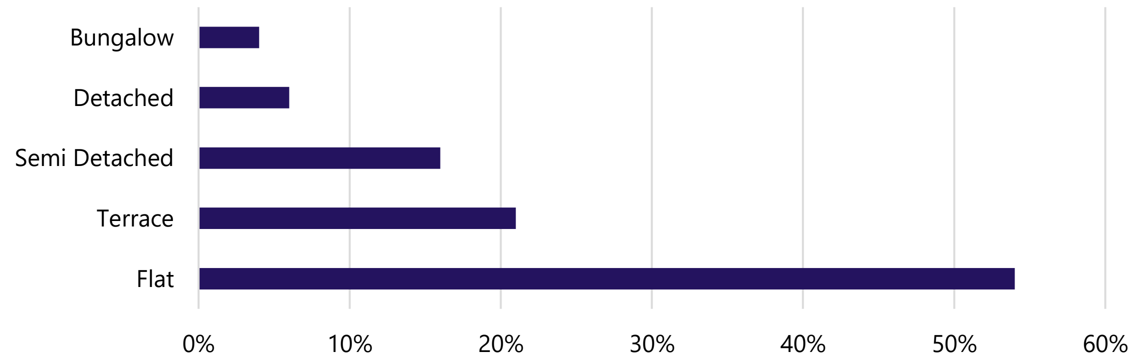


Figure 0—5 Domestic property type distribution in Brighton & Hove

[9] Source: Parity Projects, Pathways dataset, 2023, Accessed on 03/10/2023. All rights reserved.
[10] https://energysavingtrust.org.uk/
[11] https://www.gov.uk/government/statistics/lower-and-middle-super-output-areas-gas-consumption
[12] https://www.gov.uk/government/statistics/lower-and-middle-super-output-areas-electricity-consumption
[13] https://www.gov.uk/government/statistics/total-final-energy-consumption-at-regional-and-local-authority-level-2005-to-2021

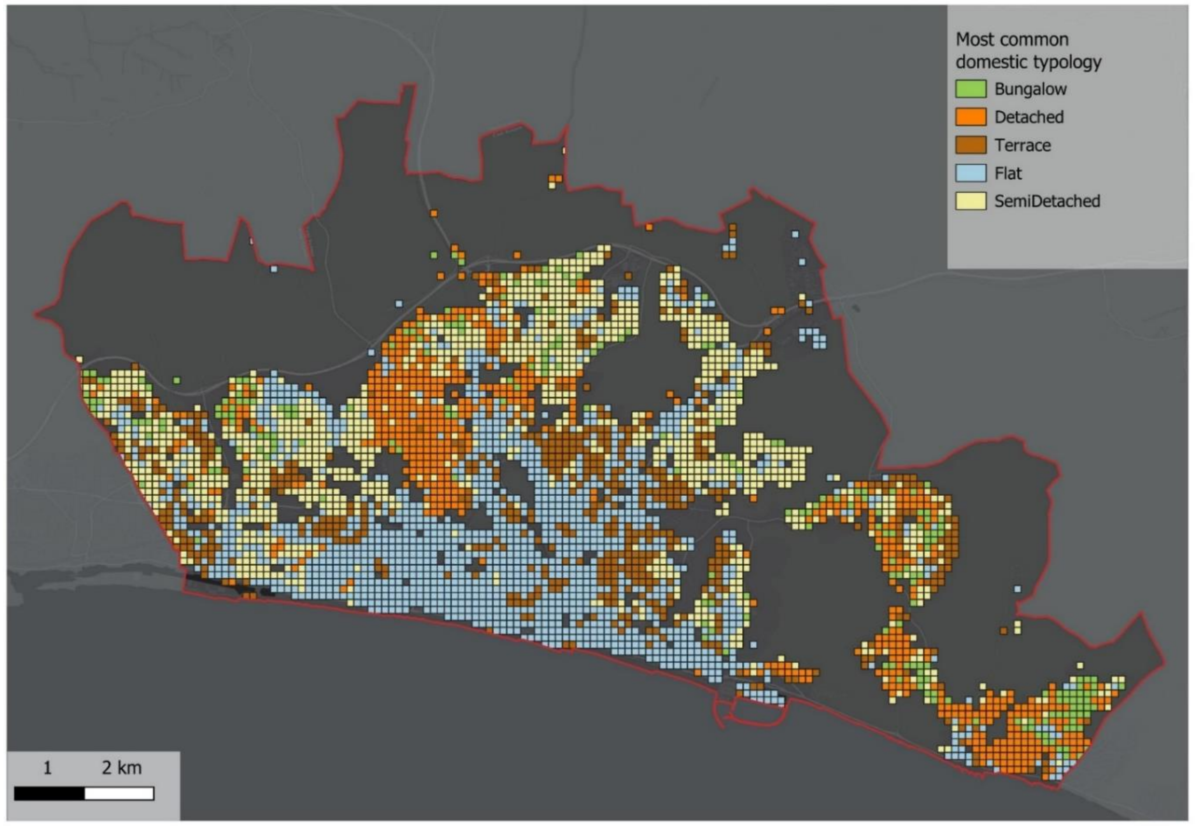


Figure 0—6 Most common domestic type at 100m grid scale

Figure 0—7 displays the distribution of Energy Performance Certificate (EPC) ratings among domestic stock in Brighton & Hove where above 72% of stock have EPC D and below.

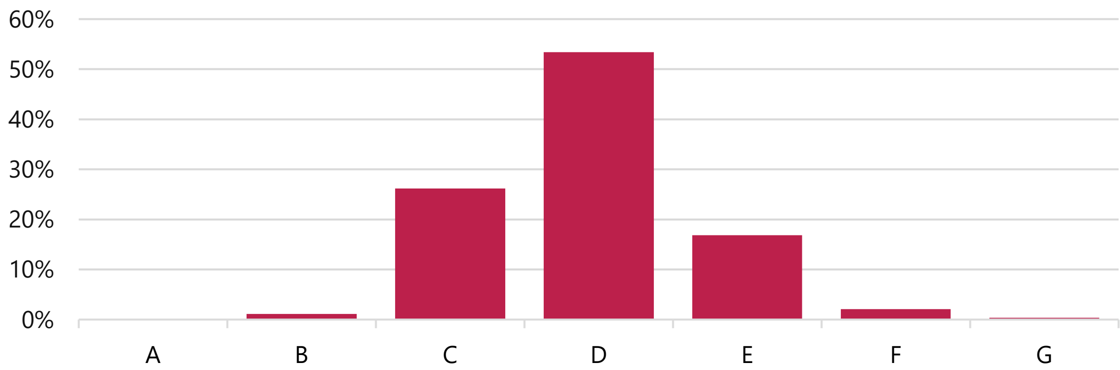


Figure 0—7 Share of Energy Performance Certificate in domestic properties in Brighton & Hove

The geographic distribution of these EPC grades is explored later in section 0, in the context of fabric retrofit.

Non-Domestic

There are over 11000 non-domestic properties in Brighton & Hove. Of these, the majority are offices and retail properties, counting for above 60% with almost equal split, followed by hospitality at 13%. The split across all main typologies is provided in Figure 0—8.

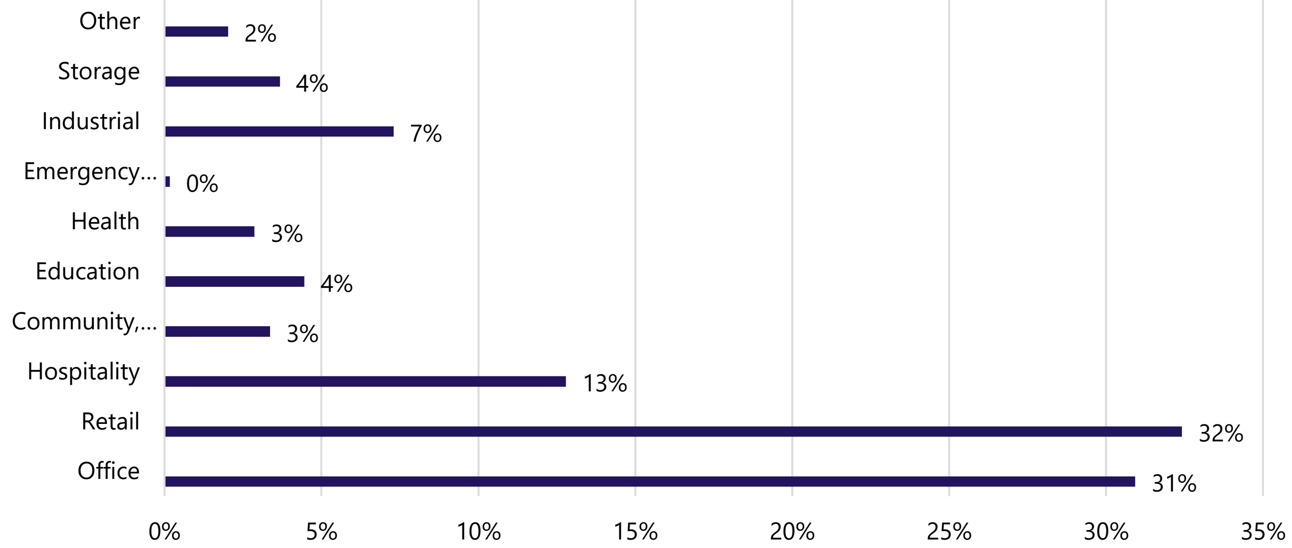


Figure 0—8 non-domestic property type distribution in Brighton & Hove

There are over 6800 (~61%) non-domestic properties with energy ratings D and below as Figure 0—9 presents.

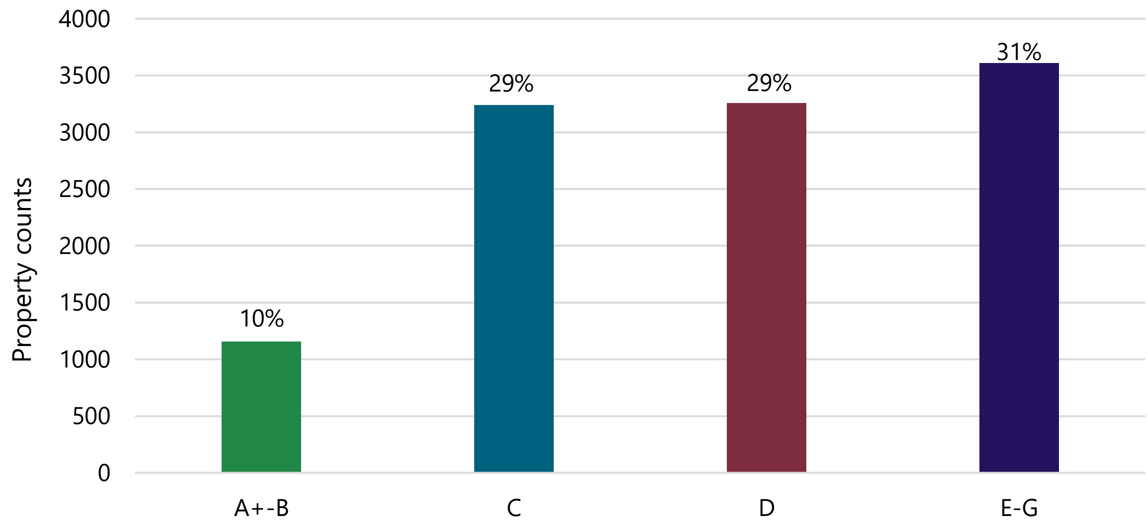


Figure 0—9 Count and share of energy ratings among non-domestic properties in Brighton & Hove

Figure 0—10 indicates the energy rating distributions among different typologies.

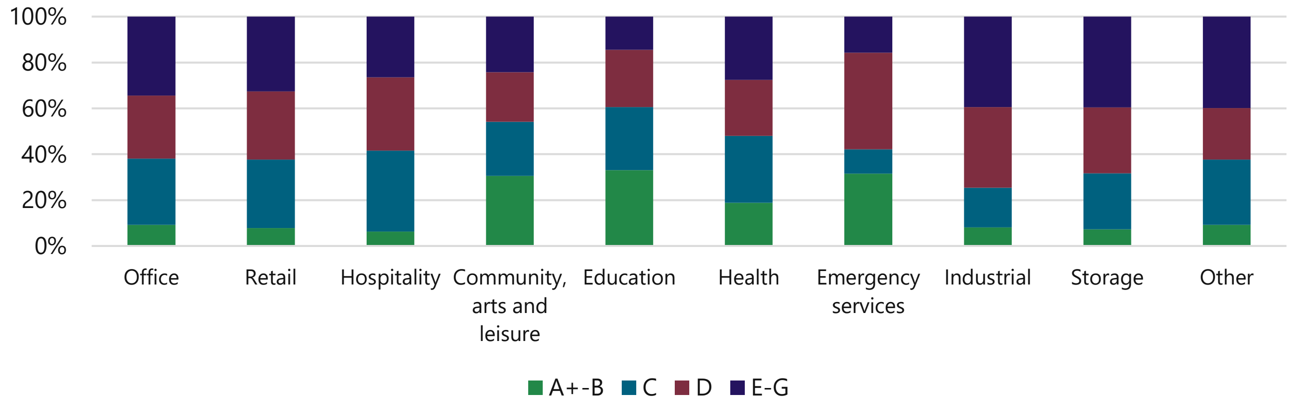


Figure 0—10 Share of energy ratings among different non-domestic typologies in Brighton & Hove

Overall, industrial, storage, office and retail typologies are among the lowest-performance properties in Brighton & Hove, with more than 60% having energy rating D and below. Education with above 60% having energy ratings above C are among the best performing non-domestic typologies.

Brighton & Hove Council assets

According to the recent data provided by Council, BHCC owns 15,384 domestic properties. This total encompasses the Council properties, leasehold properties, Seaside properties and TACC general fund properties. Of these, 12,125 properties are managed by the BHCC Housing.

Figure 0—11 provides the distribution of EPC in 12,125 Council properties. With over 88% properties having EPC C or above, Council properties are significantly more energy-efficient than other domestic properties in Brighton & Hove.

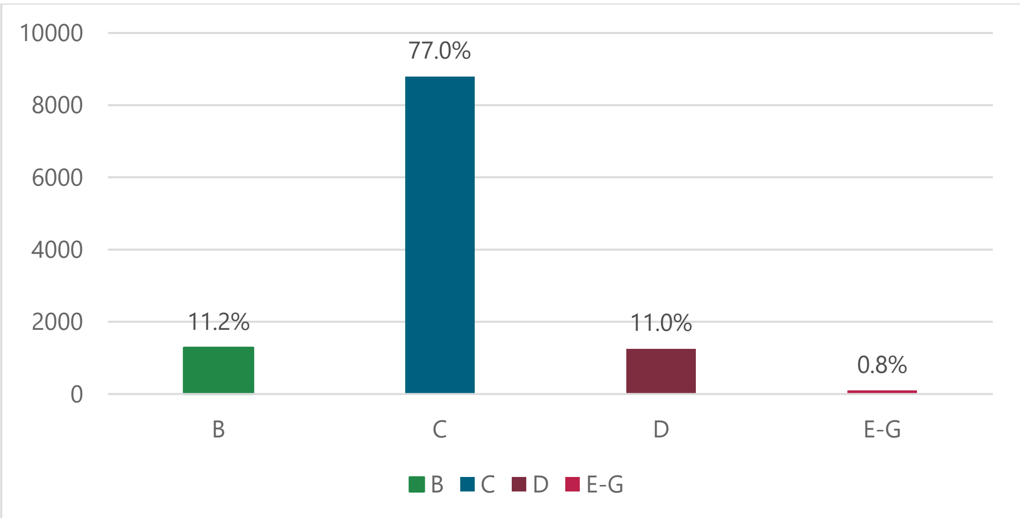


Figure 0—11 EPC rating in Council properties managed by the BHCC Housing

As indicated in Figure 0—12 flats form the majority of Council properties accounting for 63%. This is followed by semi-detached houses at 18%, and terrace houses at 15%.

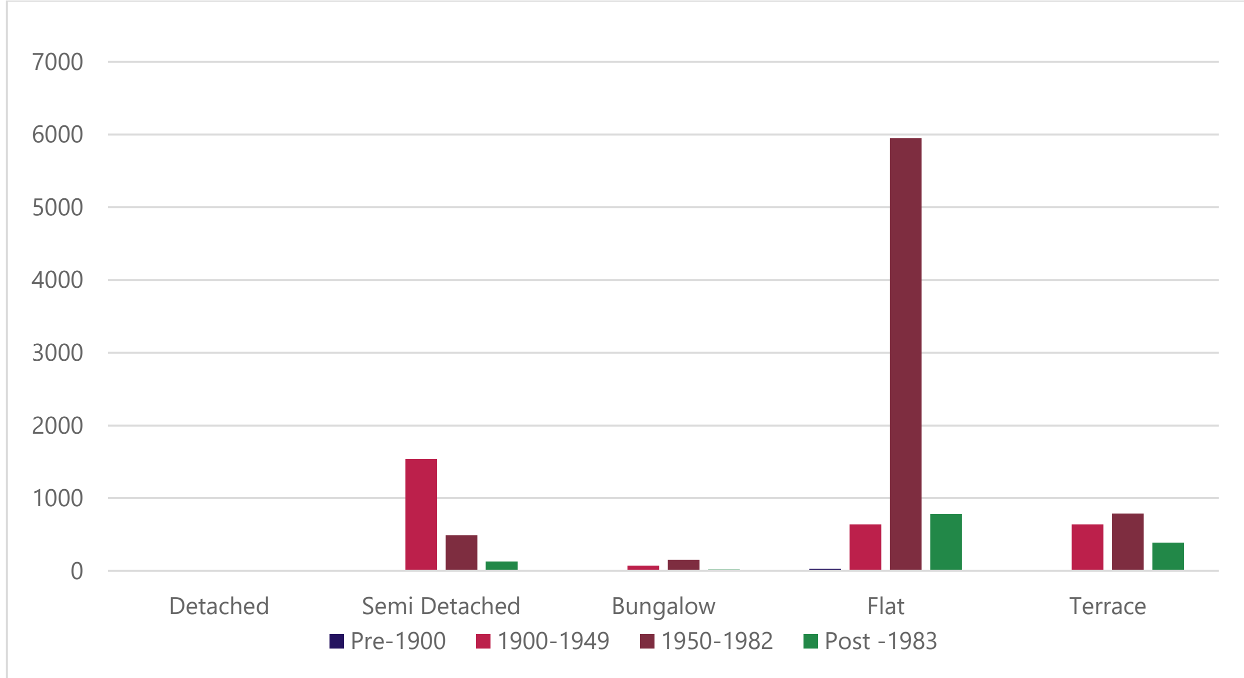


Figure 0—12 Count of Council properties (managed by BHCC housing) by age and typology

The Figure 0—13 maps the BHCC freehold lands. The specific data for Council-owned domestic properties was provided at very end of the project. Therefore, in order to identify the Council-owned properties to be utilised in modelling and analysis in this study, domestic and non-domestic data were spatially matched with the Council land ownership map. The matching process served as the basis for identifying properties owned by the Council. It is important to note that this approach may introduce some uncertainties regarding identifying the Council properties. Moreover, the count of Council-owned property presented in this report is mainly related to the properties which are located on Council-owned land, whether the Council has control over them remain unknown.

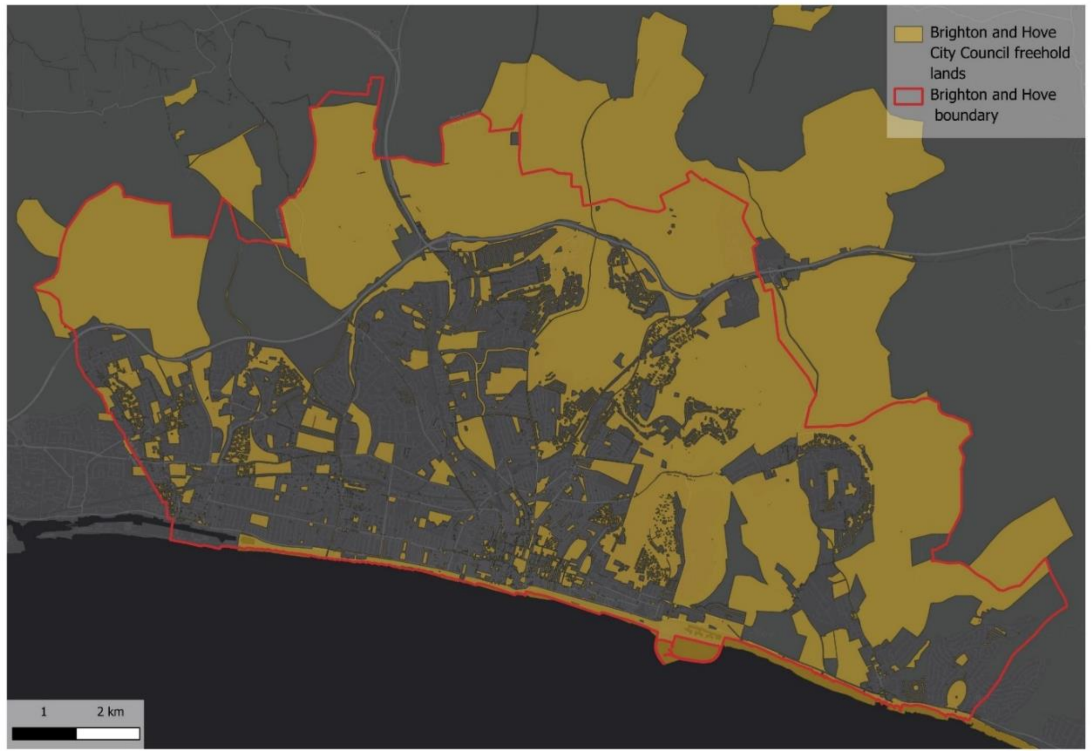


Figure 0—13 Brighton & Hove City Council land ownership map

The council owns around 1900 non-domestic properties in Brighton & Hove. Regarding typologies, the trend follows that of the city-wide non-domestic stock: offices constitute the majority, accounting for around 26%, followed by retail properties at 20%. The education sector represents 13% of the overall non-domestic housing stock.

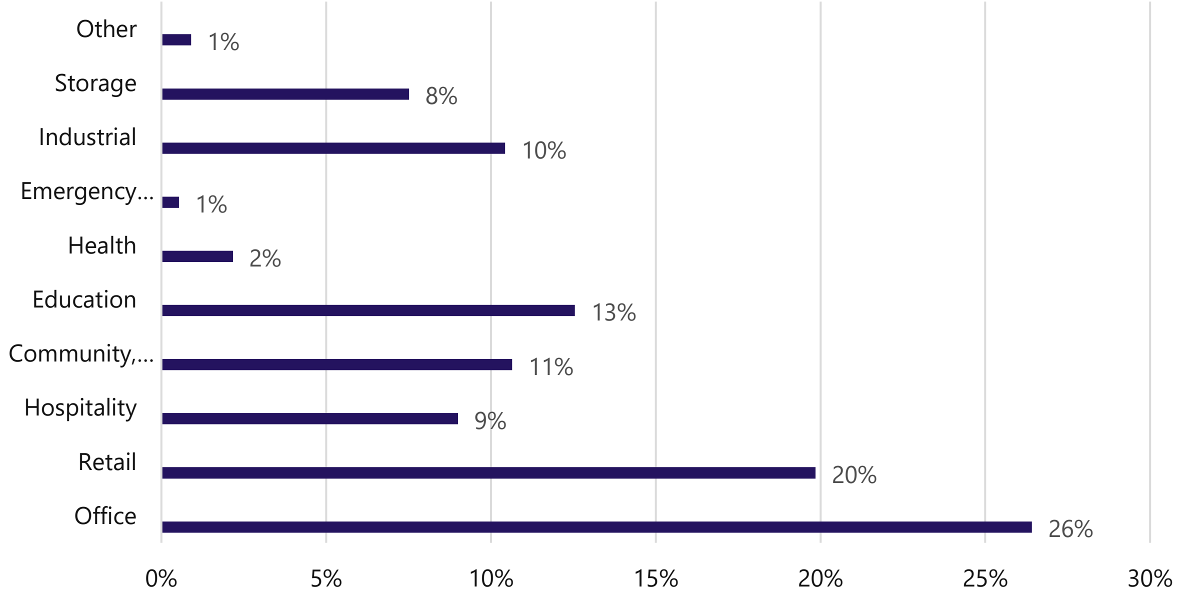


Figure 0—14 Council-owned non-domestic property type distribution

Over 60% of the council-owned non-domestic properties has energy rating D or below. Figure 0—15 provides the energy rating distribution in different non-domestic typologies owned by the Council. Industrial and storage are among the lowest performance buildings, with more than 70% having ratings above D. Whilst Education with above 60% having energy ratings above C are among the best performance non-domestic typologies.

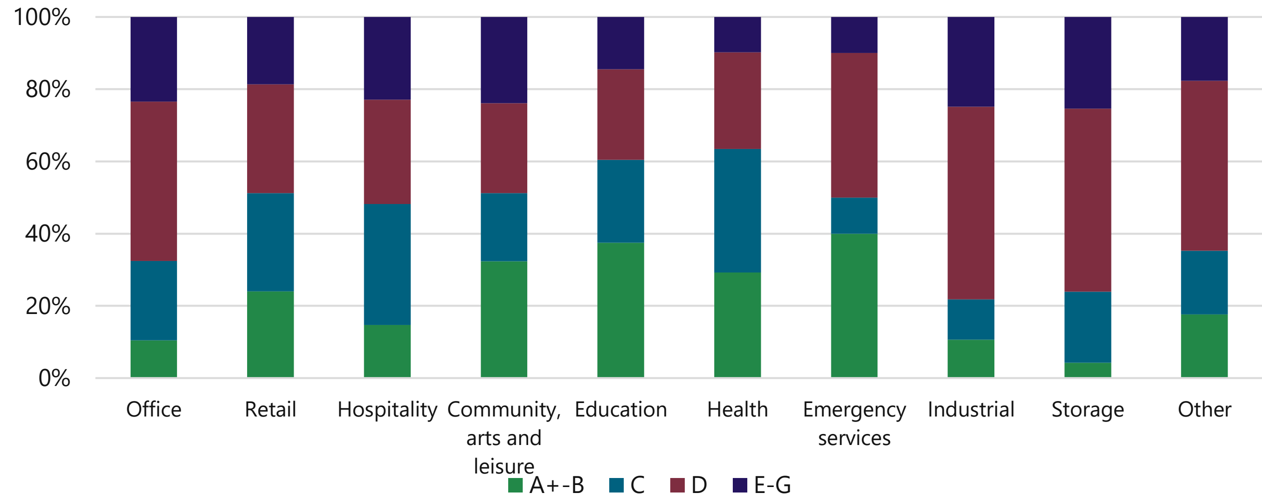


Figure 0—15 Share of EPC ratings among different council-owned non-domestic typologies in Brighton & Hove

The total annual gas and electricity consumptions in the properties on Council owned lands is estimated circa 244GWh and 128GWh respectively. Figure 0—16 shows the share of gas and electricity consumed in BHCC assets in Brighton & Hove.

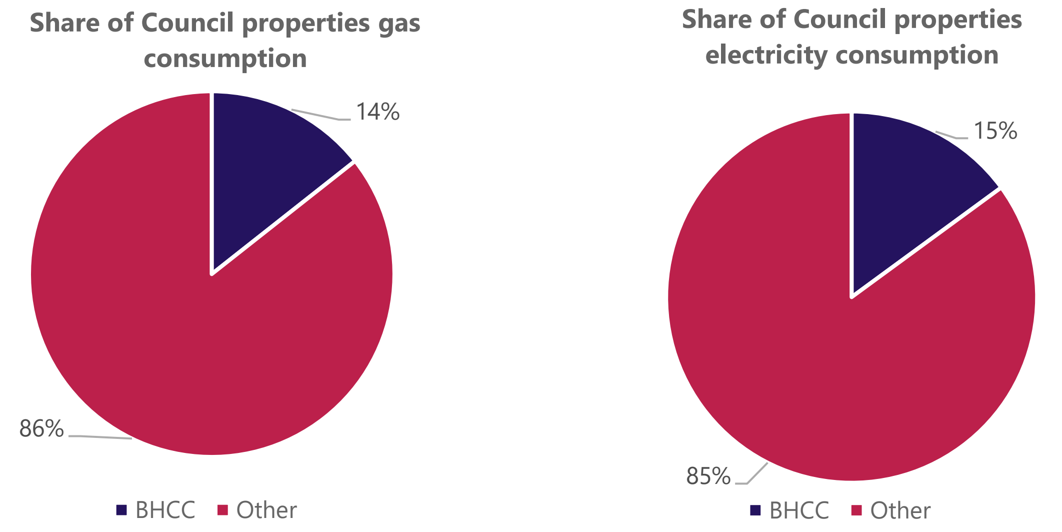


Figure 0—16 Share of gas and electricity consumptions in Council owned properties

Societal factors

Societal factors are key to consider when carrying out decarbonisation pathways analysis. These factors are important to consider for helping to ensure a just transition. The societal factors examined are fuel poverty and indices of multiple deprivation, with the former directly integrated into much of the analysis.

Fuel Poverty

The Department for Energy Security and Net Zero (DESNZ) provides annual sub-national statistics on Fuel Poverty. The most recent one published in 2024 covers data from the reporting year 2022[14]. Fuel poverty in England is measured using the Low Income Low Energy Efficiency (LILEE) fuel poverty metrics. A household is considered fuel poor[15] if:

- it is living in a property with an energy efficiency rating of band D, E, F or G as determined by the most up-to-date Fuel Poverty Energy Efficiency Ratings (FPEER) Methodology[16];
- its disposable income (income after housing costs (AHC) and energy needs) would be below the poverty line

According to the 2022 statistics, among 125,042 households in Brighton & Hove 16,527 (13.2 %) are living in fuel poverty, this is slightly above the England average of 13.1%. Figure 0—17 provides an indication of the fuel poverty at LSOA level in Brighton & Hove highlighting the areas with worst fuel poverty.

Comparing the fuel poverty data from 2021 and 2022 reveals an approximate 2% increase in the number of households living in fuel poverty. This increase reflects the impact of the 2022 energy price rise on the level of fuel poverty in Brighton & Hove.

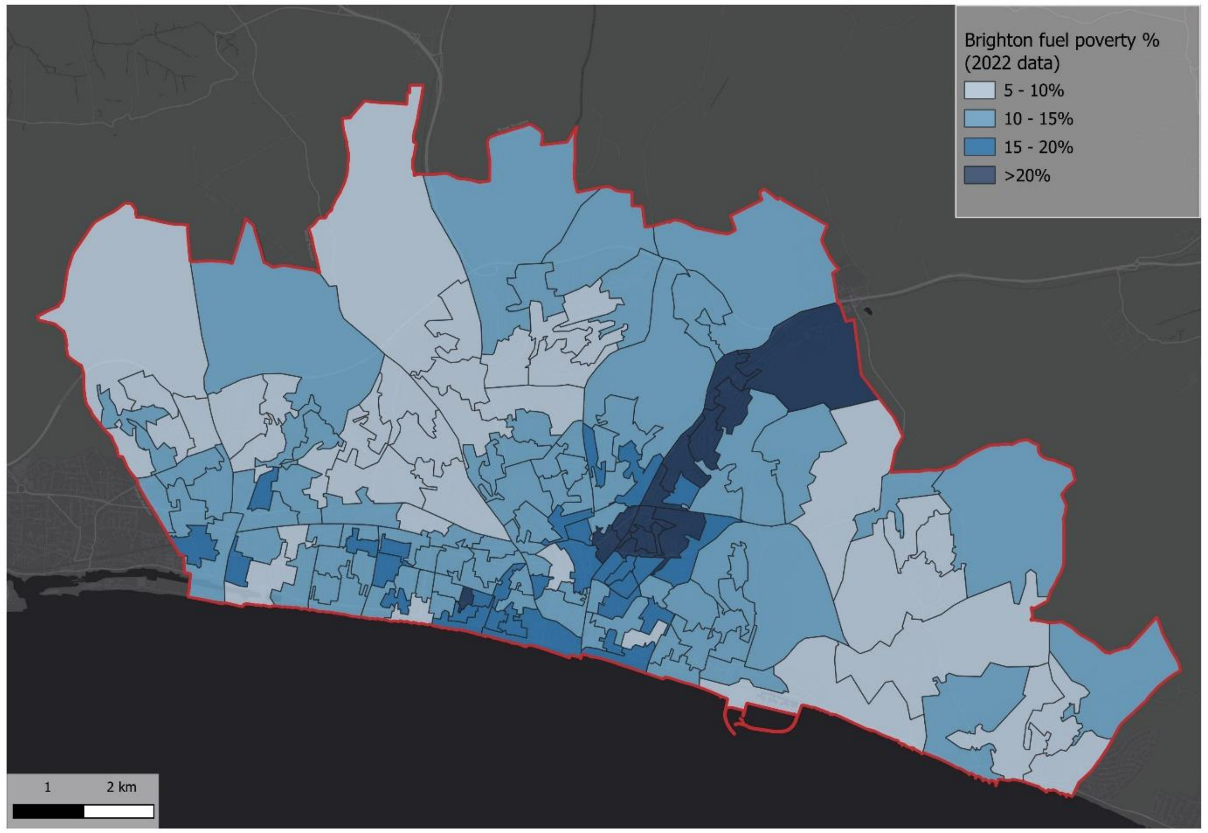


Figure 0—17 Percentage of household in fuel poverty at LSOA level (2022)

Indices of Multiple Deprivation

The Indices of Multiple Deprivation (IMD) is a dataset that assess the relative deprivations across small areas[17]. It provides insight into the socio-economic conditions by considering different indicators across seven deprivation domains according to their respective weights. These domains include income, employment, education, health, crime, barriers to housing and services and the living environment.

Data from the English indices of deprivation (2019)[18] provides the ranks and deciles for the IMD at LSOA level. The LSOA with the rank of 1 is the most deprived, while the LSOA with a rank of 32,844 is the least deprived. The deciles are calculated by dividing the ranking into 10 equal groups. LSOAs in decile 1 fall within the most deprived 10% of LSOAs nationally and LSOAs in decile 10 the least deprived 10%.

The mean average decile score for all 166 LSOAs within Brighton & Hove provide an average IMD decile of 5.55. Figure 0—18 shows the LSOA map of the IMD across Brighton & Hove highlighting the most deprived areas in Brighton & Hove.

The IMD and fuel poverty are also considered in the analysis in this study in order to prioritise areas with worst fuel poverty or those in lower deciles for early interventions. Consideration of the project type and cost to the residents are key elements in this context, as it is important to avoid putting non-cost effective additional financial burden on these communities.

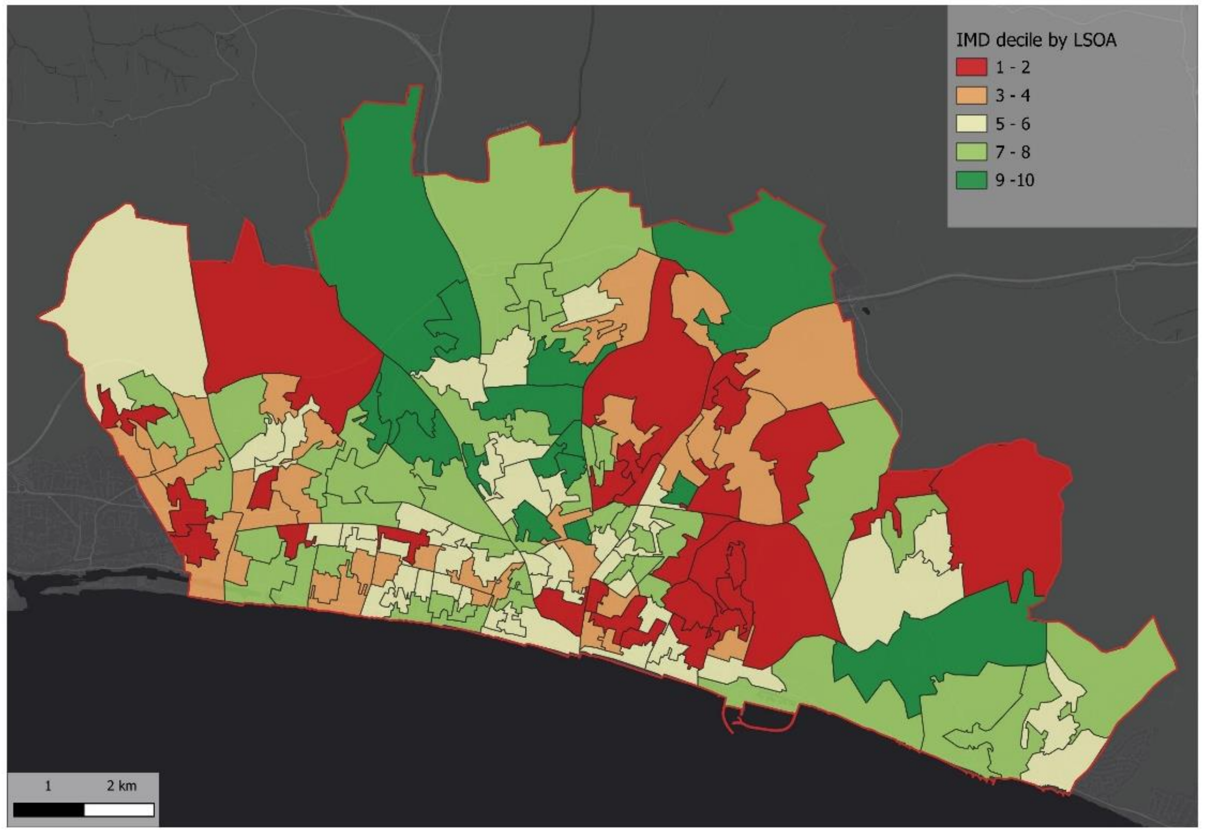


Figure 0—18 Map of IMD decile at LSOA level

Policy and Strategic Context

This section provides a brief overview of some key policy and strategic context for the pathways analysis. It is important to note the scenarios section (section 0) explores the Future Energy Scenarios, which is a major element of the strategic context, to be viewed alongside national and local policy items.

[14] https://www.data.gov.uk/dataset/f3009590-2bc9-40d9-8dc3-571e6fddae45/fuel-poverty-in-england-sub-regional
[15] https://www.gov.uk/government/statistics/sub-regional-fuel-poverty-2023-2021-data/sub-regional-fuel-poverty-in-england-2023-2021-data
[16] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/332236/fpeer_methodology.pdf
[17] https://data.cdrc.ac.uk/dataset/index-multiple-deprivation-imd
[18] https://www.gov.uk/government/statistics/english-indices-of-deprivation-2019

National Policy

According to the Climate Change Act 2019[19], the UK government has been legally committed to achieve net zero by 2050. Following this, a number of legislations and strategies have been adopted across different sectors.

The Committee on Climate Change (CCC) plays a crucial role in ensuring that the UK remains on track to meet its climate goals. Based on CCC recommendation[20], the UK aims for a 78% reduction in carbon emissions by 2035 relative to 1990 level. This is equivalent to 63% reduction from 2019 emissions. This interim carbon reduction target has been set to limit the total stock or volume of greenhouse gasses emitted by the UK, so that it can achieve its 2050 net zero target without surpassing its so-called 'carbon budget', or nationally determined contribution under Article 4 of the Paris Treaty.

The CCC has required strong contributions from four key areas, as listed below:

- Reducing demand in carbon-intensive activities which involves reduction in travel and improving energy efficiency in buildings, vehicles, and industry.
- Adopting low-carbon solutions such as district heating and direct electric heating from people and business and transition to electric vehicles. All heavy goods vehicles should become low carbon by 2040 as well as industries.
- Expansion of Low-Carbon Energy Suppliers through increasing the share of renewables electricity generation by 100% by 2035. Low-carbon hydrogen production to be utilised in sectors less suited to electrification, such as parts of industry and shipping
- Increasing planting for carbon capture and increasing the share of agricultural lands for bioenergy production

Figure 0—19 presents the type of abatement in the CCC balanced Net Zero Pathway.

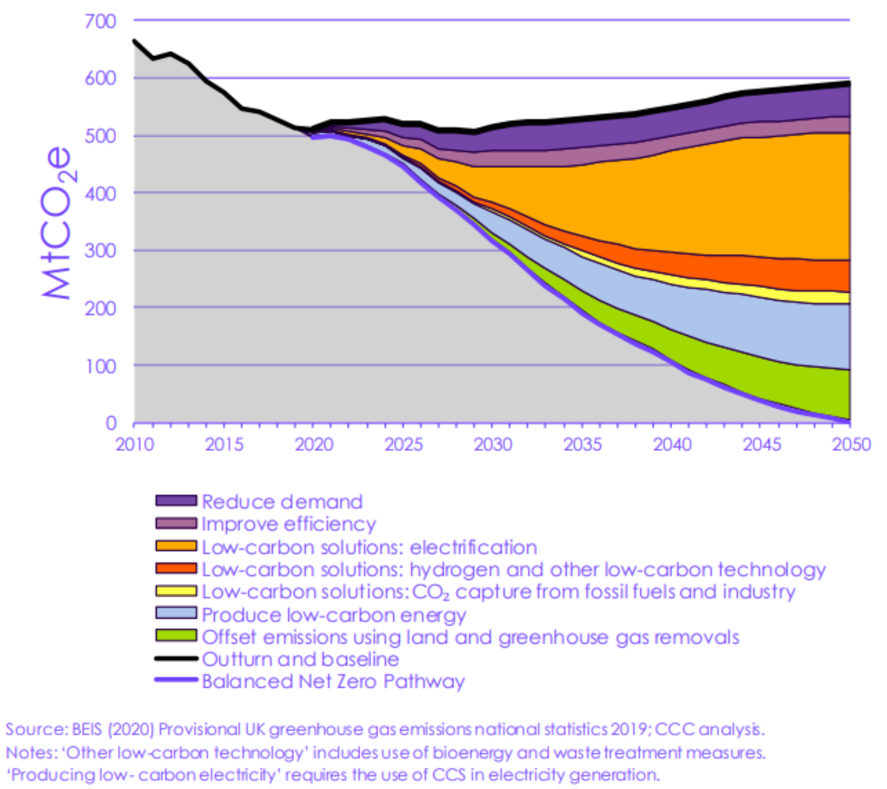


Figure 0—19 Types of abatement in the CCC Balanced Net Zero Pathway

The UK Net Zero Strategy[21] outlines policies and proposals to achieve net zero emissions by 2050 in the UK. It sets out the full decarbonisation of the power system by 2035 relying on renewable generations and flexibility measures, including storage. The strategy also aims to eliminate the sale of new gas boilers by 2035 and to ensure that all the new heating appliances installed in homes and workplaces will be low-carbon technologies. Fundings, such as the Boiler Upgrade Scheme, Heat Pump Ready Programme, Social Housing Decarbonisation Scheme and Home Upgrade Grants support this. Moreover, it sets out the public sector decarbonisation fundings with the aim of reducing their emissions by 75% by 2037.

The Energy Security Bill was introduced to Parliament on 6th July 2022. It introduces a regulatory framework for heat networks to facilitate heat network zoning and incentivising the use of low carbon fuels in transport.

The Energy Act 2023[22] is the biggest piece of energy legislation aiming to transform the UK's energy system, introduced in 15 parts, provides a wide range of provisions for new energy activities, regulations, heat networks and energy performance of buildings. Following is a summary of relevant parts:

- Regulation of new technology including low carbon heat schemes, renewable transport fuel obligations and removal of greenhouse gases
- Delivering a more affordable and efficient energy system
- Regulation of heat networks: designating a regulator for heat networks and assigning heat network zones; creation of a Heat Network Zones Authority and zone coordinators; and enforcement powers and imposition of penalties
- Energy performance of premises and energy savings opportunity schemes

The Energy Act 2023 provides the powers for government to implement Heat Network Zoning (HNZ) in England through regulations. It is a key market enabling action, where Central and Local Governments are working to gather evidence and identify areas where heat networks are the lowest cost solution for decarbonisation of the heating system. The HNZ consultation completed in February 2024 and the Department for Net Zero and Energy Security (DESNZ) is aiming to introduce the HNZ from 2025.

For transport, the Zero Emission Vehicle (ZEV) mandate[23] sets out the percentage of new zero emission cars and vans manufacturers will be required to produce each year up to 2030. By 2030, 80% of new cars and 70% of new vans sold in Great Britain will be zero-emission. This percentage will escalate to 100% by 2035. The Transport Decarbonisation Plan[24] outlines the Government plan for decarbonisation of the entire transport system in the UK and achieve net zero by 2050. This can be achieved through electrification of transport system, improving the public transport, and development of charging infrastructure.

Finally, energy decarbonisation is not a statutory responsibility of local authorities. Meaning powers and budgets and have not yet been devolved for local authorities to govern the transition and directly tackle the challenges. Despite this Brighton & Hove have strong local policy which is integrated alongside this national context.

Local Policy

Brighton & Hove City Council declared a Climate and Biodiversity Emergency in 2018 and made a commitment to become a Carbon Neutral City by 2030. To achieve this, the Council introduced the Carbon Neutral 2030 Programme[25] in 2021. The program outlines an ambitious science-based target for the whole city to achieve net zero target by 2030. It focuses on various sectors, including travel and transport, energy and water, waste management, the built environment, and nature conservation with three strategic objectives:

- Reduce greenhouse gas emissions
- Enhance biodiversity

[19] https://www.theccc.org.uk/what-is-climate-change/a-legal-duty-to-act/
[20] The-Sixth-Carbon-Budget-The-UKs-path-to-Net-Zero.pdf (theccc.org.uk)
[21] https://www.gov.uk/government/publications/net-zero-strategy
[22] https://www.legislation.gov.uk/ukpga/2023/52/contents/enacted
[23] https://www.gov.uk/government/news/pathway-for-zero-emission-vehicle-transition-by-2035-becomes-law
[24] https://www.gov.uk/government/publications/transport-decarbonisation-plan
[25] https://www.brighton-hove.gov.uk/climate-action/climate-action-what-were-doing/carbon-neutral-2030-programme

- Adapt to climate change

The Brighton & Hove City Plan Part One[26], adopted in 2016, sets out the long-term vision, strategic objectives, and a strategic planning policy framework to guide the new development required until 2030. The City Plan Part Two[27], adopted in 2022, continues to shape the city's growth and development.

Regarding its own developments, the council agreed the New Build Housing Sustainability Policy in September 2022, which sets ambitious targets for energy use, embodied carbon, and water use, reinforced by the council's Environmentally Sustainable Procurement Policy. A new Housing Revenue Account Asset Management Strategy will be produced in 2024. This will outline the ambition, opportunities and priorities for improving and managing existing housing stock. A more detailed energy plan for Council homes will follow this high level strategy document.

BHCC is currently developing its fifth Local Transport Plan (LTP5) which sets out their priorities and outcomes for transport and travel across city to 2030[28].

The council's Air Quality Action Plan[29] sets the context for reducing nitrogen dioxide and other toxic emissions in the city and also recognises the linkages between air quality and climate change. It includes 5 priority areas such as 'encouraging and supporting uptake of ultra-low and zero exhaust vehicles' and 'reducing emissions from buildings, new developments, energy production and construction sites' and a list of over 60 actions that will contribute towards its overall objectives.

The Council's Electric Vehicle Infrastructure (EVI) Strategy will encompass both our internal aspirations, as well as our external plans for the strengthening of our public network of EV chargepoints. The EVI Strategy will consider the impact of the Government's plans to ban the sale of petrol and diesel vehicles by 2035 and how the growth of EVs residing in Brighton & Hove, as well as those coming into the city for work or pleasure are to be accommodated in terms of charging. The EVI Strategy is being developed during the course of 2024, with consultation planned for the first half of 2025.

The council has invested over £500k in growing its private charging infrastructure and continues to invest in decarbonising its fleet, including refuse vehicles and maintenance vans, through delivery of its Fleet Strategy (2020 – 2030).

[26] https://www.brighton-hove.gov.uk/planning/planning-policy/city-plan-part-one
[27] https://www.brighton-hove.gov.uk/planning/city-plan-part-two/adopted-city-plan-part-two
[28] https://www.brighton-hove.gov.uk/travel-and-road-safety/travel-transport-and-road-safety/local-transport-plan
[29] https://democracy.brighton-hove.gov.uk/documents/s183871/Air%20Quality%20Action%20Plan%202022%20APX.%20n%202.pdf

Scenarios

Background to scenario building

The scenarios are based predominately on UKPN's Distributed Future Energy Scenarios (DFES) 2023, available from their website[30]. These are a localised set of different energy system scenarios, based on the National Grid Future Energy Scenarios (which cover the whole of the UK). These scenarios help inform UKPN's spending plans. Context from other decarbonisation pathways, notably the Climate Change Committee's Sixth Carbon Budget[31], are used to provide context.

Although, the DFES forms the basis of the work there are some changes. The more detailed property level information allows more detailed transition modelling for heating systems, meaning there is variation in technology choice. Also, the DFES aims for a 2050 decarbonisation, whilst for Brighton & Hove the aspirations are for a more rapid decarbonisation. Brighton & Hove have declared a Climate Emergency but the 2030 timeframe was considered too challenging to meet. For context it would require heating system changes in ~4,200 non-domestic properties and ~117,400 domestic properties, which equates to a new heating system in ~50 properties a day from April 2024 to December 2030. For context England saw ~25,000 air source heat pumps installed in 2023[32], equating to ~68 per day. Thus, a high level of decarbonisation is aimed for by 2030, with a focus on BHCC stock, but 2040 is the end date for scenario modelling. This 2040 date is still 10 years ahead of the DFES 2050 target, intermediate targets and deployment numbers in the DFES are adjusted according to align with 2040.

The scenarios explored are described in 0 but first it is important to understand the role of hydrogen, as alongside timing the most significant deviation from the Future Energy Scenarios is the lack of hydrogen.

Hydrogen

The decision was made to exclude hydrogen as an option for heating, based on two main challenges for largescale deployment of hydrogen in Brighton & Hove's gas network:

- It is **not deployed at scale in the UK** – with the UK Government still focusing on research[33]. This raises questions about deliverability in the 2040 timescale for Brighton & Hove's decarbonisation. Blending of 20% hydrogen and biomethane into the gas grid to reduce the carbon emissions in the short term is awaiting central government decision – with the consultation having closed in autumn of 2023[34]. However, this reduction in carbon emissions, whilst potentially important in the short term, would not decarbonise heating by 2040
- It **requires a regional strategy** rather than just Brighton & Hove, due to the nature of gas network interconnectivity.

Additionally, two large trial projects for hydrogen heating deployment in Whitby and Redcar were scrapped this year – showing the challenges for large scale hydrogen adoption (including public opposition). There is also the broader national context of the National Infrastructure Commission recommending that "government should not support the rollout of hydrogen heating"[35], as well as over 50 independent studies not presenting compelling evidence for large scale use of hydrogen for heating[36]. These factors mean hydrogen have a very high level of uncertainty, which is particularly challenging given the timescales for decarbonisation that are being aimed at in Brighton & Hove.

However, it is important to note that although hydrogen is not considered for heating in Brighton & Hove it is in a strong place locally for other applications. Hydrogen Sussex[37] is a group of note working in this area. Their focus is on hydrogen for non-heat applications such as transport and shore power. The latter is of more significance for the neighbouring Shoreham and Newhaven ports rather than Brighton & Hove, however, transport is important to consider.

Brighton & Hove Buses were engaged for greater context to this scenario modelling. The focus for local bus routes had a greater degree of electrification focus, with new chargers being installed at bus depot redevelopments. Hydrogen options have been deployed by the company in other locations but complexities with supply were noted. A local supply of low-cost green hydrogen could help with this, but the electrification option is more realistic in the near term. Hydrogen is therefore considered more for coaches and HGVs, where alignment to national strategy is key – as these vehicles travel long distances and therefore would be dependent on national charging infrastructure. This is the only sector hydrogen is considered in the analysis.

Scenario selection process and scenario definitions

The DFES explores four scenarios: Falling Short, System Transformation, Consumer Transformation, and Leading the Way. System Transformation is based on a switch of properties away from natural gas to hydrogen. As has been noted hydrogen is not considered for Brighton & Hove. The alternative option considered was the switch to a large scale deployment of heat networks. This requires a coordinated, centralised, approach to heating system change – similarly to what would be needed for a hydrogen option. The System Transformation scenario is thus replaced by a High Heat Networks options.

These different scenarios, or pathways, are used to form a basis of an Action Plan for Brighton & Hove's progression to net zero, this process is outlined in Figure 0—1.

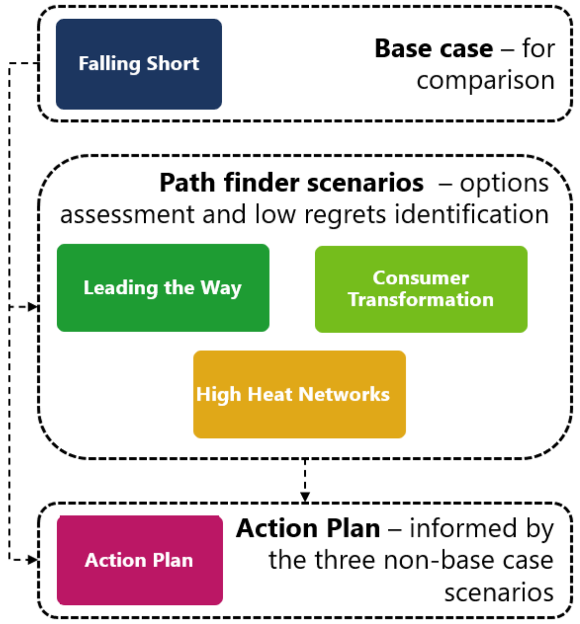


Figure 0—1 Summary of the use of scenarios for developing an Action Plan for Brighton & Hove.

[30] https://dso.ukpowernetworks.co.uk/distribution-future-energy-scenarios
[31] https://www.theccc.org.uk/publication/sixth-carbon-budget/
[32] This is based on the Microgeneration Certificate Scheme (MCS) data https://mcscertified.com/battle-of-the-nations-renewable-uptake-across-the-uk-in-2023/
[33] Department of Energy Security and Net Zero, 2023: Hydrogen Strategy Update to the Market: August 2023. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1179651/hydrogen-strategy-update-to-the-market-august-2023.pdf
[34] Department of Energy Security and Net Zero, 2023: Hydrogen Blending into GB Gas Distribution Networks. https://assets.publishing.service.gov.uk/media/650057d81886eb00139771f8/hydrogen-blending-into-gb-gas-distribution-networks-consultation.pdf
[35] National Infrastructure Commission, 2023: Technical Annex: hydrogen heating. https://nic.org.uk/app/uploads/NIA-2-Technical-annex-hydrogen-heating-Final-18-October-2023.pdf
[36] Rosenow, A meta-review of 54 studies on hydrogen heating, Cell Reports Sustainability (2023), https://doi.org/10.1016/j.crsus.2023.100010. https://northeastbylines.co.uk/wp-content/uploads/2023/12/PIIS2949790623000101.pdf
[37] https://hydrogensussex.org/

A summary of these scenarios and insights gained from them is provided in 0 to 0. One of the main way the path finder scenarios group, identified in Figure 0—1, are used is to identify areas of Brighton & Hove which have the same solution in all scenarios. These are considered as low regrets options and form the basis of the Action Plan.

Falling Short

The Falling Short scenario is not adapted from the DFES, this means the deployment rates are kept the same. This means the level of change in the energy system is very low, as Falling Short fails to reach energy system decarbonisation in 2050 so the 2040-time frame of this study makes it even more challenging.

Figure 0—2 provides a qualitative indication of actions taken in different energy system elements, with an arrow pointing to green indicating high prioritisation for delivery of carbon reduction, yellow is neutral to the current system and red worse than present day.

Fabric improvement	Very limited fabric improvement, due to limited heating system change.
Heat networks	Relatively high heat network deployment, focus in central Brighton.
Heat pumps	Very few heat pumps adopted.
Car ownership/use reduction	Negligible changes in ownership and usage.
EV charger numbers	High EV charger deployment to allow for widespread EV switch.
Renewable deployment	Very limited additional PV deployment, likely to be exceeded without intervention.
Flexibility / diversity	Some additional battery capacity, limited behavioural change.

Figure 0—2 Summary of Falling Short actions for different key decarbonisation areas.

Whilst Falling Short does not hit net zero by 2040 there are some improvements. Mostly related to EV ownership and associated charger numbers, however, the greatest level of change in this area is likely to come after 2030. Low levels of fabric improvement and change in heating systems, which are more intrusive technologies to install, are the limiting elements missing from this scenario – which are required for net zero.

The level of renewable deployment is particularly disappointing in Brighton & Hove in the DFES. The region has a strong supply chain and a review of data sources showed that the DFES was substantially underestimating the quantity of PV currently installed. The level of PV Brighton & Hove is likely with no intervention to exceed the value assumed by UKPN for this baseline scenario.

Flexibility and diversity are two important components of the energy system. Although they are not central to the falling short scenario it is useful to clarify what they mean in an energy system context. Flexibility refers to the ability to change generation or consumption/demand patterns to support the electricity network. In fossil fuel-based energy systems, with the ability to easily dispatch additional generation to match demand there has traditionally been relatively little need for demand to be flexible. However, renewable generation is generally not dispatchable and, often more importantly in the local context, the electricity network cannot always distribute the electricity required at times of peak demand. This issue will increase with the electrification of heat and transport. Higher flexibility refers to either demands being able to vary to match what the grid can supply or for local technology to provide additional supply. In the context of Brighton & Hove batteries are the key technology considered for this in the electricity network.

Diversity refers to natural differences in demand. This accounts for the fact that not everyone in Brighton & Hove will be using all of their appliances at once, for example, every household charging an EV, having a shower, cooking a meal, using the tumble dryer and having the heating on full at the same time. Currently, particularly with electric heating, electricity networks assume a very low diversity. This means the electricity network must have capacity to supply the full demand for heat to every consumer on the network at any time if electrification of heating is to take place. If this is not the case upgrades to the electricity network would be required before a building could switch from a gas boiler to a heat pump.

As energy networks become more advanced with integration of technology like smart meters and distributed storage, there is more opportunity for consumers to directly supply flexibility services and for a more detailed understanding of diversity. This shift in how the electricity system functions is increasingly being captured by the phrase Smart Local Energy Systems (SLES). In some of the higher electrification scenarios increased flexibility and assuming greater diversity in demand[38] is key to helping reduce high electricity network reinforcement costs.

High Heat Networks

As hydrogen is not assumed for heating in Brighton & Hove an alternative to the DFES System Transformation[39] scenario is required. Heat networks have the most similar shift in technology, with large scale solutions being the preference. To mirror the system transformation DFES relatively few behaviour changes are included. A summary of the principles of scenario is provided in Figure 0—3.

Fabric improvement	Some fabric improvement to allow for low temperature heating systems.
Heat networks	Widely spread, particularly in areas with flats and terraced houses as well as central areas.
Heat pumps	Heat pumps still deployed but with a focus in outer areas.
Car ownership/use reduction	Negligible changes in ownership and usage, reflecting limited consumer change.
EV charger numbers	High EV charger deployment to allow for widespread EV switch.
Renewable deployment	Some additional PV deployment.
Flexibility / diversity	Some extra diversity (due to heat networks) and some battery adoption.

Figure 0—3 Summary of High Heat Networks actions for key decarbonisation areas.

The High Heat Networks scenario does still include heat pumps, due to the nature of Brighton & Hove not all being suited to heat networks. The lack of behavioural change means the impact of these heat pumps on the electricity grid is high. Alongside the upfront capital costs of heat networks this requirement for electricity network upgrades means the upfront capital for shared assets to enable decarbonisation will be high.

[38] It should be noted that these assumptions are based on engineering standards such as those used in Sweden and Denmark for heat networks and the CIBSE standards in the UK.

[39] This DFES scenario focuses on use of the existing gas network to provide hydrogen rather than natural gas to properties.

These factors, alongside fewer interim measures like travel mode shift and renewables, means the carbon reduction in this scenario is the slowest of those aiming for net zero by 2040. This is an important commonality with the equivalent DFES hydrogen based System Transformation scenario.

Consumer Transformation

The Consumer Transformation scenario allows for earlier and more incremental decarbonisation than the High Heat Networks scenario. With wider adoption of many different decarbonisation options, as shown in Figure 0—4.

Fabric improvement	High level of fabric improvement, allowing for low carbon heating.
Heat networks	Focuses on new developments, flats and large non-domestic (focus on public sector) demands.
Heat pumps	Heat pumps deployed widely, helping with earlier decarbonisation.
Car ownership/use reduction	Mode shift, particularly in early years helps with some decarbonisation before widespread EVs.
EV charger numbers	High EV charger deployment to allow for widespread EV switch.
Renewable deployment	High level of PV deployment, on both public and non-public sector assets.
Flexibility / diversity	Interest in load shifting and battery deployment alongside solar.

Figure 0—4 Summary of Consumer Transformation actions for key decarbonisation areas.

Both heat networks and property level heat pumps are widely deployed in this scenario. For the high level of heat pump demand flexibility and a high level of assumed diversity among technologies is important for allowing early deployment without high levels of grid upgrade.

The change in consumer behaviours and high level of engagement with the energy system also leads to coupled adoption of technologies for greater cost effectiveness. For example, houses with a driveway for an EV charger, roof space for PV and a heat pump as the chosen decarbonisation pathway would generally adopt these technologies together under the scenario. The PV (with a battery system) would be used onsite to charge the EV and heat or cool the house, whilst in winter the battery would help reduce the cost of electricity for the electrified heating – as the battery could be charged at times of low-cost tariffs.

The heat networks and communal systems in this scenario will focus on flat and connection of large non-domestic properties. In both cases identification of properties which BHCC have a high degree of influence, generally based on ownership, are a focus for initial projects.

One of the key behaviour changes in early years in this scenario is modal shift away from car usage, helping to reduce carbon emissions in early year – whilst there is still a large number of fossil fuel vehicles on the road. This is in general alignment with the Climate Change Committee's 6th Carbon Budget. It should be noted that although usage decreases vehicle numbers align to the Quantifiable Carbon Reduction (QCR) Tool that the Transport for the South-East are developing[40]. This QCR tool is the basis of the EV deployment for all scenarios.

[40] More details are provided in section 0.

Leading The Way

The Leading The Way scenario is very similar in the DFES to the Consumer Transformation scenario. This was also found in separate pathway analysis in this project when defining the scenarios. This is in a large part due to the nature of Brighton & Hove's building stock – meaning the switch in heating system technology (which is the main variable between the scenarios). A summary of the different options is provided in Figure 0—5.

Fabric improvement	High level of fabric improvement, allowing for low carbon heating.
Heat networks	Similar to Consumer Transformation with slightly greater deployment.
Heat pumps	Heat pumps deployed widely, helping with earlier decarbonisation.
Car ownership/use reduction	Mode shift, particularly in early years helps with some decarbonisation before widespread EVs.
EV charger numbers	High EV charger deployment to allow for widespread EV switch.
Renewable deployment	High level of PV deployment, on both public and non-public sector assets.
Flexibility / diversity	Interest in load shifting and battery deployment alongside solar.

Figure 0—5 Summary of Leading The Way actions for key decarbonisation areas.

There is a very small increase in heat networks and a slight reduction in heat pumps, as well as slight increase fabric improvement. The slight increase in fabric improvement allows for some earlier decarbonisation, as it immediately creates energy savings whilst being future proofed for low carbon heating. This is important as some heating solutions, like heat networks, can have a relatively long lead time for deployment.

In the context of Brighton & Hove the main difference between Leading the Way and the Consumer Transformation scenario is timing. With the combination of consumer and centralised approaches driving faster low carbon technology adoption.

Scenario reporting

The reporting of scenarios and creation of the associated Action Plan will focus on the Leading The Way scenario. As discussed, this is very similar to the Consumer Transformation scenario, with the main difference being some decarbonisation actions are taken quicker. Other scenarios, particularly Falling Short, are used to provide some context.

Changes in the energy baseline

The scenarios focus on decarbonisation of existing buildings within Brighton & Hove, however, new developments and changes in demand are considered.

New developments and population growth

Major new planning developments are noted and considered in the analysis. These tend to be the focus of decarbonisation opportunities, such as heat networks. The general principles with population growth and new developments are any new developments should aim to have zero/negligible operating emissions. The challenge for decarbonisation is much lower for new buildings than retrofitting old buildings. Consequently, this is one of the key points in any Action Plan for zero emissions pathways.

The City Plans Part 1[26] and Part 2[27] provide the Adopted Policies Map. The map presents the development areas boundary, site allocations and designations within Brighton & Hove boundary. These are also can be viewed on the interactive Adopted Policy Map[41].

Some of the major development and redevelopment plans in the city are:

- **King Alfred Leisure Centre** is a Council-led redevelopment plan involves either redeveloping the current site for leisure and housing or using an alternative site to build the new leisure centre[42]
- **Brighton Gasworks project** aims to transform the former Brighton Gasworks (located next to the A259) into new homes and commercial spaces[43]. It is allocated for redevelopment in City Plan Part 1.
- **Toad's Hole Valley** located in North Hove, this site is allocated in City Plan Part 1 to deliver over 800 new homes along with a offices, retail spaces and community centre[44].
- **New England House project** is a Council-led refurbishment plan focuses on the New England House building, accommodating over 100 small to medium enterprises.
- **Waterfront project** is a plan to redevelop the Brighton Centre site, extend the Churchill Square shopping centre and provide a new replacement conference centre and entertainment venue in the city[45].
- **Brighton General Hospital** on Elm Grove is allocated for a mixed-use redevelopment in City Plan Part 2[27], the site will include a health and care facility, a minimum of 200 residential units and community facilities[46]

Climate led changes in demand

The key driver for this decarbonisation pathways analysis is climate change (although there are other benefits such as health). Climate change will impact the energy demand of buildings in Brighton & Hove in the 2040 timeframe. The main way this will impact the scenario analysis is an increased demand for cooling. This is captured across the scenarios both in terms of demand and technology adoption (using the DFES as a basis for this). One of the main benefits of low carbon solutions like heat pumps is some models can also work in cooling mode, reducing the need for additional investment to adapt to the impacts of climate change.

[41] https://bhcc.maps.arcgis.com/apps/webappviewer/index.html?id=aa076c468ec74c0a806087a6b09ddebc
[42] https://www.brighton-hove.gov.uk/city-regeneration/major-developments/king-alfred-development
[43] https://www.brighton-hove.gov.uk/city-regeneration/major-developments/brighton-gasworks
[44] https://www.brighton-hove.gov.uk/city-regeneration/major-developments/toads-hole-valley
[45] https://www.brighton-hove.gov.uk/planning/major-developments/waterfront-project
[46] https://www.brighton-hove.gov.uk/city-regeneration/major-developments/brighton-general-hospital

Fabric retrofit

Introduction

This section presents the characteristics of the properties in Brighton & Hove. It also recommends priority areas for early improvement opportunities. The section is split out between domestic and non-domestic properties comprising the baseline context and the recommended improvements from the scenario modelling along with identifying a number of priority areas for early adoption.

As discussed in section 0, multiple datasets are used in this process, however, two core datasets form the basis of the analysis. These are Parity[9] data[9] for the domestic sector and Non-Domestic Analytics[10] for the non-domestic sector (provided by Energy Savings Trust[10]). These two datasets also provide the underlying data for the heating system analysis along with the fabric retrofit.

It is important to acknowledge that data on the non-domestic fabrics are limited, with the efficiency improvement primarily influenced by the property energy ratings.

Domestic building retrofit

Domestic – Existing Fabric

Among the ~136,600 domestic properties in Brighton & Hove, over 72% have an EPC rating of D or below. Figure 0—1 shows the count of domestic properties with EPC D and below by LSOA, highlighting the high density of properties with the poorest energy performance in the city centre area. These are the properties requiring greater attention to improve their energy efficiency. Moreover, with the decarbonisation of the heating system through electrification, prioritising the energy efficiency improvement becomes more important. This is essential for the successful integration of low-carbon technologies such as heat pumps as it enables the smaller heating system and lowers the strain on the electricity grid.

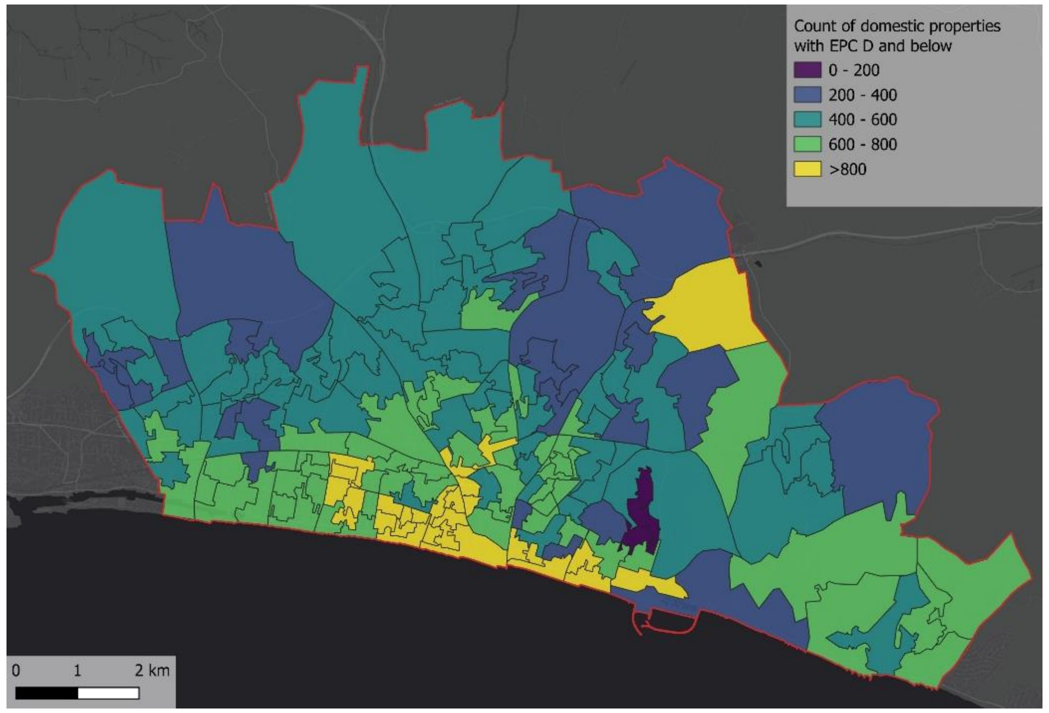


Figure 0—1 Count of domestic properties with EPC D and below by LSOA

The Figure 0—2 provides an LSOA level summary of different building fabric prevalence in the Brighton & Hove boundary regardless of their EPC rating. The fabric make-ups include uninsulated solid walls, unfilled/partially filled cavity walls, single glazing/old double glazing, and uninsulated roofs[47]. The maps highlight areas with greater potential for energy efficiency improvement and can help to target specific retrofit programmes.

The count of domestic properties with uninsulated solid walls and old glazing are highest in the city centre area. There are circa 1200 listed buildings[48] in Brighton & Hove and 30% of domestic properties are in conservation areas (see Figure 0—1). The city centre area has high density of listed buildings with single glazing and uninsulated solid walls which makes the fabric improvement rather challenging and require a customised approach. Improving the energy efficiency of listed buildings requires a more considered 'whole building' approach which combines increasing energy efficiency with sustaining the heritage assets[49].

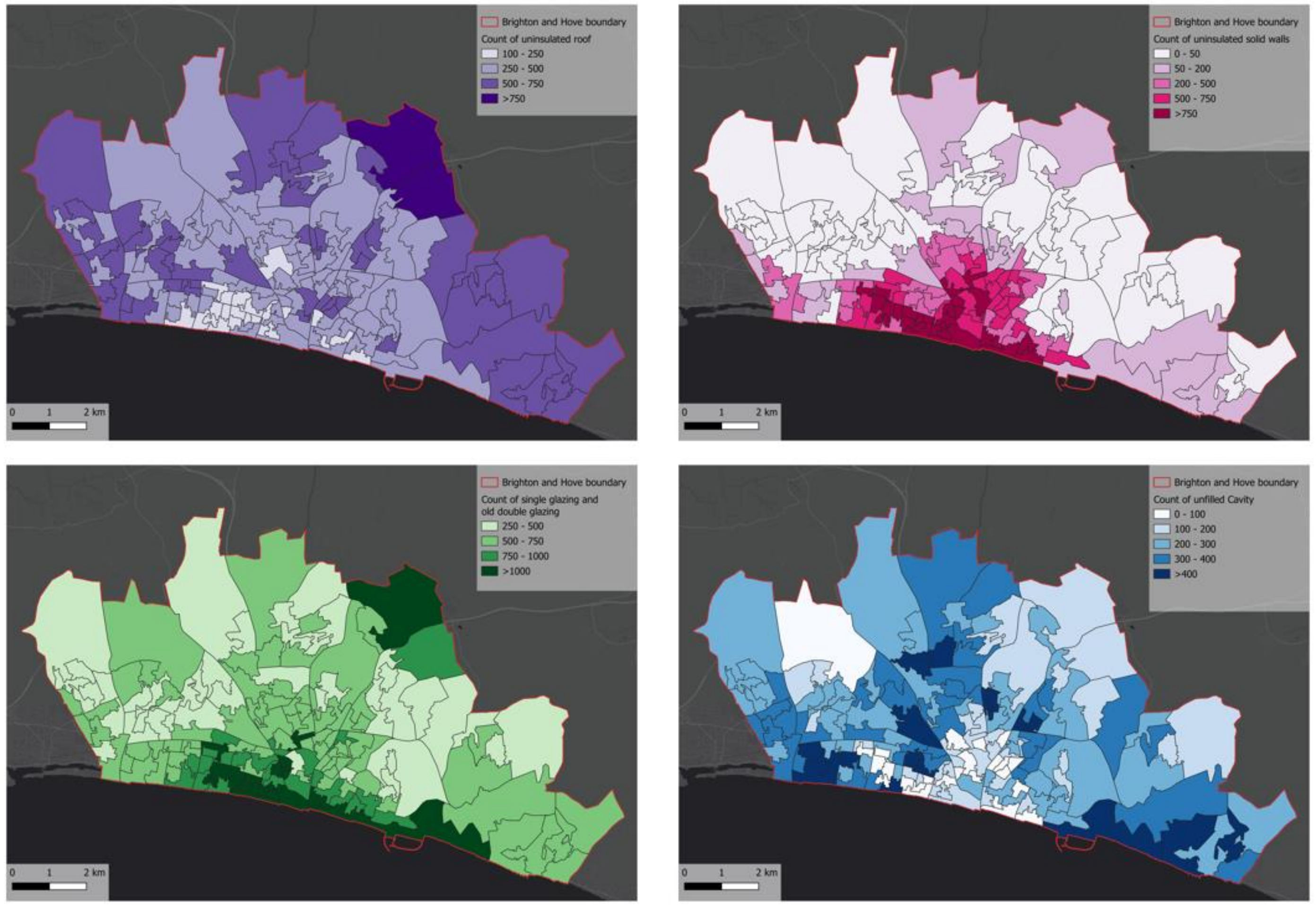


Figure 0—2 LSOA level data presenting the count of domestic properties with: uninsulated or partially insulated roof (top left), uninsulated solid walls (top right), single glazing and old double glazing (bottom left) and unfiled cavity or partially filled cavity walls (bottom right)

Moreover, Table 0—1 shows the percentage of properties with various fabric make-ups. This includes:

- Share of properties with unfilled or partially filled cavity walls
- Share of properties with uninsulated solid walls

[47] This also covers the properties that requiring some level of loft top up and does not have enough loft insulation.
[48] It is worth clarifying that each building may contain more than one property. Property refers to each individual stock.

[49] Historic England 2020, Energy Efficiency and Traditional Homes, Historic England Advice Note 14 See: https://historicengland.org.uk/images-books/publications/energy-efficiency-and-traditional-homes-advice-note-14/

- Share of properties requiring roof insulation or loft top-up
- Share of properties with single glazing or old (pre-2002) double glazing[50]

Table 0—1 Share of properties with different fabrics with potential for improvement (regardless of EPC rating)

Single-glazing or old double-glazing	Uninsulated roof/loft	Uninsulated solid wall	Unfilled or partially fille cavity
80.2% (with 32% single glazing and 48% old double glazing)	52.8%	41.3%	29.5%

The council owned properties constitute around 13% of the total domestic properties in Brighton & Hove. Among the estimated 17,800 properties owned by the Council (estimation based on the properties situated on Council owned lands), only 36% have EPC rating D or below. This confirms Council owned properties, overall, have better energy performance compared to the other domestic properties. Table 0—2 provides the share of different fabric make-ups among the properties owned by the Council.

Table 0—2 Share of Council owned with different fabrics with potential for improvement (regardless of EPC rating)

Single glazing or old double glazing	Uninsulated roof/loft	Uninsulated solid wall	Unfilled or partially fille cavity
77.5% (with 3% single glazing)	43.8%	15.2%	25.0%

Regarding the number of fabric improvements that could potentially be implemented in each individual property, Figure 0—3 provides an overview of the properties requiring only one, two or three improvements among both Council owned properties and the rest. Approximately 29% of the properties require all three measures while 50% require two measures and 15% require only one measure.

However, it is important to note that these figures do not imply each individual measure is needed or feasible for every property. Other factors such as EPC ratings, building type, the energy efficiency goal, and the required low-carbon heating system solution are also crucial in identifying feasible retrofit measures.

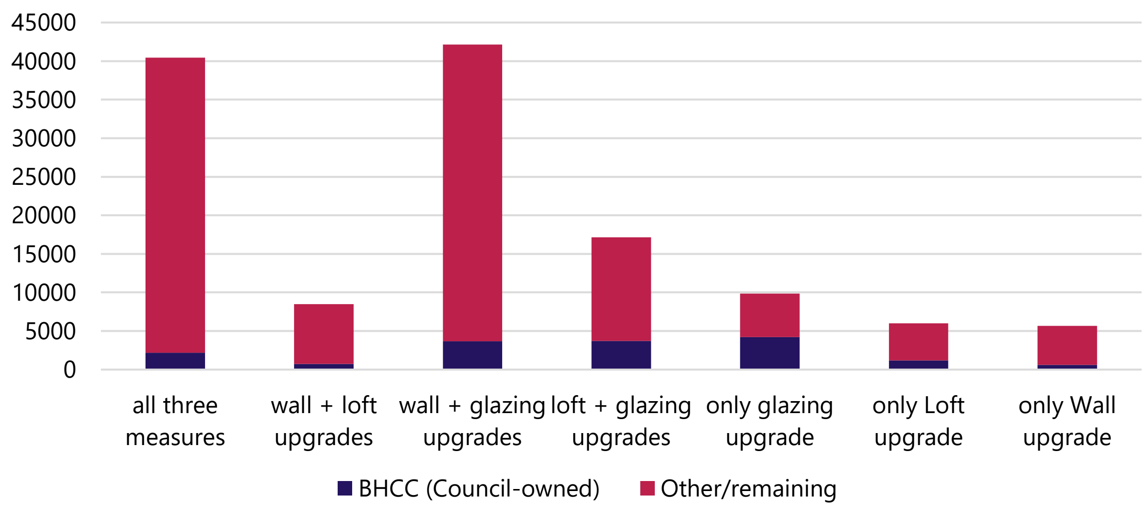


Figure 0—3 Count of domestic properties requiring different fabric improvement.

[50] if the property has double glazing but the glazing age was unknown and the property was being built before 2002, it was assumed old double glazing)

[51] BHCC advise on improving energy saving and sustainability in conservation areas and listed buildings, see: https://www.brighton-hove.gov.uk/planning/heritage/improving-energy-saving-and-sustainability-conservation-areas-and-listed-buildings

Approximately 40% of domestic properties in Brighton & Hove have uninsulated solid walls. While properties could greatly benefit from solid wall insulation (internal wall insulation or external wall insulation), this intervention is rather expensive and highly disruptive, especially in listed buildings with a high risk of losing original features and poor specification and installation. Therefore, more easily implementable measures such as loft top up and draught proofing could be prioritised.

A high proportion of properties (~80%) require a form of glazing upgrade, ranging from upgrading single glazing or old double glazing. Of these properties, over 30% are in conservation areas. These properties can greatly benefit from upgrading single glazing. In most cases, installing new double or triple glazing is feasible in listed buildings and conservation areas, unless the property's windows contribute to its special external historical and architectural interest[51,52]. While glazing upgrades can be costly, the energy saving they provide becomes more necessary with the heat pump roll-out, as it enhances the heat pump performance and addresses the potential noise issue associated with heat pumps, while also noticeably improving the properties' comfort levels.

Domestic – Energy Efficiency Improvements

As previously mentioned, over 70% of domestic properties in Brighton & Hove have EPC D or below (according to Parity data), which highlights the importance of energy efficiency improvements. Some of the possible building fabric improvements are listed in Table 0—3 along with their estimated retrofit cost and energy savings[53,54]. Additionally, the table displays the count and share of each measure regardless of the properties' EPC rating. The count of potential measures is estimated based on the fabric make-up in each individual property obtained from Parity data. The energy savings and cost of retrofit for each individual measure can vary based on the building type and building floor area. For instance, the cost of solid wall insulation in a small, terraced house could be noticeably cheaper than a large, detached house. However, terraced houses could benefit less from wall insulation than detached houses – having fewer walls impacted.

Table 0—3 Potential retrofit measures descriptions, along with estimated cost and energy savings

	Description	Retrofit cost per property [£]	Potential energy savings [%]	Count of potential measures	Percentage [%]
Unfilled and partially filled cavity wall insulation	Cavity wall is made up of two walls with an air gap in between before regulations required the gap to be insulated. The Cavity walls can be insulated by injecting the insulation material into the cavity. This is typically a low-cost and low-disruptive retrofit, making it an effective way to improve both energy efficiency and comfort.	380 – 1,400	4% - 14%	40,330 (29.5%)	29.5
Solid wall insulation	Solid walls are made up of one or more layers of construction materials with less than 10mm gap in between. They can be insulated internally or externally. Internal wall insulation (IWI) is more intrusive as it requires moving the radiators, removing skirting boards and sockets, while the external wall insulation (EWI) is generally less disruptive than IWI, but it could be more expensive. Solid wall insulation not only enhances energy efficiency but also reduces draughts and noise.	4,400 – 18,000	9% - 18%	56,422 (41.3%)	41.3

[52] In many cases sound historic windows can accommodate slimline double-glazing fitted into the existing casements and on unlisted buildings in conservation areas this would not require permission

[53] Element Energy 2020 Assumption of trajectories for residential heat decarbonisation to inform the Sixth Carbon Budge

[54] UCL 2020 Analysis Work to Refine Fabric Energy Efficiency Assumptions for use in Developing the Sixth Carbon Budget

	Description	Retrofit cost per property [£]	Potential energy savings [%]	Count of potential measures	Percentage [%]
Glazing upgrade	Upgrading windows to new double/triple glazing or secondary glazing if building is in conservation area. This is a high-cost and moderately disruptive upgrade measure. Upgrading the windows could noticeably improve the comfort through better airtightness and improved thermal performance. Moreover, it also reduces the external noise.	2,700 – 12,200	5% - 7%	109,585 (80.2% with 32% single glazing)	80.2
Roof and loft insulation	Adding an extra insulation layer could cut the heat losses through the roof. This is a low- disruptive and low-cost upgrade which reduce the energy demand with a noticeable comfort improvement. It should be noted that this is likely an overestimate.	350 - 960	5% - 17%	72,077 (52.8%)	52.8
Draught proofing	Draught stripping is a low-cost and minimally disruptive measure that improves the comfort along with some energy saving.	80 - 360	2% - 3%	99,313 (72%) (The count of properties with EPC D or below)	72

The decarbonisation of heating can be achieved by reducing the heating demand through fabric improvement, replacing existing heating system with more efficient technologies and electrification of heating system considering that the grid carbon intensity is decreasing over time. Improving the fabrics alone could facilitate the better integration of low carbon heating technologies (for example, heat pump), resulting in smaller heating systems, lower energy bill and decrease strain on the grid which lowers delays to and the cost of decarbonising electricity supply. Additionally, these interventions improve the comfort, lower the energy bill and address fuel poverty in vulnerable areas.

To reduce the energy demand and prepare the houses for low-carbon technologies, the energy efficiency improvement was prioritised in the properties with an EPC D or below. Two scenarios were assessed as follows:

- Moderate retrofit: All possible fabric improvements in all properties with EPC E and below along with glazing upgrade and loft upgrade in properties with EPC D
- Deep retrofit: All possible fabric improvements in all properties with EPC D and below

As some of the retrofit measures are restricted or might require planning permissions for listed properties or properties in conservation areas, this consideration is factored into the retrofit analysis. For instance, EWI was not considered for listed buildings regardless of their EPC ratings.

Table 0—4 and Table 0—5 provide insights into the total count of retrofit measures, the number of houses requiring retrofit, the potential energy savings, and the cost of retrofit for domestic properties and for the BHCC owned properties.

The total heating demand (space heating and hot water) is estimated to be around 1,183 GWh in domestic properties. Through moderate and deep fabric retrofit, it is possible to reduce the demand by 12% and 7.7% respectively,

Table 0—4 Overview of fabric improvement for domestic properties in Brighton & Hove

	Count of retrofit measures	Number of properties retrofitted	Energy savings (MWh/year)	Cost (m£)
Moderate retrofit	169,052	95,874	91.1	654.9
Deep retrofit	225,573	98,433	142.7	953.3

Table 0—5 Overview of fabric improvement for domestic properties owned by BHCC

	Count of retrofit measures	Number of properties retrofitted	Energy savings (GWh/year)	Cost (m£)
Moderate retrofit	9,879	6,097	3.4	32.7
Deep retrofit	13,227	6,298	5.9	44.6

Table 0—6 provides the count and estimated cost of different fabric interventions in moderate and deep retrofit scenarios.

Table 0—6 Count and cost break down of required measures in deep and moderate retrofit scenarios

	Deep Retrofit		Moderate retrofit	
	Count	**Cost of retrofit**	**Count**	**Cost of retrofit**
Single glazing	35,132	158	35,132	158
Old double glazing	49,616	329	49,616	329
Uninsulated Solid wall	47,820	395	14,283	121
Unfilled/partially filled cavity	32,426	34	9,442	8
Loft/roof requiring upgrade	60,579	37	60,579	37

The energy saving and cost associated with draught proofing have not been included in the numbers presented in the tables. This is an easily implementable and low-cost measure which would lead to slight energy saving along with improvement in comfort. It is estimated that there is potential for circa 19 GWh energy saving in properties with EPC D and below through draught proofing, which would cost ~£18m.

It is also worth highlighting that while a large proportion of properties require different fabric upgrades, certain upgrades, such as glazing upgrades are going to happen as a part of the buildings' general maintenance in the coming years. This implies that the actual total cost of fabric intervention would be lower. An indication of these differences in costs is provided in section 0.

Table 0—7 provides an insight into the number of required measures and the count of properties needing retrofit by 2040 under any of the UKPN DFES scenarios detailed in section 0. It also provides the estimated cost of retrofit and the resulting energy saving across all scenarios. Similarly, Table 0—8 provides insight for the domestic properties owned by BHCC.

As detailed in section 0, the "Falling Short" scenario reflects the slow progression towards decarbonisation and does not achieve net zero by 2040. While, in "High Heat Networks", with large scale heat network roll out, there is a reduced need for retrofitting. In both "Consumer Transformation" and "Leading the Way" scenarios, energy efficiency has a significant role given the high level of electrification of heat, reducing the demand at the consumer level is becoming more vital.

Table 0—7 Overview of fabric improvement measures in different scenarios by 2040

Scenario	Count of retrofit measures	Number of properties retrofitted	Energy savings (GWh/year)	Cost (m£)
Falling Short	38325	16724	24.2	162.0
High Heat Networks	156221	68170	98.9	660.2
Consumer Transformation	219301	95696	138.7	926.8
Leading the Way	241065	105193	152.5	1018.8

Table 0—8 Overview of fabric improvement measures in different scenarios for domestic properties owned by BHCC by 2040

Scenario	Count of retrofit measures	Number of properties retrofitted	Energy savings (GWh/year)	Cost (m£)
Falling Short	2247	1070	1.1	7.6
High Heat Networks	9160	4362	4.1	30.9
Consumer Transformation	12859	6123	5.8	43.4
Leading the Way	14135	6731	6.4	47.7

Domestic - Delivery scale review of energy efficiency improvements

In order to identify priority areas for early fabric deployment, multiple factors are considered as follows:

- LSOA level count of properties with EPC D and below requiring fabric improvements (Figure 0—4 to Figure 0—7).
- LSOA level potential energy reduction through retrofit (Figure 0—8).
- Fuel poverty map (2022) to identify areas with the worst fuel poverty to be considered first, as fabric improvement could decrease the energy bill. Moreover, government fundings like Great Britain Insulation Scheme (GBIS)[55] has been designed to help the low-income groups.
- 100m x 100m grid level count of properties with EPC D and below requiring fabric improvements. The grid level maps provide finer resolution to identify priority areas for interventions (Figure 0—9 to Figure 0—12).
- BHCC ownership to identify early opportunities and accelerate implementation of retrofit.

Figure 4—4 to Figure 4—7 provide the LSOA level count of different fabric measures in properties with an EPC D or below as well as in the Council owned properties. The maps highlight the top 10% of areas with the highest level of fuel poverty. These areas are prioritised for early interventions. The analysis also identifies other priority areas such as areas with great potential for energy savings or areas that could benefit from government fundings to support retrofit initiatives.

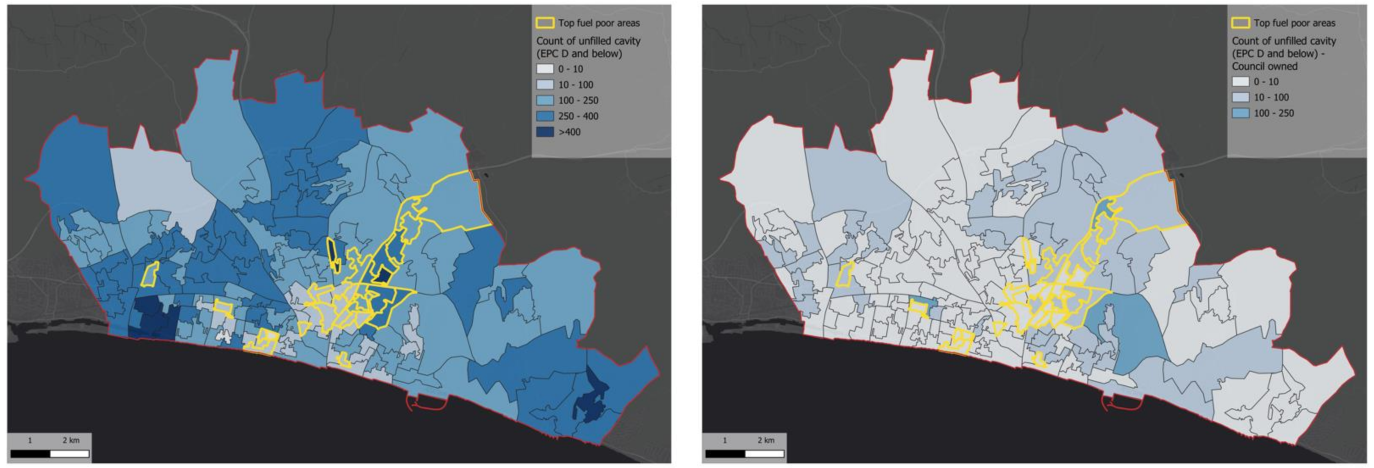


Figure 0—4 LSOA level count of unfilled/partially filled cavity walls in properties with EPC D and below in Brighton & Hove (left) and in BHCC owned (right)

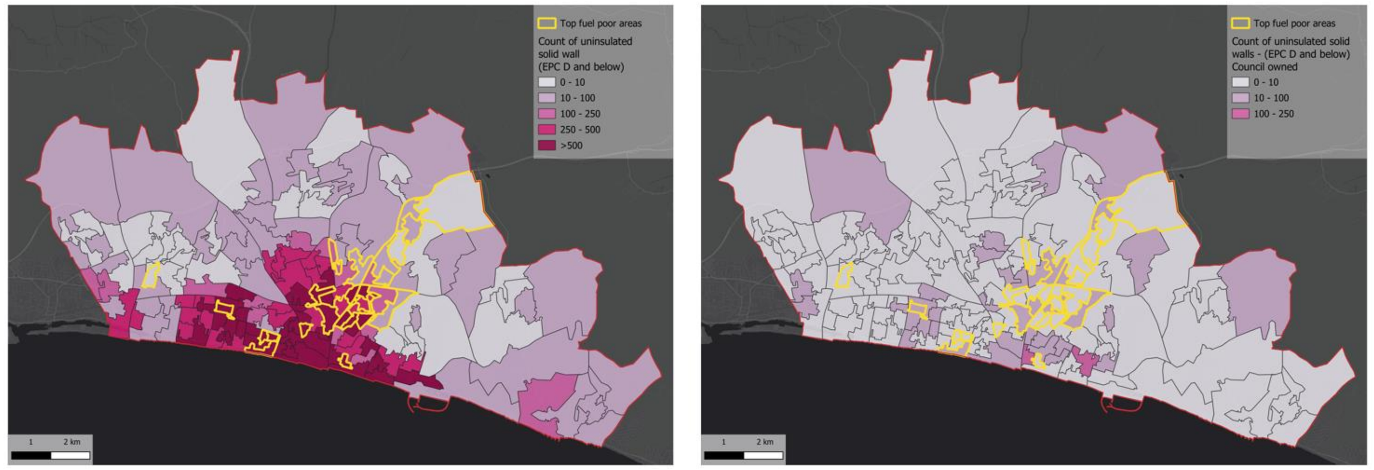


Figure 0—5 LSOA level count of uninsulated solid walls in properties with EPC D and below in Brighton & Hove (left) and in BHCC owned (right)

Figure 0—6 LSOA level count of properties with loft/roof requiring insulation in properties with EPC D and below in Brighton & Hove (left) and in BHCC owned (right)

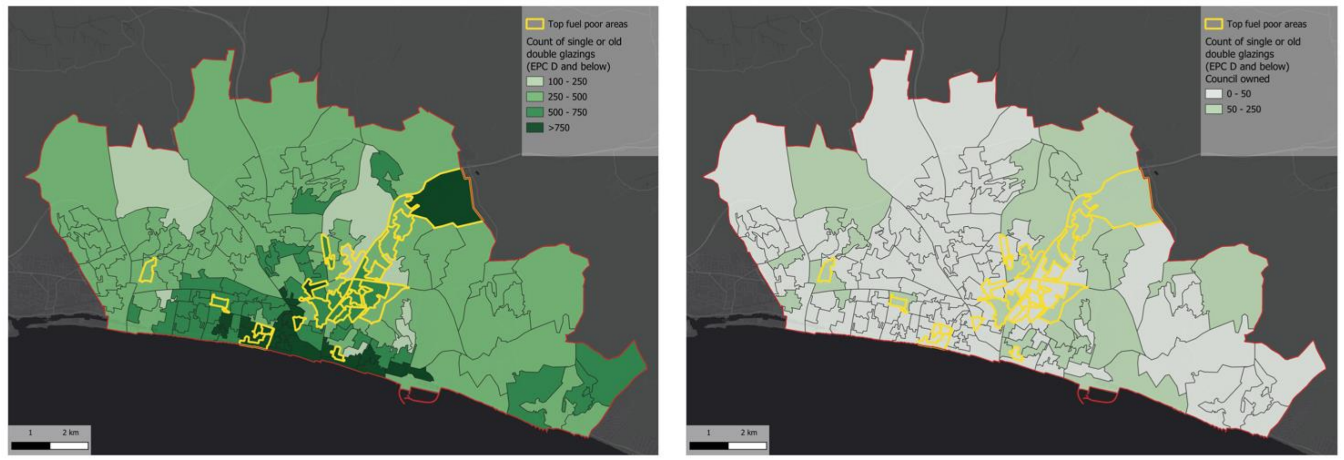


Figure 0—7 LSOA level count of single glazing and old double glazing in properties with EPC D and below in Brighton & Hove (left) and in BHCC owned (right)

[55] https://www.gov.uk/apply-great-british-insulation-scheme

Figure 0—8 shows the percentage of energy reduction achievable through fabric retrofit at LSOA level (this is aligned with deep retrofit scenario). It appears that the properties in city centre can benefit the most from fabric retrofit, given the large number of old properties with poor energy performance. However, some LSOAs exhibits smaller energy savings, these are areas with high number of council ownership, which tend to have better overall energy efficiency and lower potential for improvement is lower.

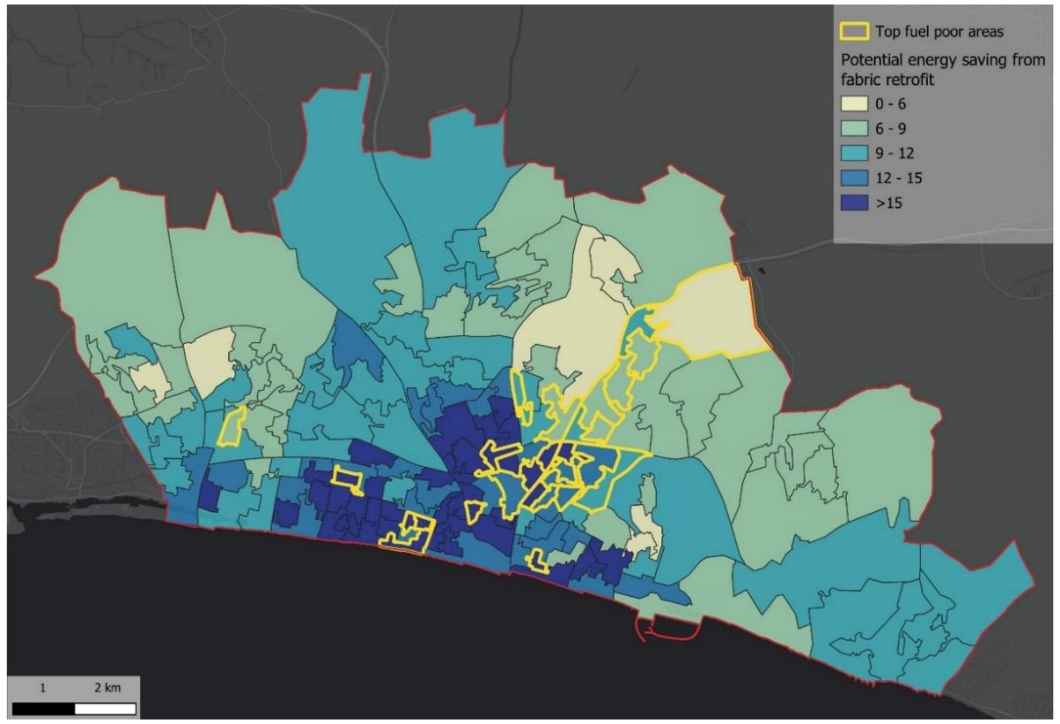


Figure 0—8 Potential energy saving % from retrofit– Comparing the energy demand before and after retrofit interventions by LSOA

Figure 0—9 to Figure 0—12 provide the count different fabric measures in properties with an EPC D or below at the 100m x 100m grid level. These maps offer finer resolutions to identify areas for early interventions.

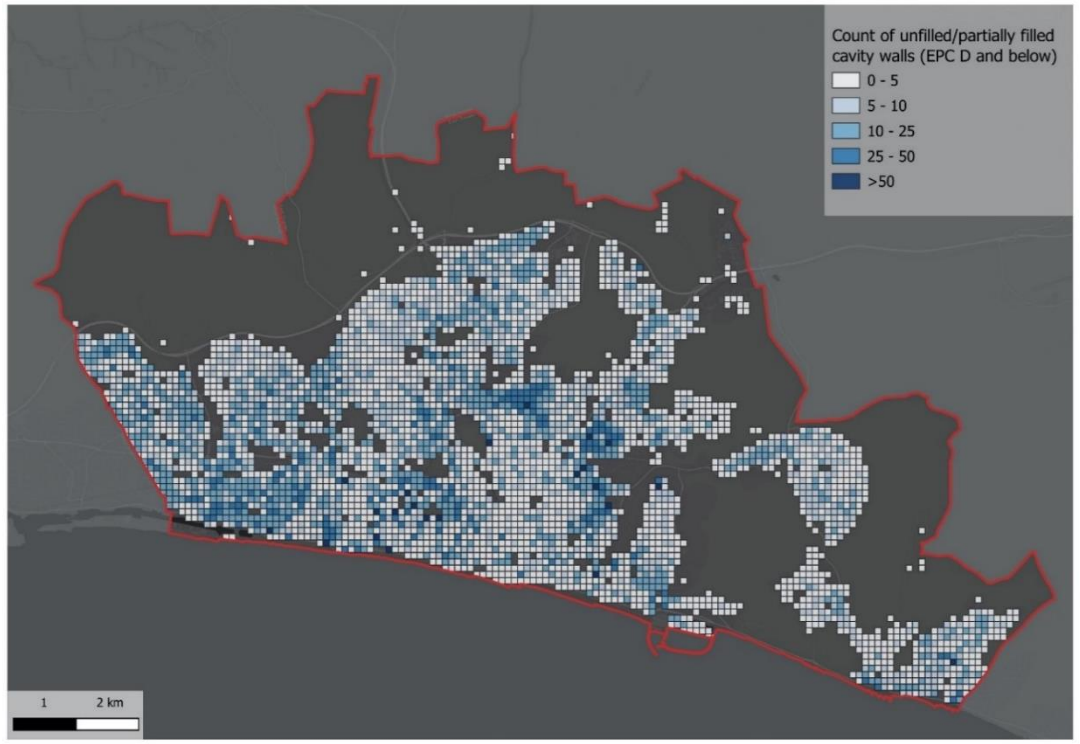


Figure 0—9 Grid level count of properties with unfilled/partially filled cavity walls with EPC D and below

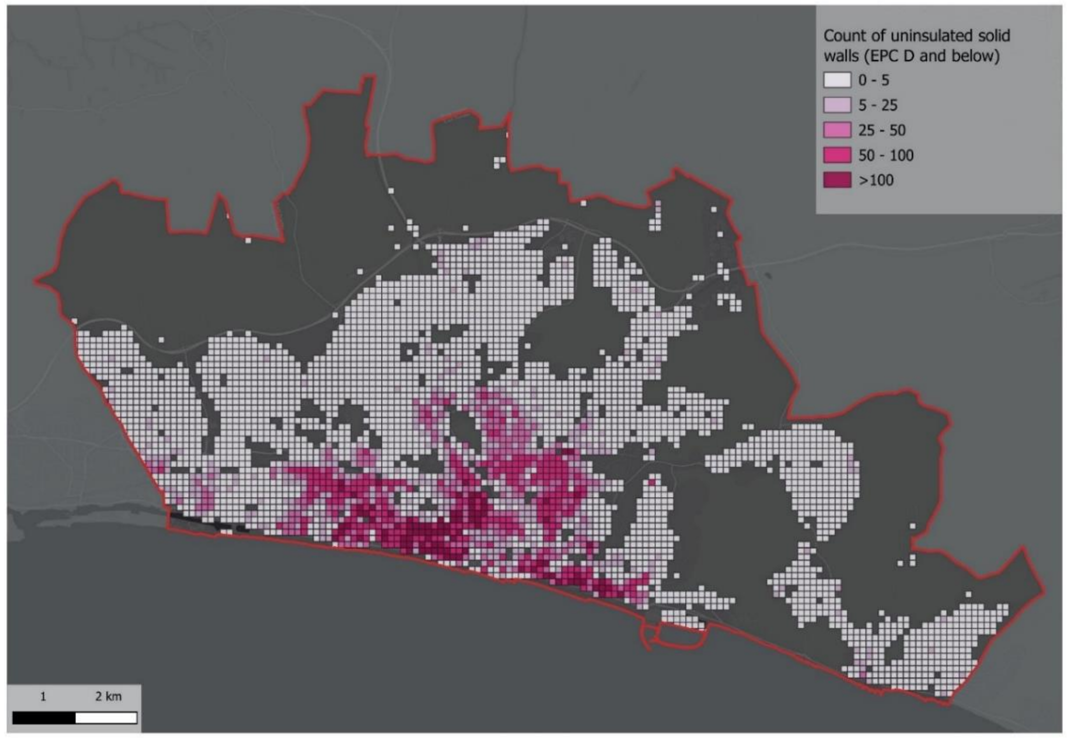


Figure 0—10 Grid level count of properties with uninsulated solid walls with EPC D and below

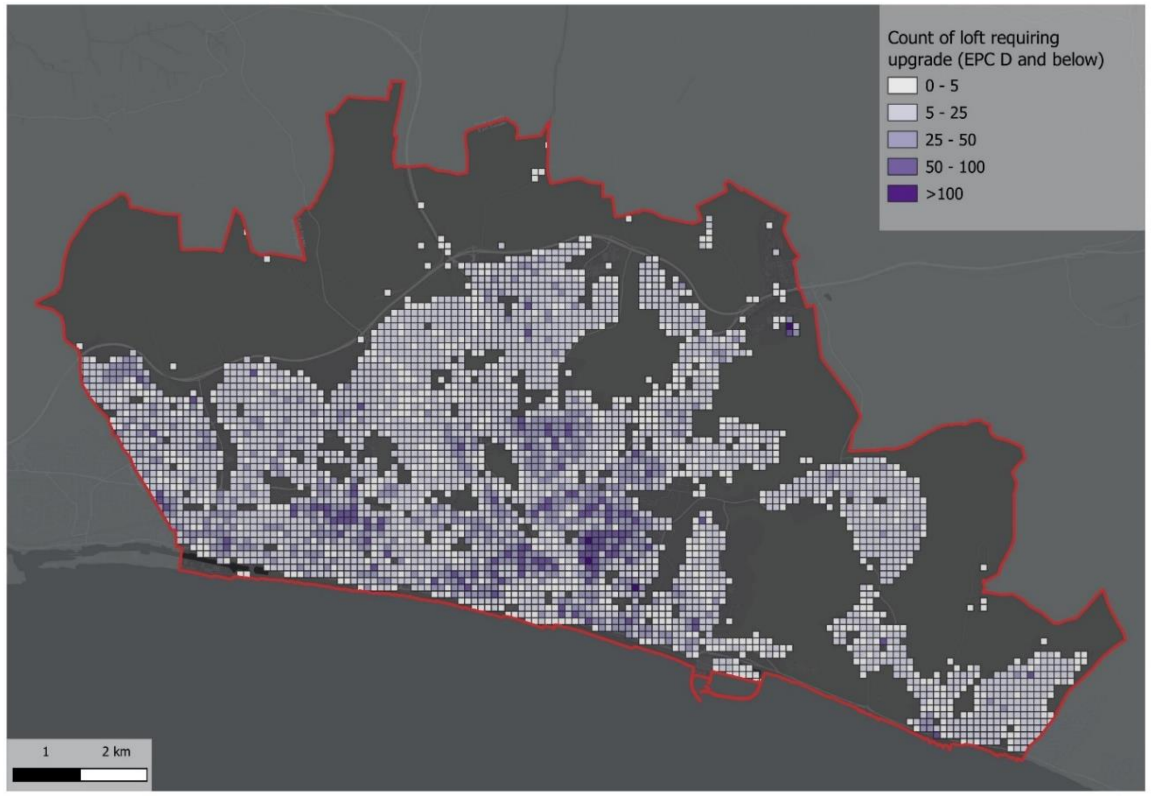


Figure 0—11 Grid level count of properties requiring loft/roof upgrade with EPC D and below

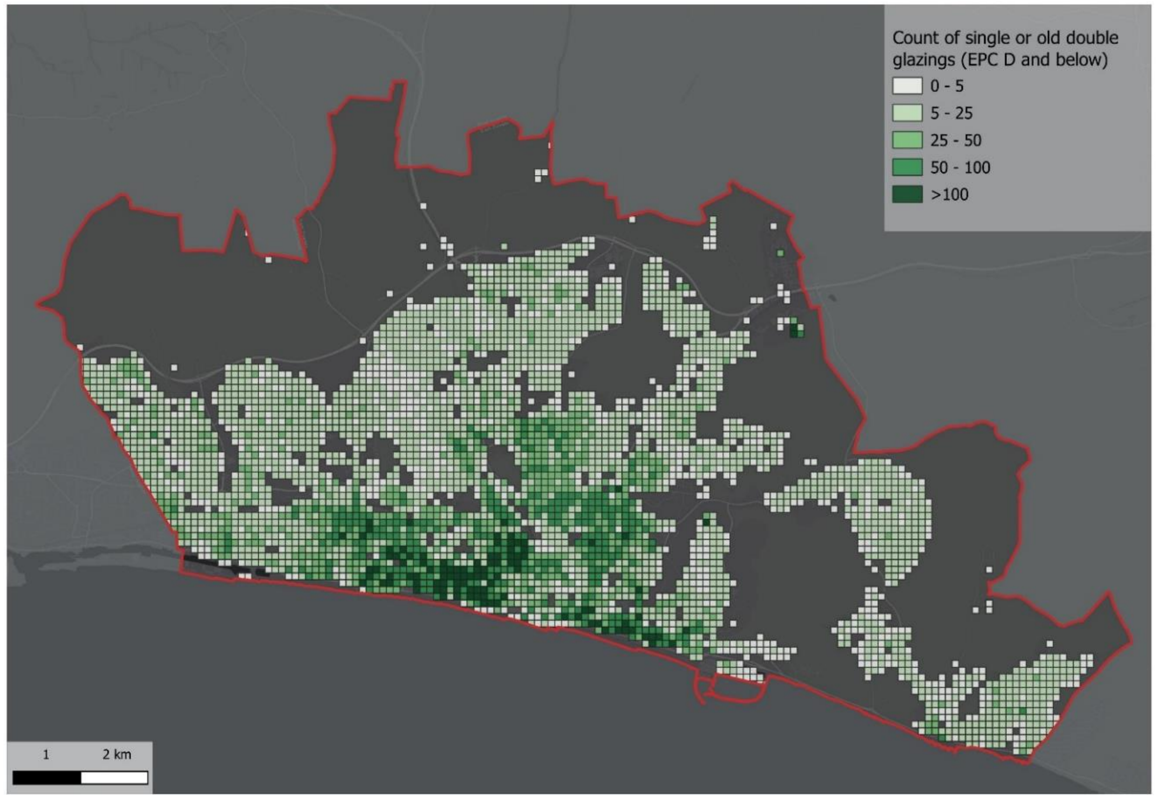


Figure 0—12 Grid level count of properties with single/old double glazing with EPC D and below

As discussed earlier, different factors including the LSOA level and 100 m x100 m grid level count of properties requiring certain intervention and their EPC ratings, the property type, the current heating system, fuel poverty area as well as the Council ownership are takeninto consideration to identify the potential initial areas for early retrofit interventions in Brighton & Hove. These are marked in Figure 0—13 and listed in Table 0—9. Some potential funding opportunities including Home Upgrade Grant 2[56] (HUG2), Social Housing Decarbonisation Scheme[57] (SHDS), Boiler Upgrade Scheme[58] (BUS) and GBIS[55] are also noted.

Table 0—9 Potential priority areas for domestic retrofit projects

No	Description
1	In **Paddock Field**, University of Brighton properties, mainly electrically heated houses, there is potential for **glazing and loft upgrades**, as well as **shared ground loop heating**.
2	Potential for fabric improvement in **Newick Rd.** Area is dominated by Council owned semi-detached properties requiring **cavity wall or loft insulations**. This makes the properties also ready for **individual heat pump roll out or shared ground loop**. Funding opportunity: SHDF
3	There is a potential for **fabric retrofit** in properties around **St. James's St,** primarily consisting of flats and a large number of listed buildings. Circa 800 properties have EPC E-G. Moreover, 25% of properties are electrically heated and might be eligible for HUG2 fundings for energy efficiency improvements. Funding opportunities: HUG2, GBIS
4	There is a potential for **glazing upgrade** in **Western Rd**, primarily consists of privately-owned and rented low-rise flats, with circa 2500 single glazing. There are around 800 electrically heated properties which might be eligible for HUG2 fundings for energy efficiency improvement.
5	Fabric upgrade in the **Hanover** area, comprising mostly privately-owned terrace houses. A large number of properties require one or two retrofit measures including **glazing upgrade and loft top up**. The area could also be suitable for **individual heat pump** roll out. Funding opportunity: BUS
6	Potential for **loft top up** in circa 120 Council owned terrace and semi-detached properties around **Egmont Rd.** This makes the properties also ready for individual heat pump roll out or shared ground loop. Funding opportunity: SHDF, GBIS
7	**Fabric retrofit** insulation in the **Moulsecoomb** mainly comprising privately-owned and rented semi-detached and terrace properties. 80% of properties have EPC D or below and half the properties could benefit from cavity wall insulation. Funding opportunity: GBIS
8	**Graham Ave** primarily consists of circa 850 privately-owned semi-detached houses. Most properties have EPC D (above 60%), and some fabric improvement like **cavity wall insulation or loft top up** could make the area suitable for a heat pump roll out. Funding opportunity: BUS
9	Potential for **loft top up** and **glazing upgrade** in area around **Brooker St.** Over 30% of properties are requiring single glazing upgrade, and about 50% need loft top up. The area mainly consists of low-rise flats and terrace houses, Funding opportunity: GBIS
10	**Fabric retrofit** in **Aldrington area** with over 2000 privately-owned and rented old low-rise flats and terrace houses**.** Over 75% of these properties having EPC D and below and could greatly benefit from **glazing upgrade and loft top up.**
11	In **Pankhurst Ave,** fabric retrofit (**cavity wall insulation and loft upgrade**) in Council owned semi-detached properties. Funding opportunity: SHDF
12	**Glazing and loft upgrades in** densely populated area in **Upper Lewes Rd**, comprising privately-owned and rented old flats and terrace houses. Fuel poverty is prevalent in the area. **Fabric improvements make the area ready for a heat pump roll out as well.** Funding opportunity: GBIS
13	A large number of old privately-owned and rented low-rise flats in **Alexandra Vilas**, circa 700 properties requiring **glazing upgrade,** as well as potential for **shared ground loop heating.** Funding opportunity: GBIS, HUG2
14	Potential for **single glazing upgrade** in ~570 properties **in Clyde Rd** which largely consists of privately-owned and rented old low-rise flats and terrace houses.
15	**Gardener St**. area is dominated by privately-owned terrace and low-rise flats. with about 75% of them are EPC D and below and over 60% are requiring **loft top-up**. This intervention could also improve the heat pump performance if a heat pump rollout happens in the area. Funding opportunity: BUS
16	Potential for **fabric improvement** in domestic properties around **Coombe Rd,** largely consists of privately-owned and rented terrace properties. Over 1200 properties have EPC D and below and could greatly benefit from **cavity wall insulation and loft top up**. The fabric improvement could also make them ready for heat pump

[56] https://www.gov.uk/government/publications/home-upgrade-grant-phase-2
[57] https://www.gov.uk/government/publications/social-housing-decarbonisation-fund-wave-2
[58] https://www.gov.uk/apply-boiler-upgrade-scheme

Fabric retrofit in **Aldrington area** with over 2000 privately-owned and rented old low-rise flats and terrace houses. Over 75% of these properties having EPC D and below and could greatly benefit from **glazing upgrade and loft top up.**

Potential for **loft top up** in circa 120 Council owned terrace and semi-detached properties around **Egmont Rd.** This makes the properties also ready for individual heat pump roll out or shared ground loop. Funding opportunity: SHDF, GBIS

Graham Ave primarily consists of circa 850 privately-owned semi-detached houses. Most properties have EPC D (above 60%), and some fabric improvement like **cavity wall insulation or loft top up** could make the area suitable for a heat pump roll out. Funding opportunity: BUS

Gardener St. area is dominated by privately-owned terrace and low-rise flats. with about 75% of them are EPC D and below and over 60% are requiring **loft top-up**. This intervention could also improve the heat pump performance if a heat pump rollout happens in the area. Funding opportunity: BUS

Potential for **loft top up** and **glazing upgrade** in area around **Brooker St.** Over 30% of properties are requiring single glazing upgrade, and about 50% need loft top up. The area mainly consists of low-rise flats and terrace houses, Funding opportunity: GBIS

There is a potential for **glazing upgrade** in **Western Rd**, primarily consists of privately-owned and rented low-rise flats, with circa 2500 single glazing. There are around 800 electrically heated properties which might be eligible for HUG2 fundings for energy efficiency improvement.

Potential for **single glazing upgrade** in ~570 properties **in Clyde Rd** which largely consists of privately-owned and rented old low-rise flats and terrace houses.

Potential for **fabric improvement** in domestic properties around **Coombe Rd,** largely consists of privately-owned and rented terrace properties. Over 1200 properties have EPC D and below and could greatly benefit from **cavity wall insulation and loft top up.** The fabric improvement could also make them ready for heat pump

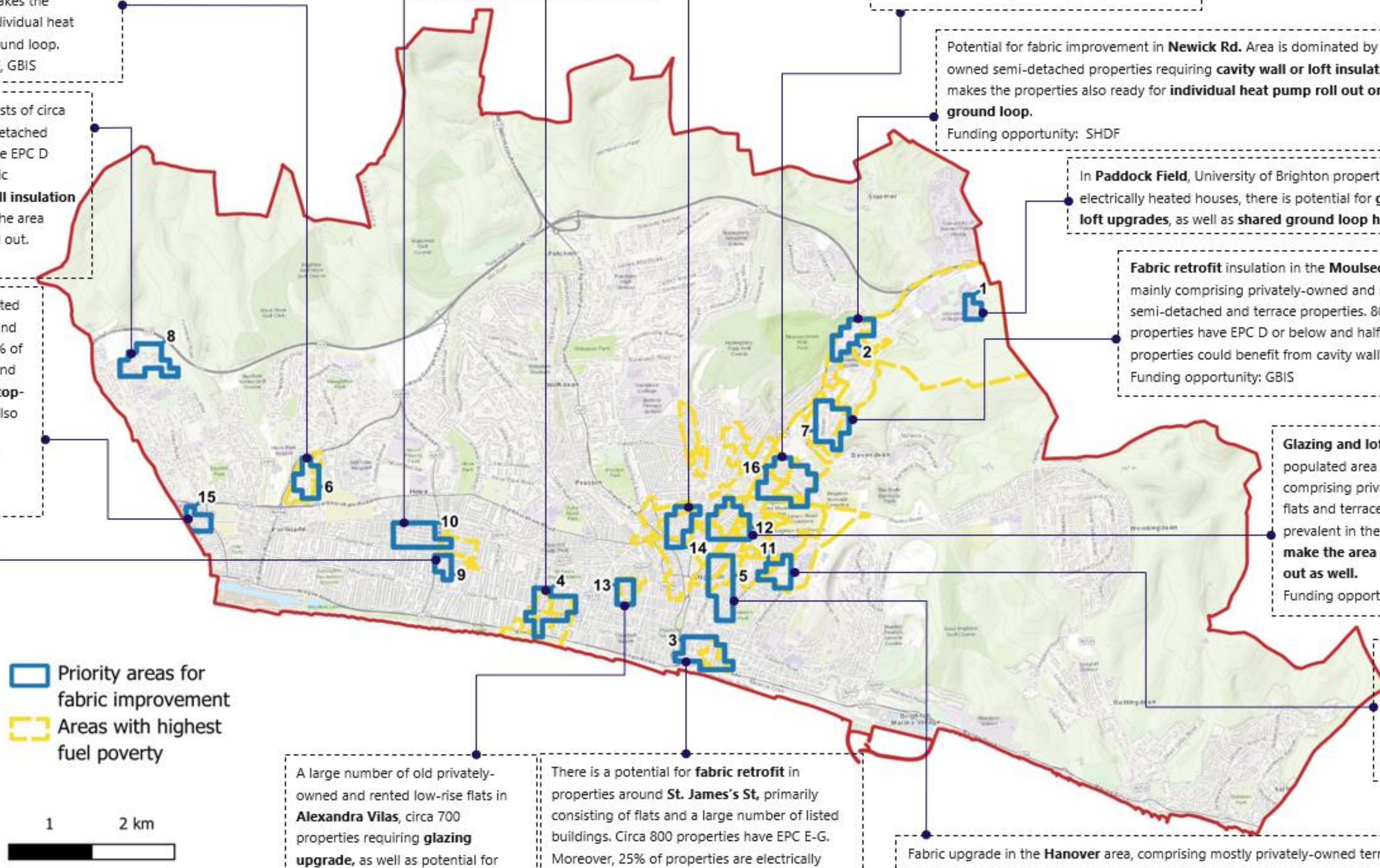
Potential for fabric improvement in **Newick Rd.** Area is dominated by Council owned semi-detached properties requiring **cavity wall or loft insulations.** This makes the properties also ready for **individual heat pump roll out or shared ground loop.** Funding opportunity: SHDF

In **Paddock Field**, University of Brighton properties, mainly electrically heated houses, there is potential for **glazing and loft upgrades**, as well as **shared ground loop heating.**

Fabric retrofit insulation in the **Moulsecoomb** mainly comprising privately-owned and rented semi-detached and terrace properties. 80% of properties have EPC D or below and half the properties could benefit from cavity wall insulation. Funding opportunity: GBIS

Glazing and loft upgrades in densely populated area in **Upper Lewes Rd**, comprising privately-owned and rented old flats and terrace houses. Fuel poverty is prevalent in the area. **Fabric improvements make the area ready for a heat pump roll out as well.** Funding opportunity: GBIS

In **Pankhurst Ave,** fabric retrofit (**cavity wall insulation and loft upgrade**) in Council owned semi-detached properties. Funding opportunity: SHDF



A large number of old privately-owned and rented low-rise flats in **Alexandra Vilas**, circa 700 properties requiring **glazing upgrade,** as well as potential for **shared ground loop heating.** Funding opportunity: GBIS, HUG2

There is a potential for **fabric retrofit** in properties around **St. James's St,** primarily consisting of flats and a large number of listed buildings. Circa 800 properties have EPC E-G. Moreover, 25% of properties are electrically heated and might be eligible for HUG2 fundings for energy efficiency improvements. Funding opportunities: HUG2, GBIS

Fabric upgrade in the **Hanover** area, comprising mostly privately-owned terrace houses. A large number of properties require one or two retrofit measures including **glazing upgrade and loft top up.** The area could also be suitable for **individual heat pump** roll out. Funding opportunity: BUS

Figure 0—13 Potential areas for retrofit priority projects

Non-Domestic buildings retrofit

Non-Domestic – existing fabric

The core dataset for analysing non-domestic data is Energy Saving Trust's non-domestic analytics[10] which does not provide any information about the non-domestic properties age and fabric. Therefore, the general indication of poor performance is primarily led by indicative energy ratings (EPC).

Among the 11,267 non-domestic properties in Brighton & Hove, 29% have EPC D, while 32% fall into EPC E-G. Figure 0—14 provides the count of non-domestic properties with energy ratings D or below at LSOA level.

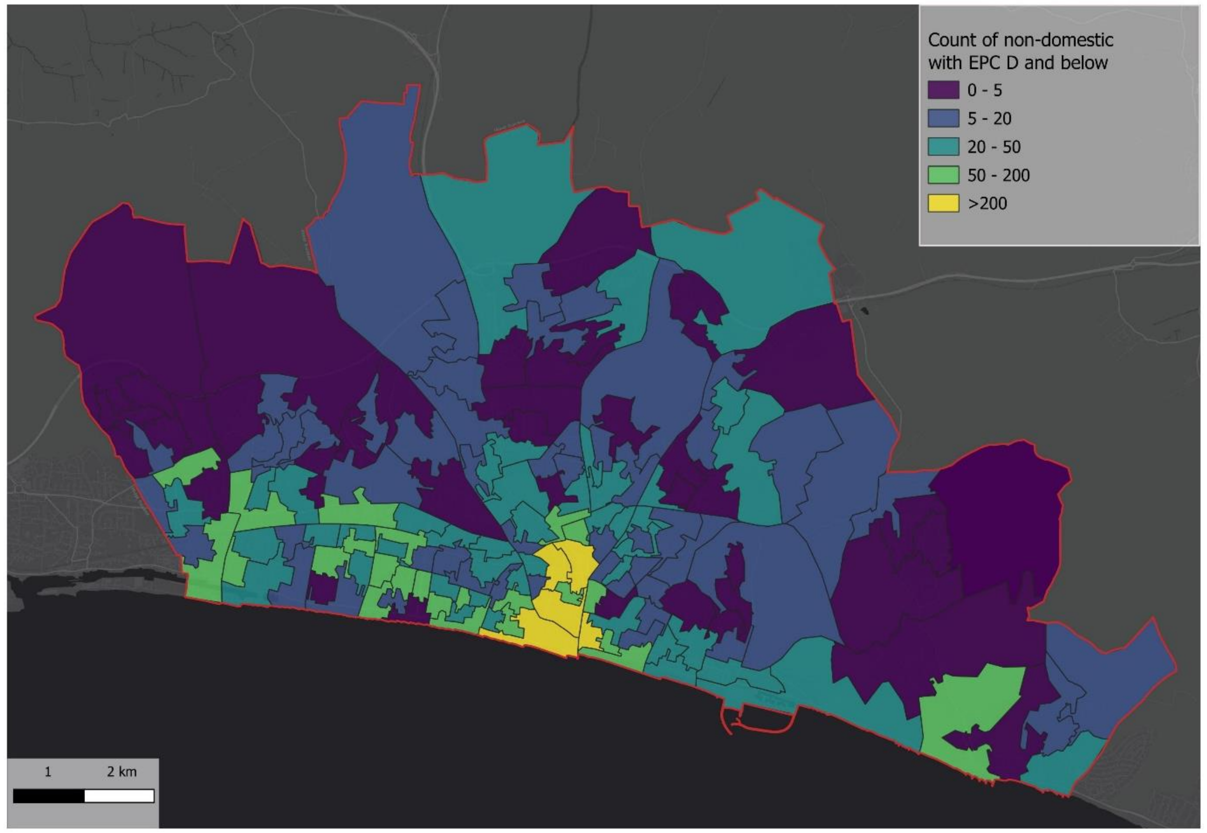


Figure 0—14 Count of non-domestic properties with EPC D or below per LSOA

There are ~1,890 non-domestic properties on Council owned lands, among which about 37% have EPC D and 21% Have EPC E-G. Figure 0—15 displays the LSOA level count of non-domestic properties with EPC D or below located on BHCC owned land.

The areas around the Queens Road and Grand Parade are among the areas with largest number of non-domestic properties with poor energy performance. Overall, the city centre area has large number of non-domestic properties with EPC D and below, due to the prevalence of old and listed buildings in that area. The listed non-domestic properties are estimated to be around 730 with over 70% of them having EPC D or below. The high density of listed buildings also contributes to the challenge of energy efficiency improvement in this area.

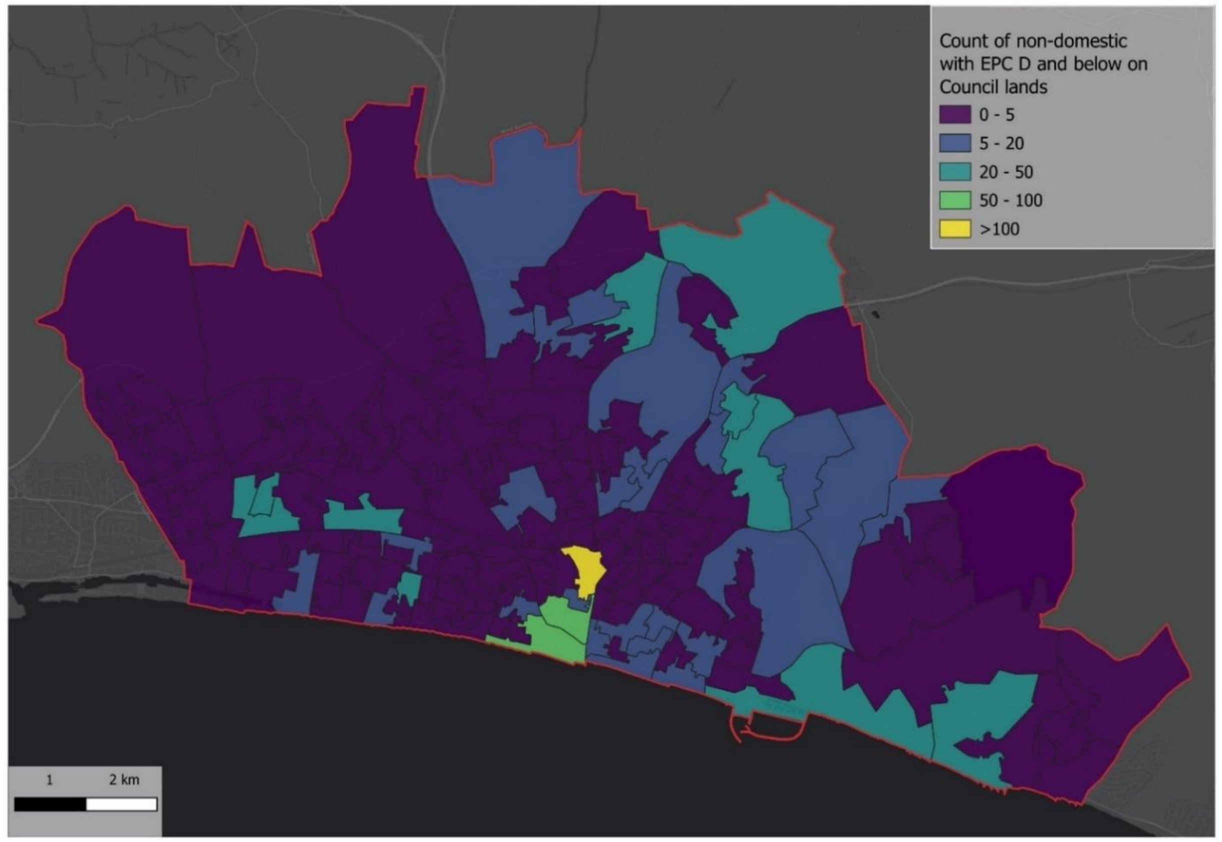


Figure 0—15 Count of non-domestic properties with EPC D or below on Council owned lands per LSOA[59]

Figure 0—16 presents the breakdown of the energy ratings by typology in Brighton & Hove. The non-domestic typologies are classified according to the typologies presented in Building Energy Efficiency Survey (BEES)[60] which divides non-domestic stocks into ten sectors. Retail (~32%) and offices (~30%) are the dominant typologies in Brighton & Hove, this is followed by hospitality including hotels, restaurants (~13%), and Industrial (~7%). Furthermore, these typologies show the highest number of properties with an energy rating of D or below which confirms the need for energy efficiency improvements in these sectors.

[59] It is worth noting that, the map shows the count of properties that are located on the Council owned lands, and it is not known if they are under Council control.

[60] The Building Energy Efficiency Survey (BEES) 2014–15 is a UK Government survey which sets out to improve and update the evidence of how energy is used, and to provide an assessment of the abatement opportunities for all non-domestic premises across England and Wales. See: https://www.gov.uk/government/publications/building-energy-efficiency-survey-bees

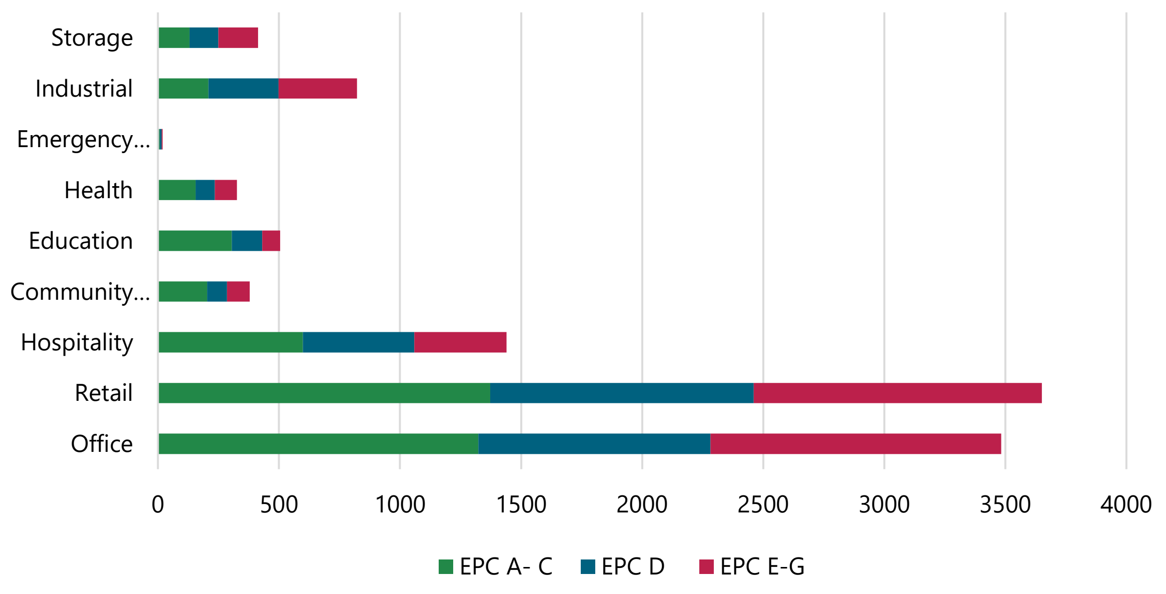


Figure 0—16 Breakdown of EPC ratings by typology among non-domestic

The total annual heat demand is estimated ~487 GWh in non-domestic properties. Of this, over 149 GWh of heat demand is in properties located on Council owned lands. The annual heat demand in non-domestic properties by typology/sector is presented in Figure 0—17, Figure 0—18. Along with the distribution of the demand between Council-owned properties and other non-domestic stocks. Of the total heat demand, 27% pertain to offices. While retail is one of the most common typologies in Brighton & Hove, considering the heat demand, the education and hospitality sectors have larger share of the demand, accounting for 20% and 17% of the total demand respectively.

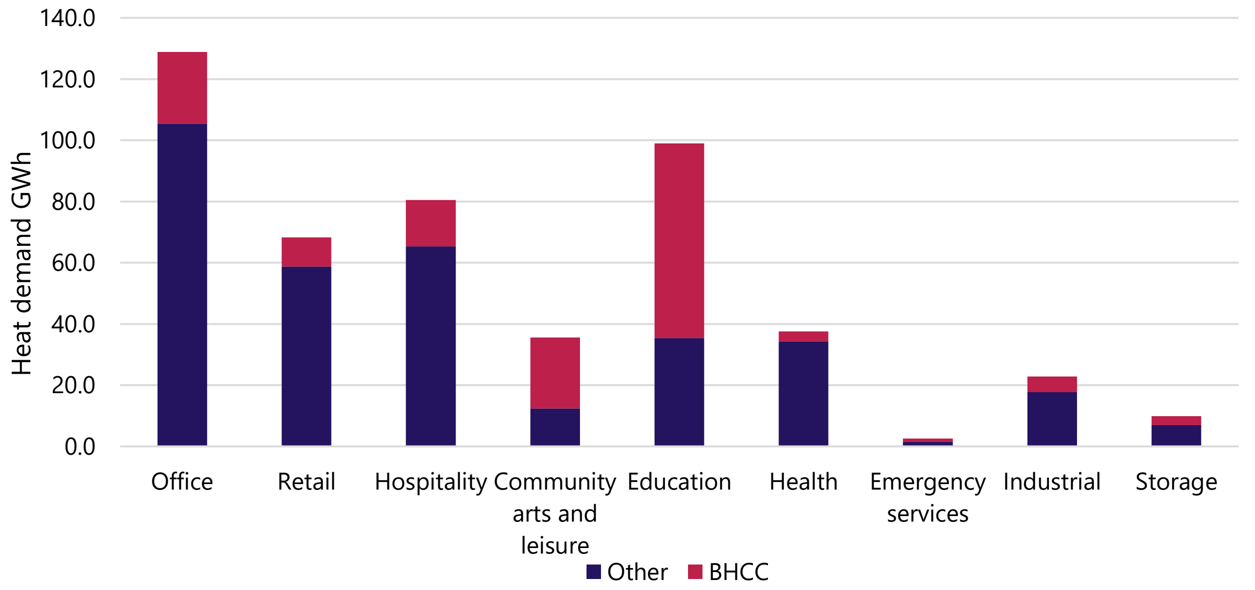


Figure 0—17 Annual heat demand in non-domestic properties by typology

Non-Domestic – Energy Efficiency Improvements

As, it was highlighted previously over 60% of non-domestic properties in Brighton & Hove have EPC D or below (32% EPC E-G and 28% EPC D) which confirms the great potential for energy efficiency improvement in non-domestic properties.

The non-domestic dataset does not provide any information about the properties' fabric condition. In order to estimate the potential energy saving from fabric improvement in non-domestic properties, the energy abatement potential was adopted from the BEES[60] which provides the potential energy efficiency improvement through building fabrics retrofit across different sectors/typologies. Similarly, for the cost analysis, the BEES assumptions regarding the capital costs associated with the efficiency improvements in different sectors were utilised and the cost data was adjusted for 2023.

Table 0—10 provides an insight into the potential energy reduction and cost of retrofit among non-domestic properties with EPC D and with EPC E-G.

Table 0—10 Overview of fabric improvement in all non-domestic properties with EPC D or below

	Number of properties	Current heat demand (GWh)	Energy saving (GWh)	Cost (m£)
Properties with EPC D	3260	109.5	12.5	39.2
Properties with EPC E-G	3610	116.9	12.5	37.7
Total (EPC D and below)	6870	226.4	25	76.9

Of the 1,890 properties on Council owned land, 1,095 of them have energy ratings D and below. Table 0—11 provide an insight into the potential energy reduction and cost of retrofit for these properties (although it is unknown which properties are under the Council control). These properties constitute around 17% of the total count of non-domestic properties in Brighton & Hove, yet they form circa 30% of the heat demand. This is linked to the presence of high-demand properties like schools, universities, and leisure centres on BHCC land.

Table 0—11 Overview of fabric improvement in non-domestic properties with EPC D or below on Council owned land

	Number of properties	Current heat demand (GWh)	Energy saving (GWh)	Cost (m£)
Properties with EPC D	691	28.8	3.3	10.2
Properties with EPC E-G	404	31.6	3.1	9.5
Total	1095	60.4	6.5	19.7

Figure 0—18 highlights the potential energy saving achievable through fabric improvement in properties with EPC D and below, by typologies, for the properties on the Council lands and for other non-domestic properties.

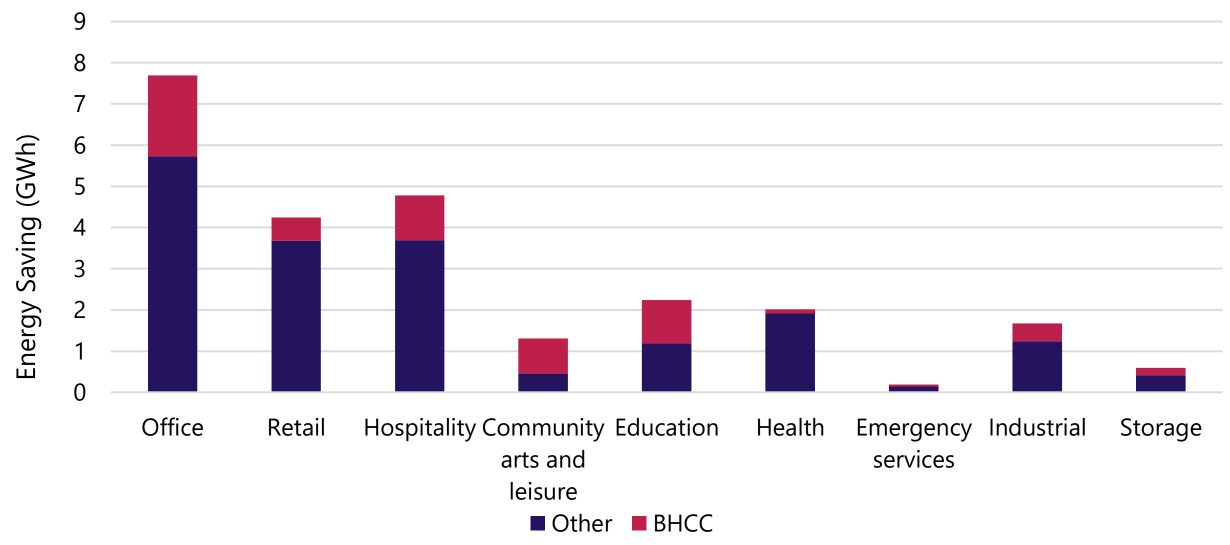


Figure 0—18 Energy saving in non-domestic properties with EPD D or below by typology

Table 0—12 indicates the potential energy saving that can be achieved through fabric retrofit in non-domestic properties with EPC D and below, categorised by typology/sector. It also provides the potential energy saving for the properties on Council owned land. The percentages represent the potential reduction in heat demand after retrofit. Among non-domestic properties on Council owned land, the offices, hospitality and industrial sectors as the sectors stands out as those that could benefit the most from fabric improvement.

Table 0—12 Potential energy saving through retrofit in different non-domestic sectors

	Potential Energy saving [(%)	
	All	**Council-owned**
Office	6.0%	8.4%
Retail	6.2%	6.0%
Hospitality	5.9%	7.2%
Community, arts and leisure	3.7%	3.7%
Education	2.1%	1.7%
Health	5.4%	2.9%
Emergency services	7.4%	4.4%
Industrial	7.3%	8.5%
Storage	6.0%	6.1%

Table 0—13 provides an insight into the estimated energy saving in non-domestic properties required in DFES scenarios (see section 0) adjusted to 2040, along with the estimated deployment cost.

The required energy efficiency improvement is very limited in "High Heat Network" scenario, this is mainly because, it is assumed that most of the non-domestic properties (particularly the ones with annual demand above 100MWh) will be connected to the heat network. Therefore, the energy efficiency improvement is less vital in this scenario. While in both "Consumer Transformation" and "Leading the Way", energy efficiency improvement plays an important role and more drastic approach regarding fabric improvement is required.

Table 0—13 Overview of fabric improvement measures in non-domestic properties in different scenarios by 2040

	Energy savings (GWh/year)	Energy saving %	Cost (£ millions)
Falling Short	7.7	1.6%	23.7
High Heat Networks	7.2	1.5%	22.2
Consumer Transformation	40.4	8.3%	124.3
Leading the Way	41.7	8.6%	128.5

Non-Domestic – Delivery scale review of energy efficiency improvements

In order to identify priority areas for early energy efficiency improvement in non-domestic properties:

- LSOA level carbon emissions in non-domestic properties, emphasizing areas with the highest emissions. Improving energy efficiency and electrifying heating systems are crucial factors for reducing carbon emissions in these regions (See Figure 0—19).
- LSOA level count of properties with EPC E-G and below that requires fabric improvements (focusing on the energy ratings E-G for identifying priority areas aligns with the minimum energy efficiency standard (MEES[61]) that non-domestic property landlords need to meet.)
- 100m x 100m grid level count of properties with EPC E-G requiring fabric improvement. The grid level map provides finer resolution (see Figure 0—20)
- 100m x 100m grid level map of energy saving potential through fabric improvement in properties with EPC E-G (see Figure 0—21)
- Council ownership to identify early opportunities which will help project progression
- Similarity in typology

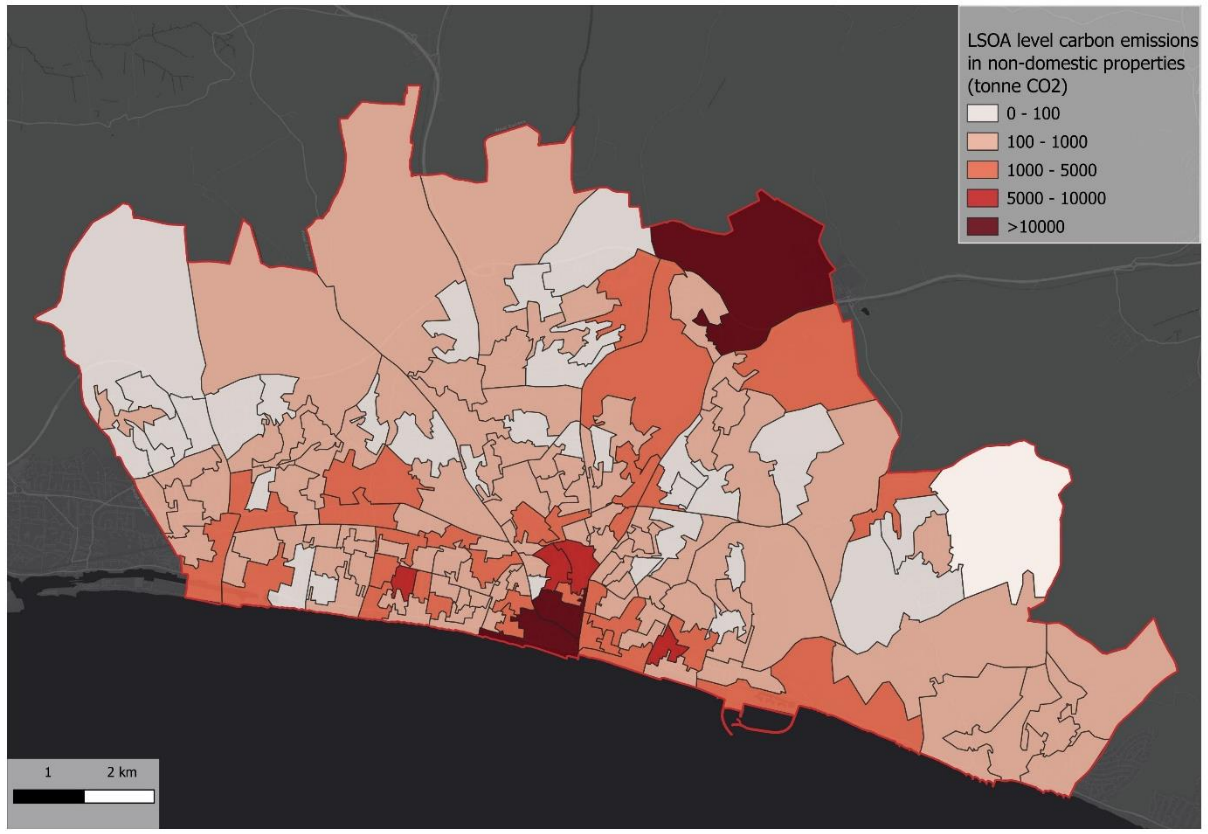


Figure 0—19 LSOA level carbon emissions in non-domestic properties (tonne CO_2)

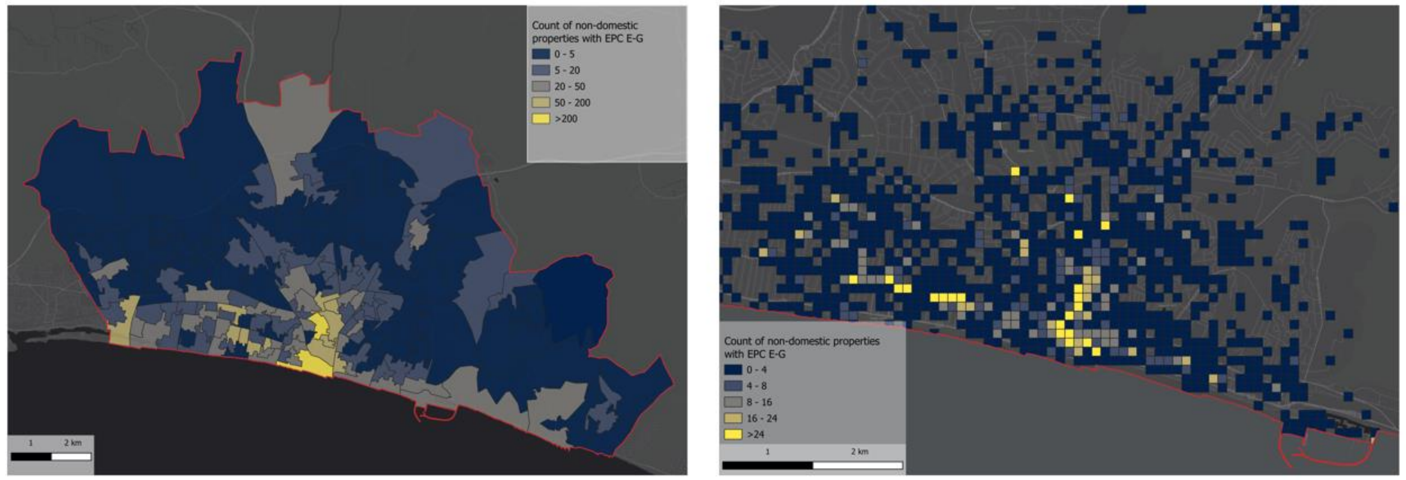


Figure 0—20 LSOA level count of non-domestic properties with E-G energy ratings (left) and zoomed in 100m grid level count of non-domestic properties with E-G energy ratings (right)

[61] https://www.gov.uk/guidance/non-domestic-private-rented-property-minimum-energy-efficiency-standard-landlord-guidance

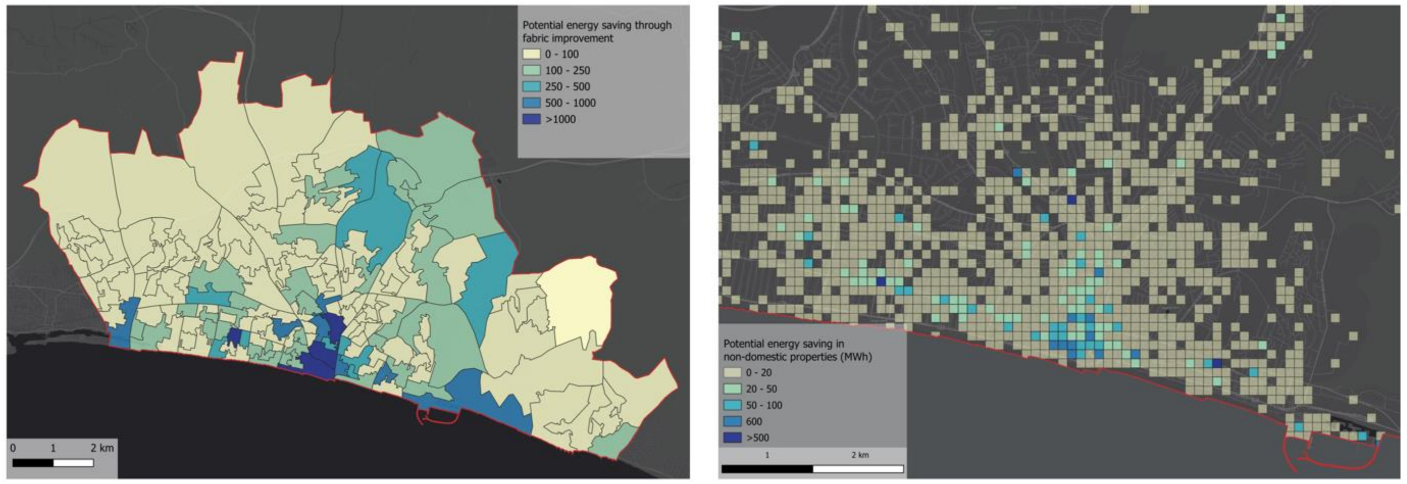


Figure 0—21 LSOA level potential energy savings through fabric improvement in non-domestic properties with E-G energy ratings (left) and 100m grid level potential energy saving through fabric improvement in non-domestic properties with E-G energy ratings (right)

A number of factors have been considered in identifying the prioritised areas, including the grid-level count of properties with E-G EPC ratings and the potential energy saving that can be achieved through retrofit, the Council ownership or having similar ownership. The priority areas for non-domestic fabric improvement are listed in Table 0—14 and highlighted in Figure 0—22.

It is worth noting that some of the buildings like King Alfred Leisure Centre and Brighton Centre are not included in the suggested priority areas. This is due to plan for major redevelopment and the potential replacement of King Alfred Leisure centre. Additionally, the Council has a major regeneration plan for the replacement of the Brighton Centre and its Cinema complex a new waterfront project[45].

Table 0—14 Potential priority areas for non-domestic fabric retrofit projects

No	Description
1	There is a potential for fabric improvements in **Hove Town Hall and the Police Station** at Norton Rd. Additionally, a large number of **offices with EPC E-G around Church Rd**. These properties present an opportunity for energy efficiency improvement, with the potential to achieve annual energy savings of 1GWh.
2	The area around **Preston Road** hosts several office blocks, the majority of which have Energy Performance Certificates (EPCs) ranging from E to G. These buildings present an opportunity for energy efficiency improvement.
3	**New England House** retrofit which is owned and run by the council through managing agents. It houses circa100 small to medium enterprises.
4	Energy efficiency improvement in circa 450 non-domestic properties with EPC E-G in **Brighton city centre** area mainly consists of retails and offices. There is a potential annual energy saving of around 1.6GWh. The area is position within the **Brilliant Brighton Business Improvement District** (BID).
5	There is a potential for Energy efficiency improvement in the **Brighton Museum & Art Gallery**. It is worth noting that this is a Grade II listed building and there is a need for a holistic approach considering the building heritage and usage along with potential energy saving measures.
6	The properties around **Western Rd**. have significant potential for fabric improvement, with over 60% of them having E-G energy ratings. This area hosts a large number of offices, retails, restaurants, and cafes. Through easy retrofit measures, there is a potential to achieve approximately 0.5 GWh in annual energy savings.
7	Energy efficiency improvement in **Royal Sussex County Hospital** with a number of low energy performance buildings. The hospital has an ambition plan to achieve net zero by 2040 through reducing their energy consumption, installing low-carbon technologies, and implementing renewables on-site[62].
8	Energy efficiency improvements in **St. Marks Church of England Primary School** with EPC E.
9	Potential fabric improvement in **University of Brighton** buildings. The University also has a great ambition to lower its carbon emission through improvements to building fabric and energy efficiency along with on-site renewable generation[63].

[62] https://www.sussex.ics.nhs.uk/wp-content/uploads/sites/9/2022/12/PCBC-Appendix-7.-UHSussex-Green-Plan.pdf

[63] https://www.brighton.ac.uk/about-us/your-university/sustainability/what-we-do/index.aspx

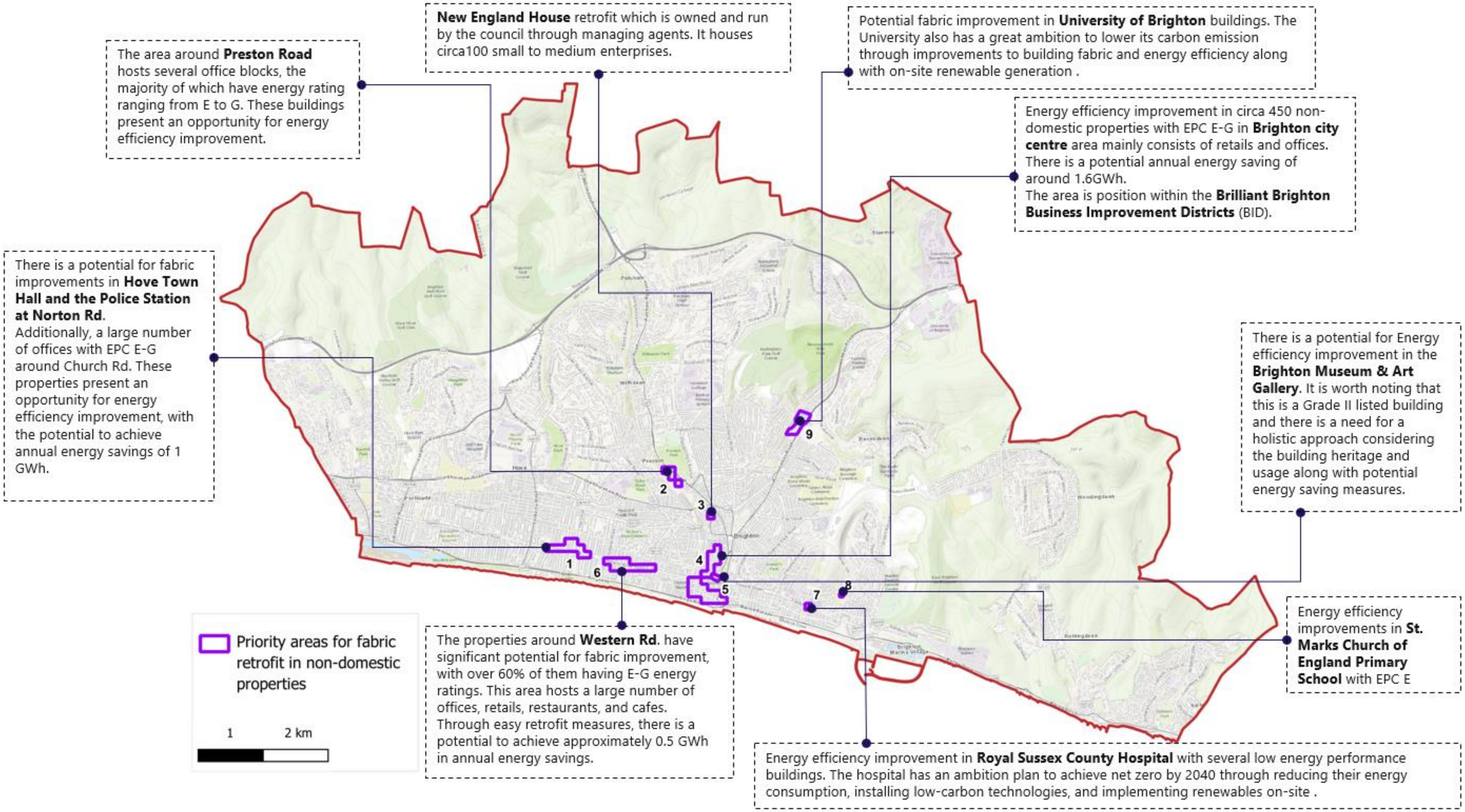


Figure 0—22 Priority areas for fabric improvement in non-domestic properties

Heating systems

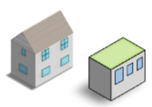
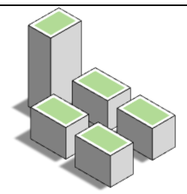
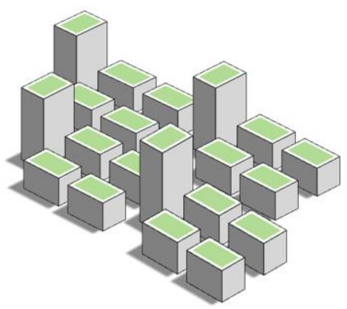
Introduction

This section focuses on a review of the heating delivery options for the properties across Brighton & Hove. Depending on a number of factors including the density of heat demand and the building typology a variety of heating system solutions are available to Brighton & Hove. This section aims to identify the most likely solution in each location for decarbonised heat supply to the buildings.

Heating typologies

In many ways, the largest and most challenging aspect of the current energy system in Brighton & Hove to transition is the way in which buildings are heated. Four different scales of heating system solutions are considered, these are summarised in Table 0—1. Understanding these different solutions helps to give context to the current heating systems in place.

Table 0—1 Summary of different heating systems considered.

Heating system solution	Building(s) type	Usual context for deployment
Single heat pump		Generally, for buildings containing just one or a few small properties, and with relatively small heat demand (for example, a house or standalone commercial property). Demand will be under 100 MWh/yr, otherwise communal or heat network is considered.
Communal system (generally from one centralised solution – such as a heat pump)		Building that contains multiple properties (for example, flats). Larger buildings with communal systems will often be identified for connection into a wider heat network. In some datasets these can be hard to distinguish from small-scale heat networks.
Small-scale heat networks		These heat networks are relatively small connecting a few geographically close buildings, for example a block or terraced houses on a shared ground loop system. Heat networks are grouped in this analysis, but it is important to note scale can vary.
District heat network		Generally, areas with high heat density and/or proximity to waste heat sources and/or areas with growing number of planned new development are suitable for heat network. For listed buildings, planning permission for heat pump installations could be challenging, making heat network more suitable option. Buildings over 100MWh/yr will potentially be mandated to connect (unless demonstrated unviable) if within a heat network zone under current plans in the Department of Energy Security and Net Zero.

Heat networks will not be differentiated between large and small when reporting but the distinction is made as in previous pathways analysis Buro Happold have found it important to emphasise that not all heat networks will be very large in scale.

Current domestic heating systems

There are 136,634 domestic properties in Brighton & Hove with an annual heat demand of circa 1200 GWh. Natural gas supplies approximately 86% of that, accounting for the heat supplied through the main gas network and a minimal fraction through gas-supplied heat network/communal heating system. Electricity supplies around 14% of the annual domestic heat demand, mainly through storage and direct electric. 0.2% of heat demand is still supplied by oil and solid fuel. Figure 0—1 provides the breakdown of heat demand by the heat source.

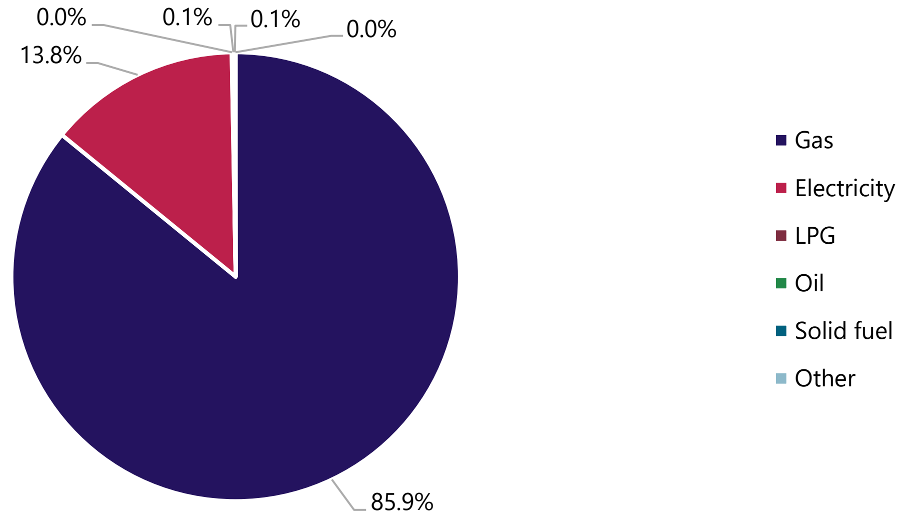


Figure 0—1 Share of domestic heat demand by heat source

The primary heating system for 84% of domestic properties is individual gas boilers, followed by 14% with direct electric or electric storage heating systems. Only 0.7% of properties are connected to gas-based heat networks and a minority are currently heated with lower carbon heat pump led systems (~0.3%). There are still few properties heated by oil and solid fuels (~0.1%, around 300 properties). This split of heating systems is provided in Figure 0—2.

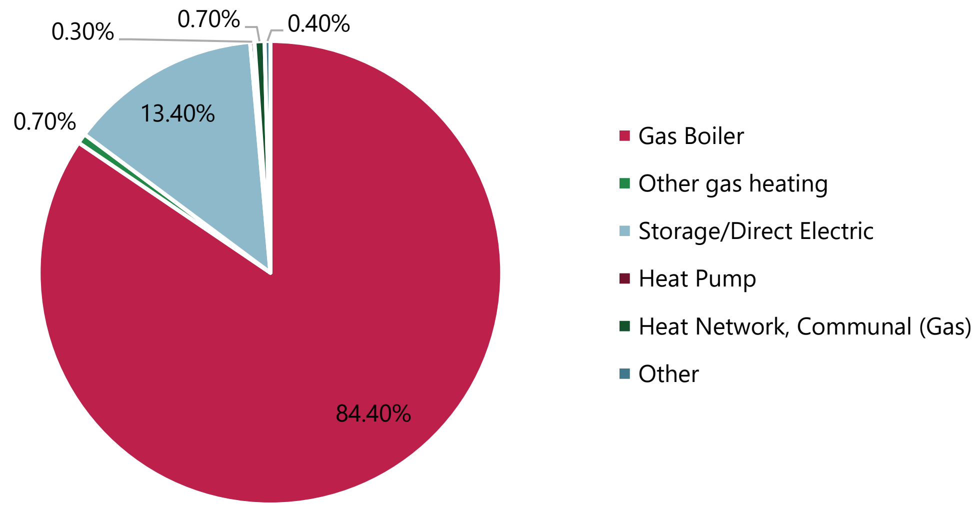


Figure 0—2 Heating systems in domestic properties

In terms of heating systems per typology, Figure 0—3 shows that storage and direct electric systems are mainly deployed in flats, making them the most electrified building typology. Approximately 23% of flats are electrically heated either via storage and direct electric systems or heat pumps. Heat networks and communal systems are also supplying only flats. Detached houses are the most fossil-based building typology. The 'Other' category includes different types of solid fuels: wood logs, bulk wood pellets, smokeless/house coal and dual fuel consisting of mineral and wood.

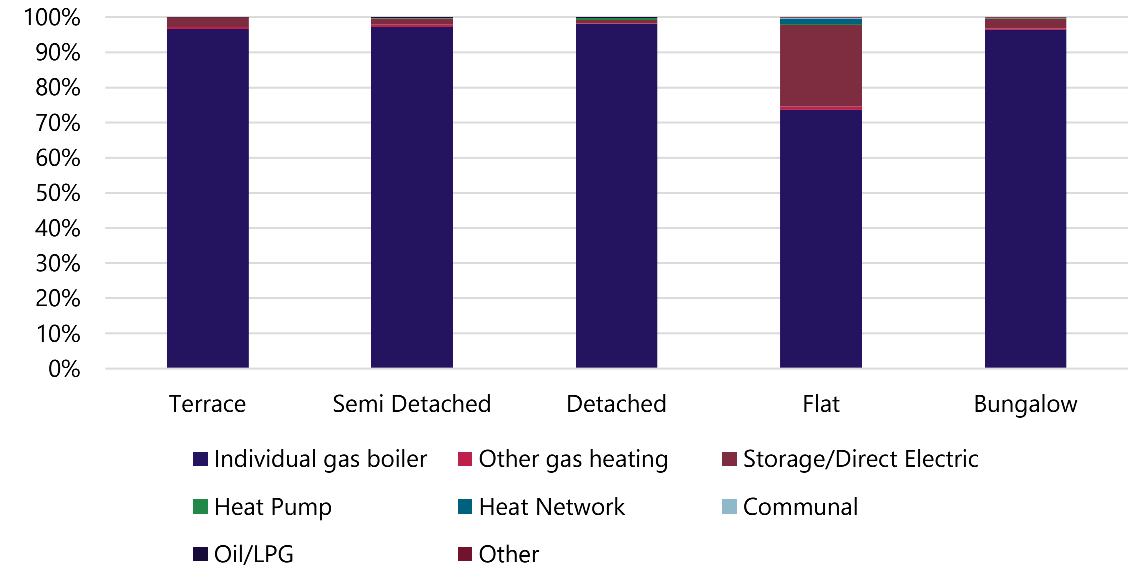


Figure 0—3 Domestic heating system by typology

The total annual gas consumption in domestic properties is circa 1290 GWh; Figure 0—4 shows the gas consumption in domestic properties at LSOA level. The highest overall domestic consumption is in the central northern and southeast areas, strongly aligning to those areas with the lowest levels of deprivation.

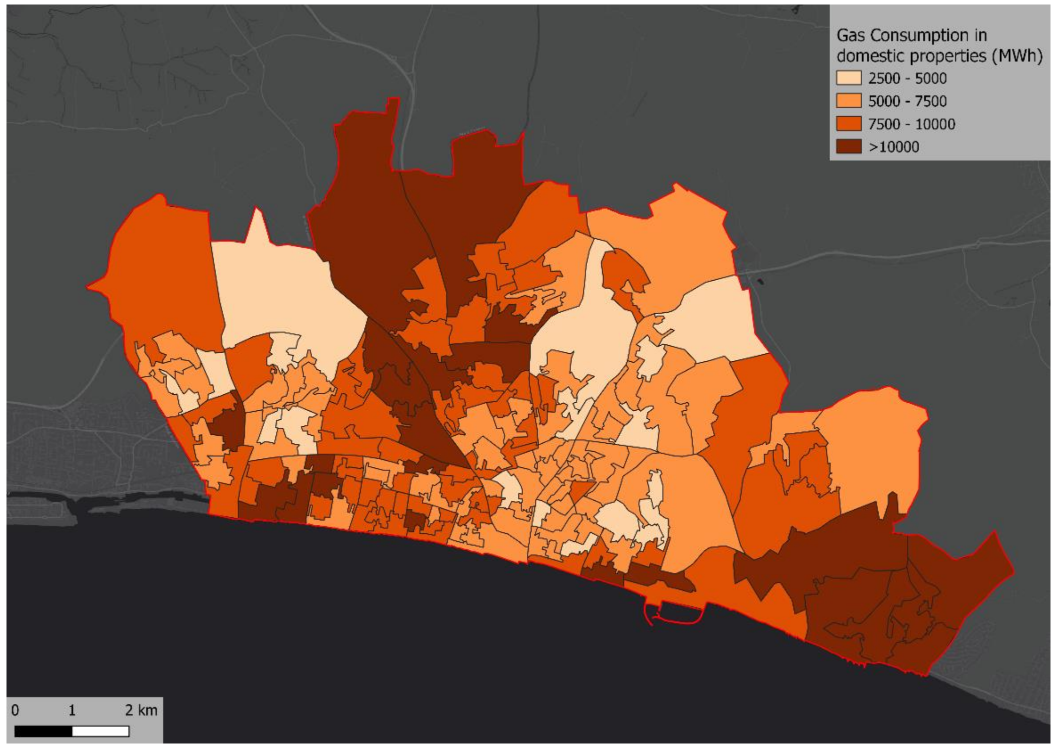


Figure 0—4 Gas consumption in domestic properties by LSOA in Brighton & Hove

The total annual electricity consumption in domestic properties is circa 422 GWh; Figure 0—5 shows the electricity consumption in domestic properties at LSOA level. The highest overall domestic consumption is in the city centre as well as in the Falmer area in the northeast.

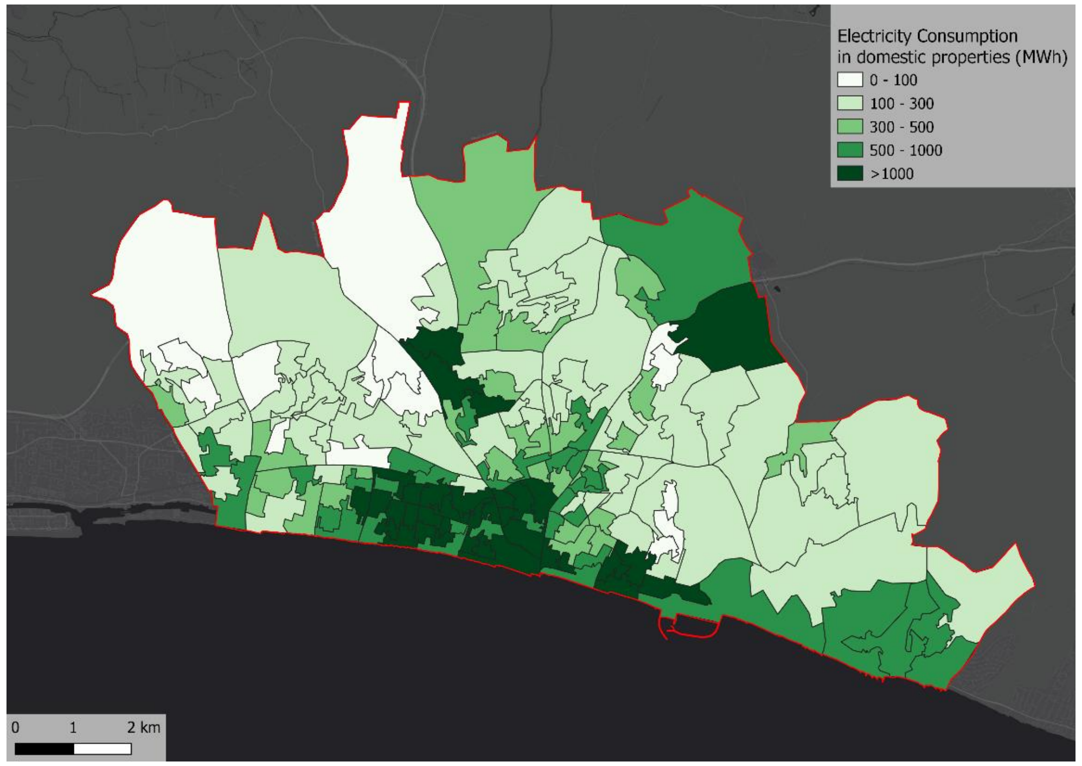


Figure 0—5 Electricity consumption in domestic properties by LSOA in Brighton & Hove

Non-domestic heating systems

There are 11,267 non-domestic properties in Brighton & Hove, ~53% of them primarily use electricity for their heating, while approximately 35% use gas for heating, as shown in Figure 0—6. These gas heated properties are a priority for heating decarbonisation.

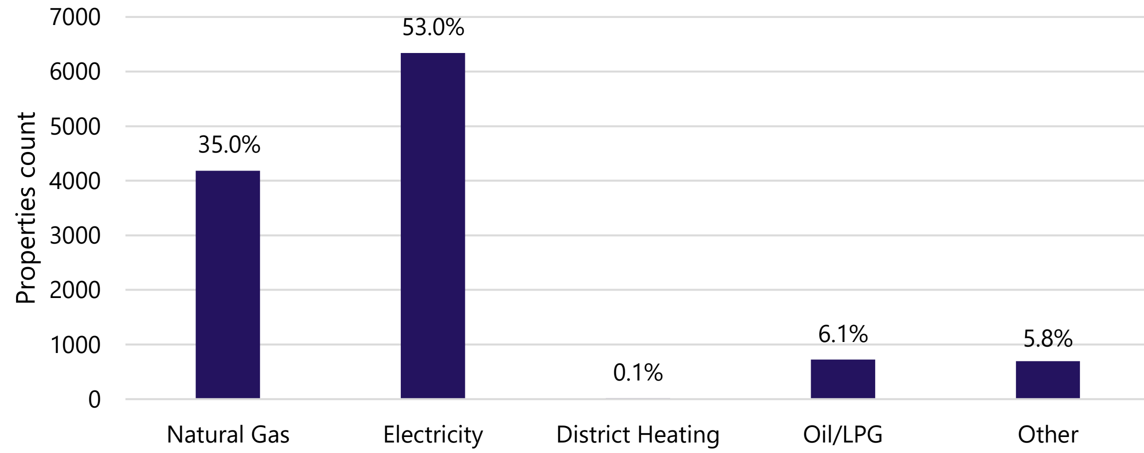


Figure 0—6 Count of non-domestic properties by primary heating system

Although this is the minority in terms of heating system count, when considering the actual heat demand gas-supplied heating system contributes to around 60% of total non-domestic heat demand of 493 GWh/yr in Brighton & Hove (see

Figure 0—7), this rises to 68% when district heating is included – which is dominated by gas as the primary fuel. This is in a large part due to larger buildings like schools and hospitals usually being heated by gas.

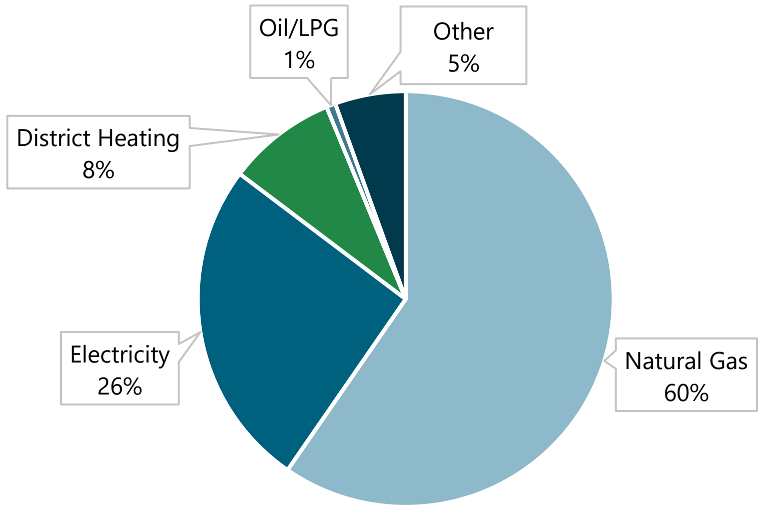


Figure 0—7 Share of heat demand by heat source in non-domestic properties

The heat network at Sussex University also currently uses gas as the heating fuel (although alternatives are being explored). This makes up the vast majority of the district heating element of Figure 0—7. This is significant as UK Government data[64] indicates that the heat network at Sussex University is the single largest source of carbon emissions in Brighton & Hove.

Figure 0—8 provides the breakdown of heat demand by the heat sources and by typologies in Brighton & Hove. Overall being very diversified, offices consume the biggest fraction at 16% followed by retail at 15% and restaurants/cafes at 14%. The 'Other' typology includes workshops, storage facilities and terminals.

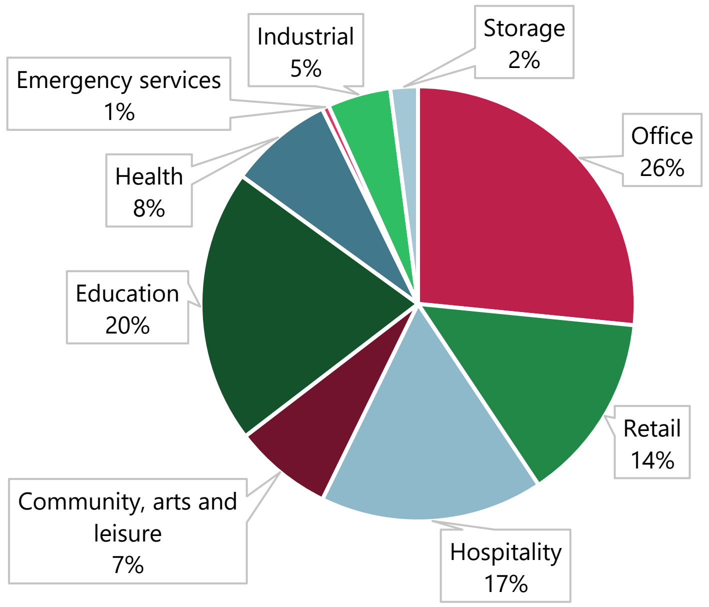


Figure 0—8 Heat demand share by non-domestic typologies

The total annual gas and electricity consumptions in non-domestic properties are 412 GWh and 425 GWh respectively. It is worth noting that 30% of the electricity usage is for heating and the remaining is for other electrical usage including ventilation, lighting, small power. Figure 0—9 and Figure 0—10 present the gas and electricity consumptions in non-domestic properties at LSOA level.

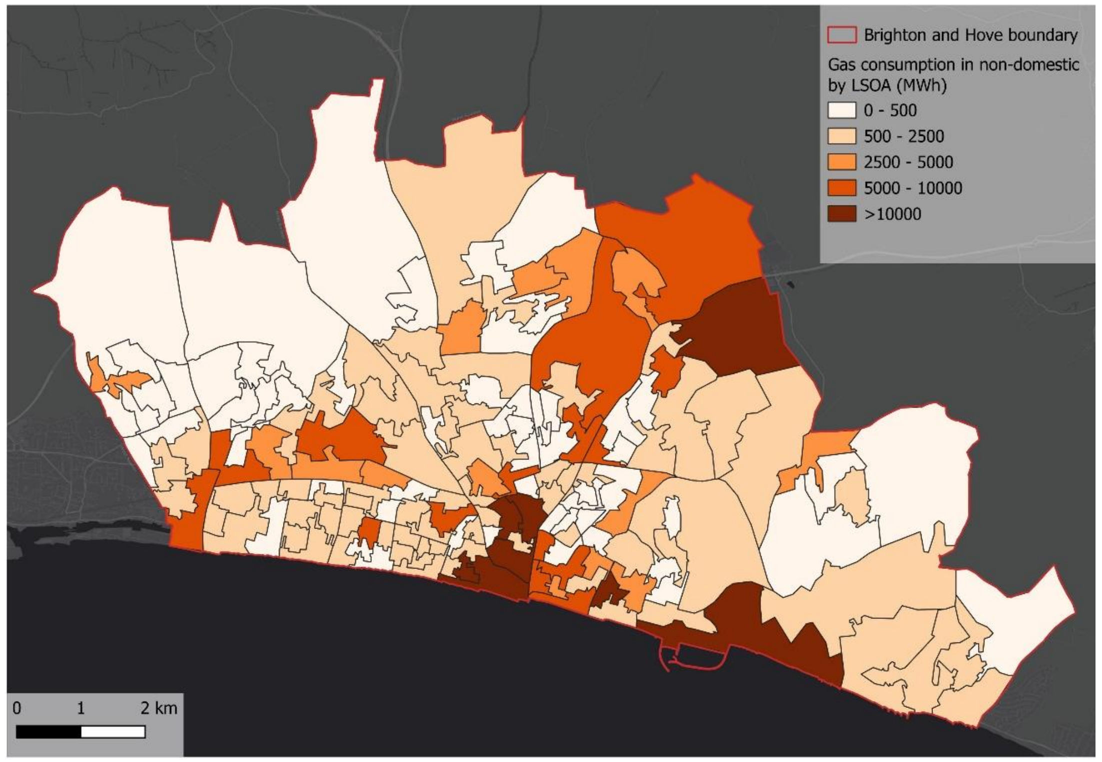


Figure 0—9 Gas consumption in non-domestic properties by LSOA in Brighton & Hove

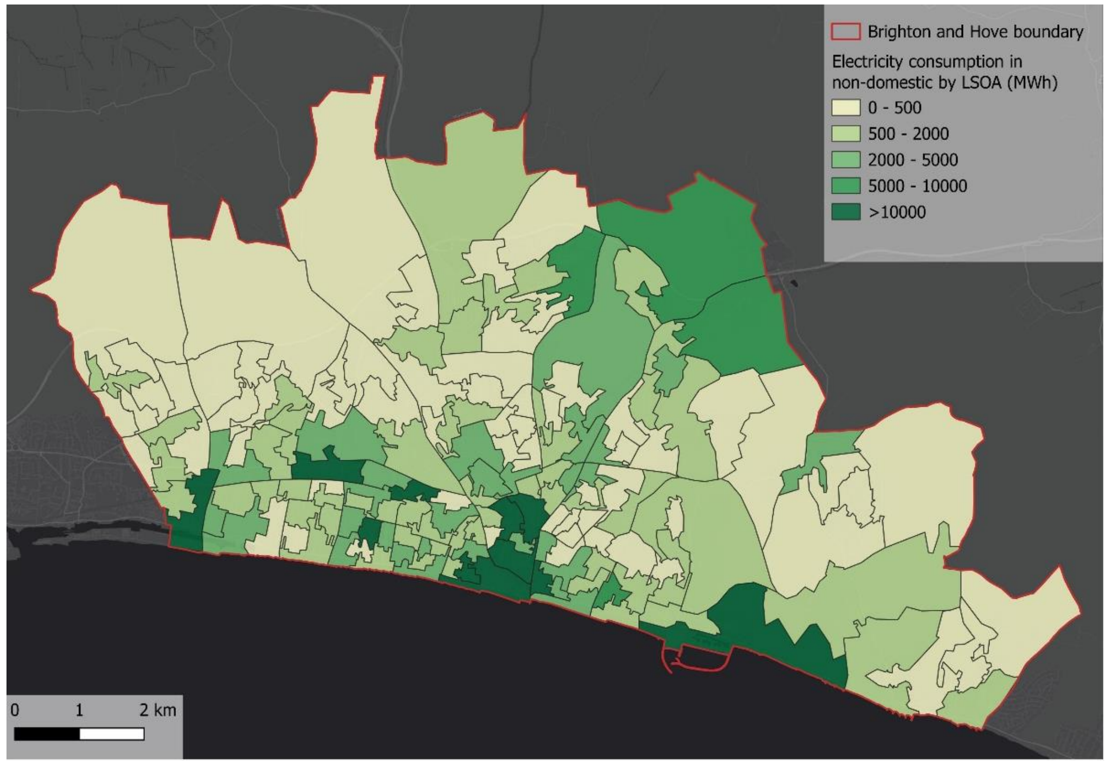


Figure 0—10 Electricity consumption in non-domestic properties by LSOA in Brighton & Hove

[64] https://naei.beis.gov.uk/data/map-large-source

Heat networks

Heat Network Zoning, and the associated workstream of the Advanced Zoning Programme, is developing into the main policy lever for heat network deployment in England. The final details are yet to be finalised with consultation closing in February 2024[65]. The approach uses a detailed national model for heat network opportunity identification. The identified zones go through a local review with a local zoning coordinator being responsible for helping the project progress through various stages. DESNZ were able to share some initial outputs for Brighton & Hove which aligned with the findings of this analysis, presented later, for the major zones identified. In zones which go through various feasibility steps public sector demands and non-domestic heat demands of over 100 MWh/yr are currently planned to be mandated to connect to the heat network.

This section explores heat network opportunities and also considers communal systems, which are similar in that they are based on the connection of multiple properties to one centralised heat source.

Existing communal systems and heat networks

Communal heating systems and heat networks are not common across Brighton & Hove. As mentioned in Section 0, only 1% buildings are supplied by communal heating systems (1,279 flats), largely gas-based and few running electricity and still on oil/LPG. Of those, BHCC owns 7 buildings with 200 flats in total. BHCC also owns 33 communal gas boilers. The location of these systems is illustrated in Figure 0—11.

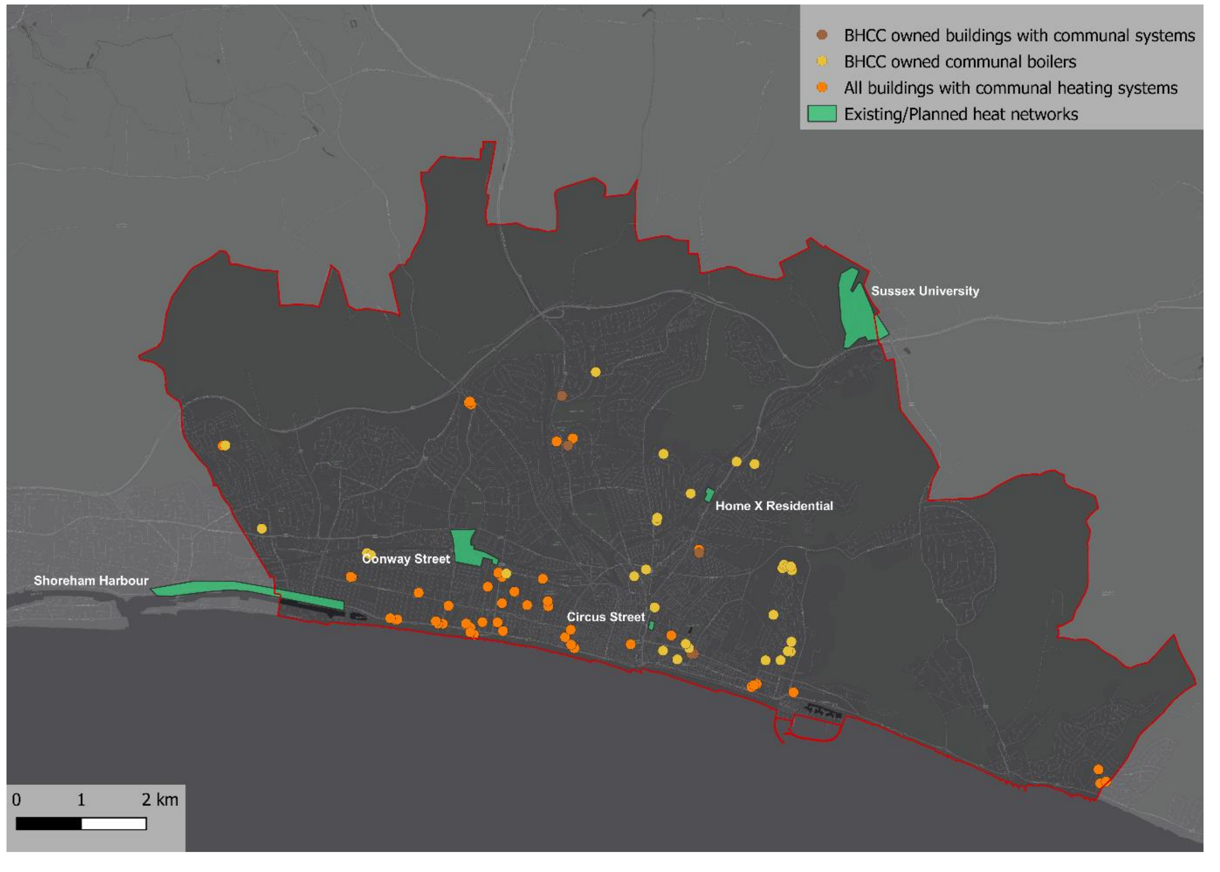


Figure 0—11 Location of communal heating systems and heat existing or planned heat networks in Brighton & Hove

In terms of existing heat networks, the University of Sussex has been supplied with a heat network since the 1960s. It has been upgraded and extended since then and is currently based on gas boilers and CHP. The University is currently looking at decarbonising their heat sources in line with their net zero targets by 2035. The Circus Street heat network, based on CHP and gas boilers, is supplying heat to student accommodations and residential properties and part of regeneration project to innovate the area. The Home X Residential Community heat network has been completed in 2023 and supplies heat to 369 residential homes. In terms of opportunities areas for future heat networks, both the Shoreham Harbour and The Conway Street have been highlighted in plans and feasibility studies. The locations for all the above-mentioned networks are illustrated in Figure 0—11.

Potential heat network zones

An initial analysis of heat network opportunity areas for Brighton & Hove was carried out based on the linear heat density. The linear heat density is a measure of heat load per meter of district heating pipework, and a useful approximation of identifying areas where a district heating network might be viable. Usually, linear heat densities[66] between 4 MWh/m/yr and 8 MWh/m/yr should be considered for a district heating network. Figure 0—12 shows the results for Brighton & Hove, together with the heat network opportunity area that were chosen starting with the linear heat density. In this analysis, only buildings with heat demands >100MWh/yr were considered for defining zones, as these larger demands drive the commercial nature of heat networks. Smaller demands within identified heat network zones were, however, considered for connection.

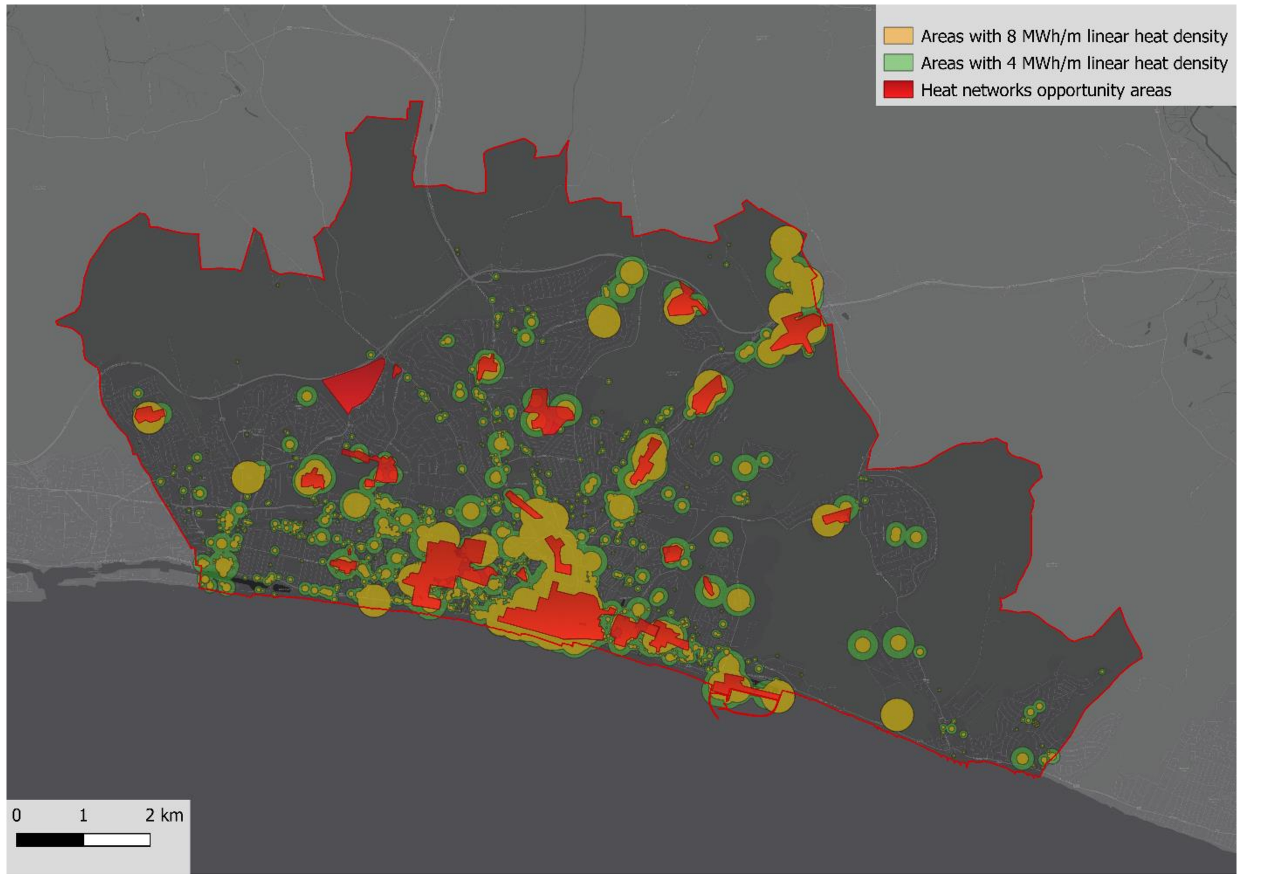


Figure 0—12 Linear heat density analysis and heat networks opportunity areas in Brighton & Hove

The heat networks opportunity areas were identified based on a combination of the following indicators:

- Linear heat density of the potential heat network areas
- Planned new developments: heat networks are easiest to be deployed in a new residential or mixed development which would need to comply with the most recent regulation (BREEAM standards, prioritisation of district heating with respect to individual heating system)

[65] https://www.gov.uk/government/consultations/proposals-for-heat-network-zoning-2023

[66] Linear heat density refers to the heat demand per meter of pipe, the higher the linear heat density the generally more economic the heat network.

- Existing communal heating systems: existing buildings are easiest to connect to a heat network if they already have a communal system in place, requiring only the removal of the communal gas boiler and the addition of a PHE in the existing plant room
- Building tenure: publicly owned buildings are the priority as BHCC has direct control over, or can influence more efficiently (for example, schools, universities, hospitals)

There were no large heat sources immediately apparent in the city near heat networks. This means some form of heat pump is likely to be the chosen technology. Marine source heat pumps are one potential opportunity for Brighton & Hove (and have been explored in Shoreham Port previously) as are ground source heat pumps, which could take advantage of aquifers in the area. The sewage network could also be explored as a potential source of heat, this would require working closely with Southern Water. However, large scale air source heat pumps are likely to be the most common solution.

Anchor loads (>500 MWh/yr) are prioritised for selecting potential zones, as these tend to be the most financially viable. A summary of the key heat network priority areas is provided below and illustrated in Figure 5-13.

- **1 Woodingdean** heat network would target anchor loads such as the Nuffield Health Brighton Hospital, Downsview School and Woodingdean Primary School but supplying also care homes and community centres.
- **2 Whitehawk** is the Whitehawk City Academy which could be connected with Whitehawk Community Hub and other blocks of flat to also create a small-scale heat network.
- **3 The Brighton General Hospital area** presents an opportunity consisting of the hospital itself and other buildings providing health services (for example, nursery, children's disability centre)
- **4 Falmer** presents the opportunity to connect the American Express Stadium and various buildings of the University of Brighton Falmer campus. It could also be seen as an extension area of the existing Sussex University district heat network.
- **5 Coldean** opportunity would connect Varley Park Halls university residences with the new residential development in Denman Place (this is a 2024 development, with 127 council homes) and Coldean Primary School.
- **6 Moulsecoomb north** opportunity sees a commercial area connecting Student Roost student accommodation and Moulsecoomb Primary School in the southern part.
- **7 Moulsecoomb south** is an area which already has a heat network supplying the newly built Home X residential community. The further opportunity would be to extend the network to the University of Brighton buildings which are just north of the development.
- **8 The Brighton Marina** opportunity consists of connecting several commercial buildings in the west area with the residential complex in the east area.
- **9-10 Kemptown** area is located just east of the city centre. The main opportunity is area 10 which comprises all the buildings of the Royal Sussex County Hospital, one of the biggest hospitals in Brighton & Hove providing anchor loads. Area 11 is proposed as an opportunity of an extension from area 10, connecting mainly Brighton College and few properties with communal heating which are also owned by the council.
- **11 City Centre** is the area with the highest linear heat density in Brighton & Hove so highlighted as an opportunity. It is acknowledged that it would be challenging given the location, the density of buildings and other utilities. This area includes the Prince Regent Swimming Complex, Royal Pavilion, Churchill Square Shopping Centre, the Brighton Centre, hotels, and several commercial properties.
- **12 Brighton Station** heat network would connect mainly high office buildings east of the station with some high residential blocks in the north (recently built).
- **13 Clifton Hill** is a small area suitable for a small scale heat network. It would connect multiple 3-4 storey residential blocks.
- **14 Central Hove** is the largest opportunity area. The heat network would connect public buildings such as the Town Hall and Hove Court, as well as high-rise residential blocks and offices with existing communal heating systems, care homes and St Christopher's Prep School.
- **15 Hove west** opportunity identifies a small-scale heat network connecting St Christopher's Prep School with the Day Nursery and other residential blocks in the area.
- **16 Rutland Gardens care homes** opportunity identifies a small-scale heat network with 3 high-demand care homes in the area.
- **17 Portslade Aldrige Community Academy** opportunity identifies the buildings as potential connections (sports centre included) and other education activities in the area.
- **18 Millview Hospital** identified heat network would connect the Mill View Hospital, Goldstone Primary schools, and care homes.
- **19 Greyhound Stadium** opportunity area focuses on connecting a leisure centre consisting of the stadium, some office buildings and Aldrington Primary School as well as Blatchington Mill School.
- **20 Prestonville** opportunity consists of a small-scale heat network connecting a high-rise office and a recently built residential building.
- **21 Varndean** is highlighted as an opportunity area despite the low density of loads, as the greenspace could be used potentially for GSHP and supplying colleges and schools that are on the park.
- **22 Patcham** is an area with a high density of care homes and health services, so the heat network would connect them with some 8-storey residential blocks on the south side facing the park.
- **23 Woodland Court** is a small opportunity west of Patcham connecting four residential blocks (4 stories each).
- **24 Toad's Hole Valley** is a privately owned 42-hectare site in north Hove. The original planning application made in November 2018 (re-submitted in 2023) would deliver more than 880 new homes, including 40% affordable housing. As well as new homes, the proposal included plans for: community and sports facilities, offices and light industry, retail space, a community centre and doctors' surgery. There is opportunity for a heat network to supply the whole new development.

In general, the majority of the opportunities identified in Brighton & Hove consist of small-scale heat networks. In terms of **small-scale priority projects**, Woodingdean (area 1) is the first area identified as such. It's a relatively small area with significant loads and with a high number of public buildings that the council would have more leverage on.

More detailed feasibilities studies are needed to determine whether the technically feasibility of small-scale heat networks. For example, an opportunity to connect five council-owned residential buildings with existing, independent communal heating systems was identified in Whitehawk; however, due to technical challenges, the council is exploring other decarbonisation options for this site.

Three sports and leisure facilities (Portslade Leisure Centre, the Prince Regent Swimming Complex, and Moulsecoomb Community Leisure Centre) are located in potential heat network zones, as well as Surrenden Pool at Dorothy Stringer School (included in zone 22) and a pool at Downsview School (included in zone 1). Leisure energy reports commissioned and completed in February 2023 identified several measures to improve the efficiency of these facilities, and others located outside potential heat network zones. In 2023/24 the government's Swimming Pool Support Fund (SPSF) provided a total of £80 million to local authorities in England to support the leisure sector to transition to a position of environmental and financial sustainability and minimise the closure of swimming pool provision. More such funding and support is needed to ensure the city's sports and leisure facilities are heat-pump and heat-network ready.

In terms of **large-scale priority projects**, Brighton City Centre (area 12) together with Kemp Town (area 10-11) should be prioritised as the one with the highest density of loads, which makes the largest area with 8 MWh/m linear heat density. The main support mechanisms for progression of these heat network opportunities are the ongoing Heat Network Zoning framework, the Heat Networks Delivery Unit and for more developed projects the Green Heat Network Fund[67].

[67] https://www.gov.uk/guidance/heat-networks-delivery-unit and https://www.gov.uk/government/publications/green-heat-network-fund-ghnf

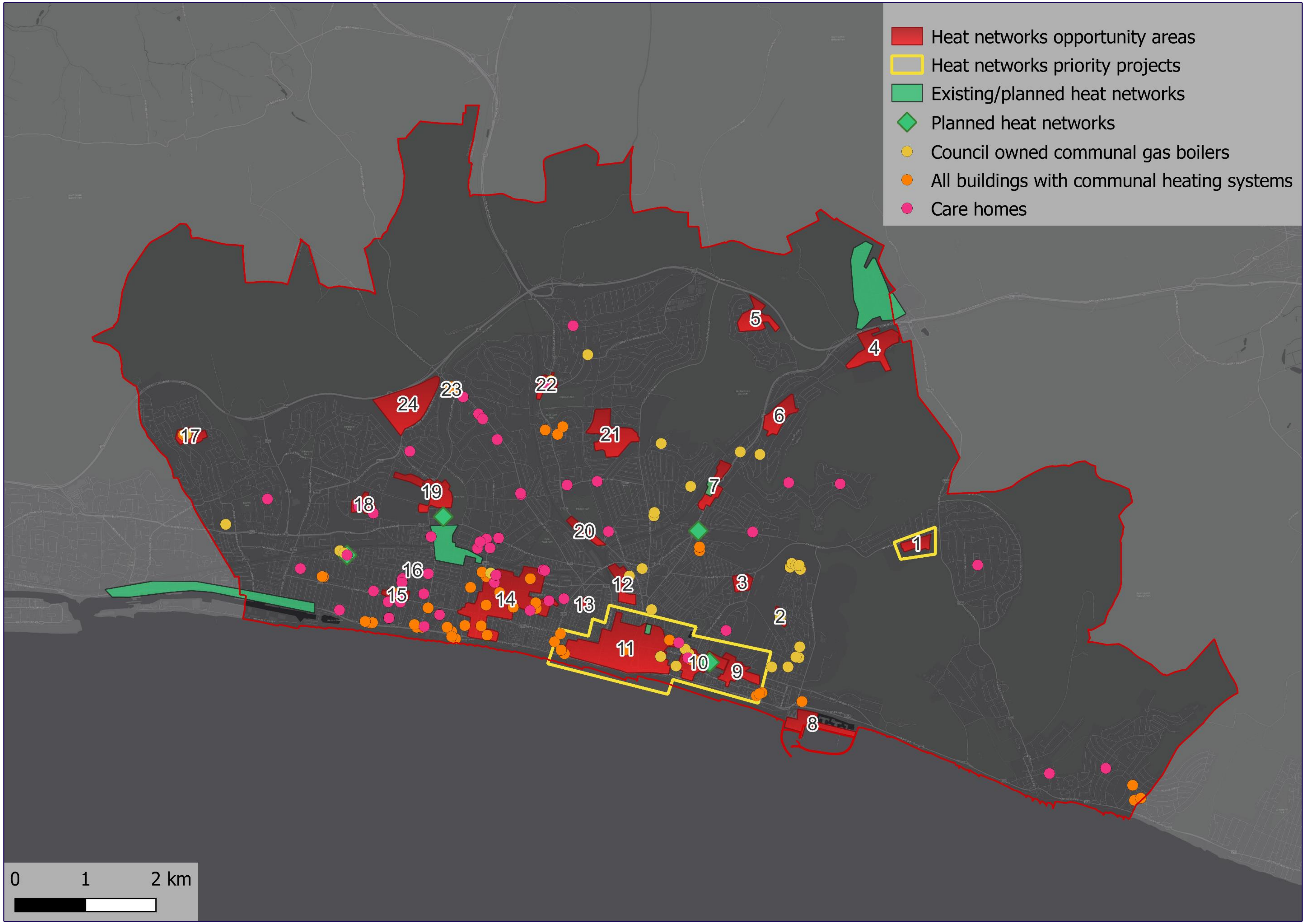


Figure 0—13 Heat network opportunities identified in Brighton & Hove

Communal systems

Alongside heat networks communal systems were also appraised. These are based on buildings which contain multiple properties that fall outside of heat network zones. Whilst it is possible to mount heat pumps on the walls of individual properties within a wider building, this can be challenging – particularly in conservation areas. Flats, in particular, are a strong focus for communal systems in Brighton & Hove. Focus areas for communal systems are identified in Figure 0—14.

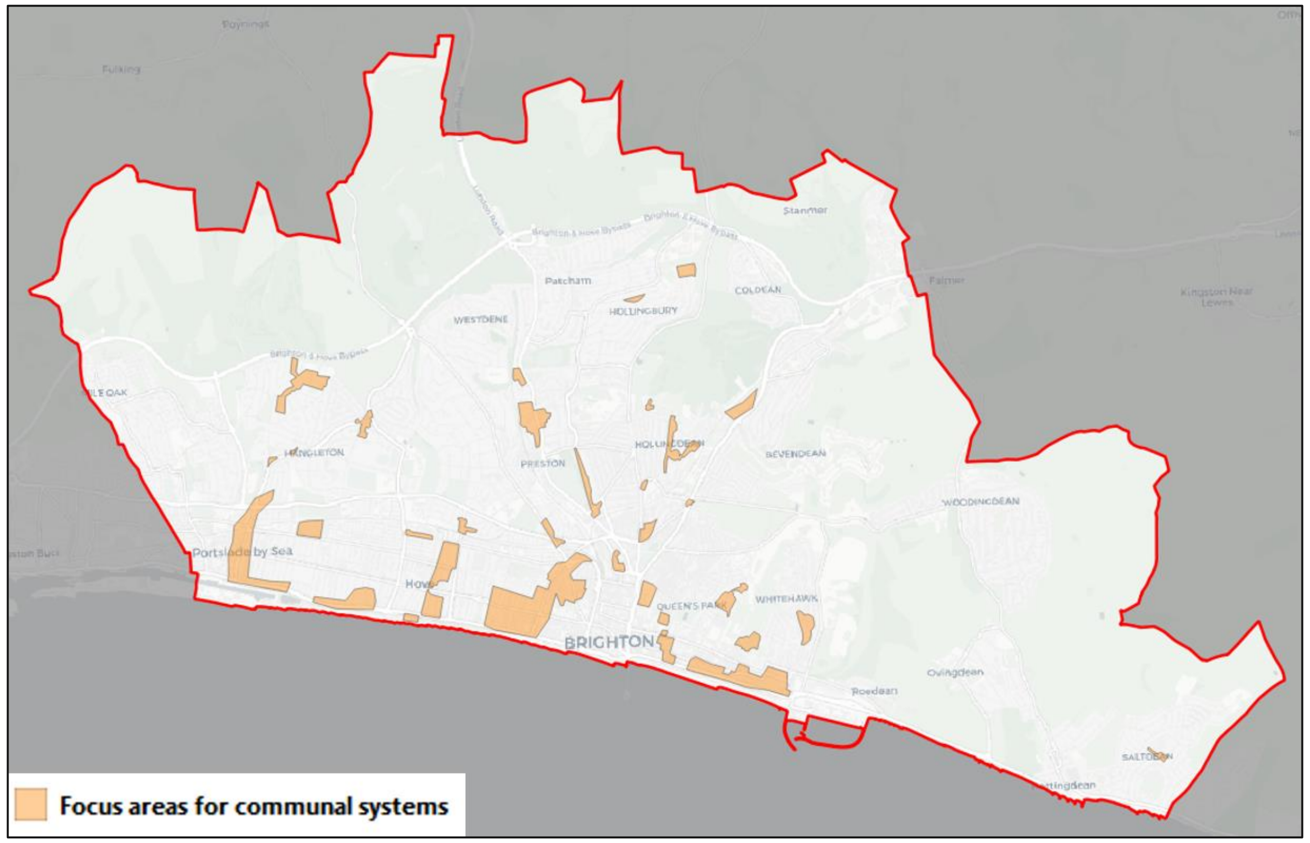


Figure 0—14 Focus areas for communal systems

These communal systems are often marginal as to whether they will be part of wider heat networks or remain at a block level. Selecting a communal option is a relatively low regrets decision as connecting a communal system is a far simpler process than many individual properties.

Summary of communal systems and heat networks

At this level of analysis, the differentiation of communal systems and heat networks can be misleading. In total ~44,000 additional properties are connected to heat networks or communal systems, ~8,500 of these are on land owned by BHCC.

Heat pump systems

This section explores the potential for individual heat pump solutions in properties in Brighton & Hove. The focus is on identifying properties suitable for replacing their existing heat system with heat pump.

Domestic heat pumps

Figure 0—15 displays the LSOA level map of all domestic properties suitable for heat pump upgrades (top map). The map in particular highlights areas in the east, northeast, and west with a large number of suitable properties for heat pump deployment. Considering the building tenure, the bottom map highlights the areas in the east, northeast and west with a high number of BHCC owned properties which are suitable for heat pump deployment. In order to identify areas suitable for heat pump deployment, a number of factors are considered as follow:

- Property type: Only houses (terrace, detached, semi-detached and bungalow) are assessed for individual heat pump installation since there is less space constraints for heat pump installation in these property types compared to flats. Flats are considered for communal heat pump installation.
- Building ownership: Local authority owned properties and social housing properties historically have a higher likelihood for adopting low carbon policies and are more likely to switch/ replace their heating system. The ownership offers a potential for a large-scale roll-out of heat pump in these properties. In private-owned properties, the Government scheme such as "Boiler Upgrade Scheme" can accelerate the adoption of heat pumps.
- Building Energy efficiency level: Heat pumps perform more efficiently in well-insulated properties. Therefore, improving the building energy efficiency is also important alongside heat pump installation. This also enables smaller heating system and reduces the need for grid reinforcement. Among 61,300 houses (terrace, detached, semi-detached and bungalow) around 15% of them have EPC B and C, making them suitable for heat pump upgrade with minimal intervention. 23% of houses have EPC D where some easy retrofits like loft top up, cavity wall insulation are required. Most of the remaining properties, require more extensive retrofit measures including wall insulation and glazing upgrade.
- Fuel poverty and Index for Multiple Deprivation (IMD): Areas with high fuel poverty and IMD are hampered for heat pump deployment, specifically gas-heated properties since the unit cost of gas is significantly lower than electricity. Switching to a heat pump for those residents could mean an additional economic burden not improving their lifestyle. High fuel poverty and IMD areas are instead targeted in case of direct-electric heated properties since the high efficiency of the heat pump could significantly decrease cost for those residents.
- Building current heating system: Properties with a gas boiler are proven to be more suitable for individual heat pump deployment, as they already have a radiator and piping system necessary for the heat pump. Properties with electric heating are also targeted as the heat pump would significantly decrease operational costs.
- Conservation areas and listed buildings: Among the properties suitable for heat pumps, 1,446 properties are in conservation areas where specific regulations apply, for instance, air-source heat pumps must not be installed on a wall or roof which fronts a highway. This does not preclude the installation of heat pump technology but does add additional constraints to locating suitable space to house the plant.
- Heat network zoning legislation: Moreover, the focus has been on the properties with the annual heat demand below 100MWh. This is mostly because demands above 100MWh may be mandated for a heat network connection from 2025 when heat zoning legislation kicks in or be more suitable for communal heating.

The total number of gas-heated properties identified as being currently suitable for adopting a heat pump without significant retrofit is approximately 24,113 in Brighton & Hove with nearly 2,883 of these properties being owned by BHCC. For direct-electric properties the total number is 13,185 of which 1070 are owned by BHCC.

Comparing Figure 0—15 and Figure 0—16 it is visible how gas-heated heat pump-ready properties are located outside Brighton & Hove city centre while the direct-electric heat pump-ready properties are located in the centre, specifically in areas with high fuel poverty.

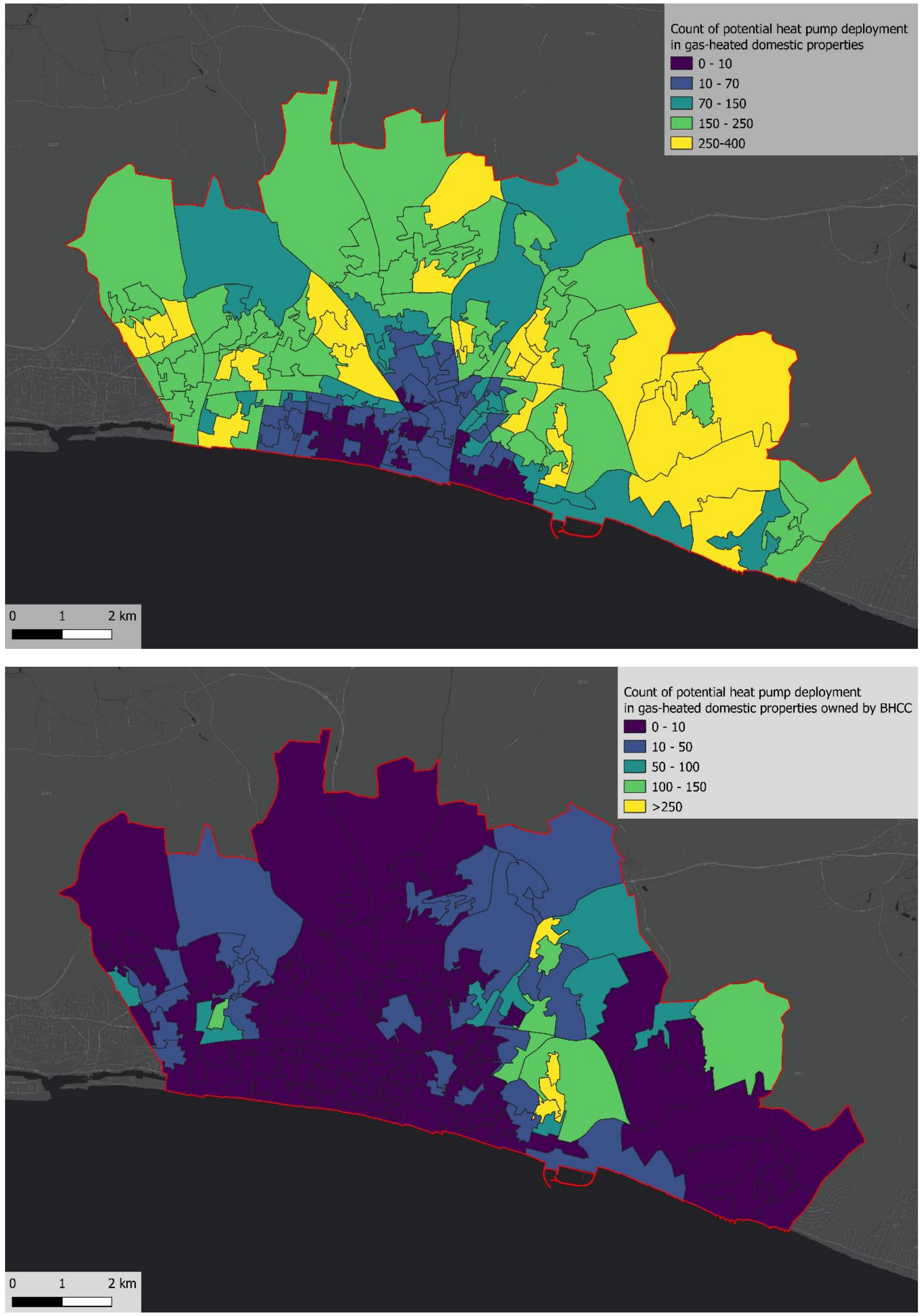


Figure 0—15 LSOA level count of potential heat pump installations in domestic properties in Brighton & Hove (top) and in BHCC owned properties (bottom)

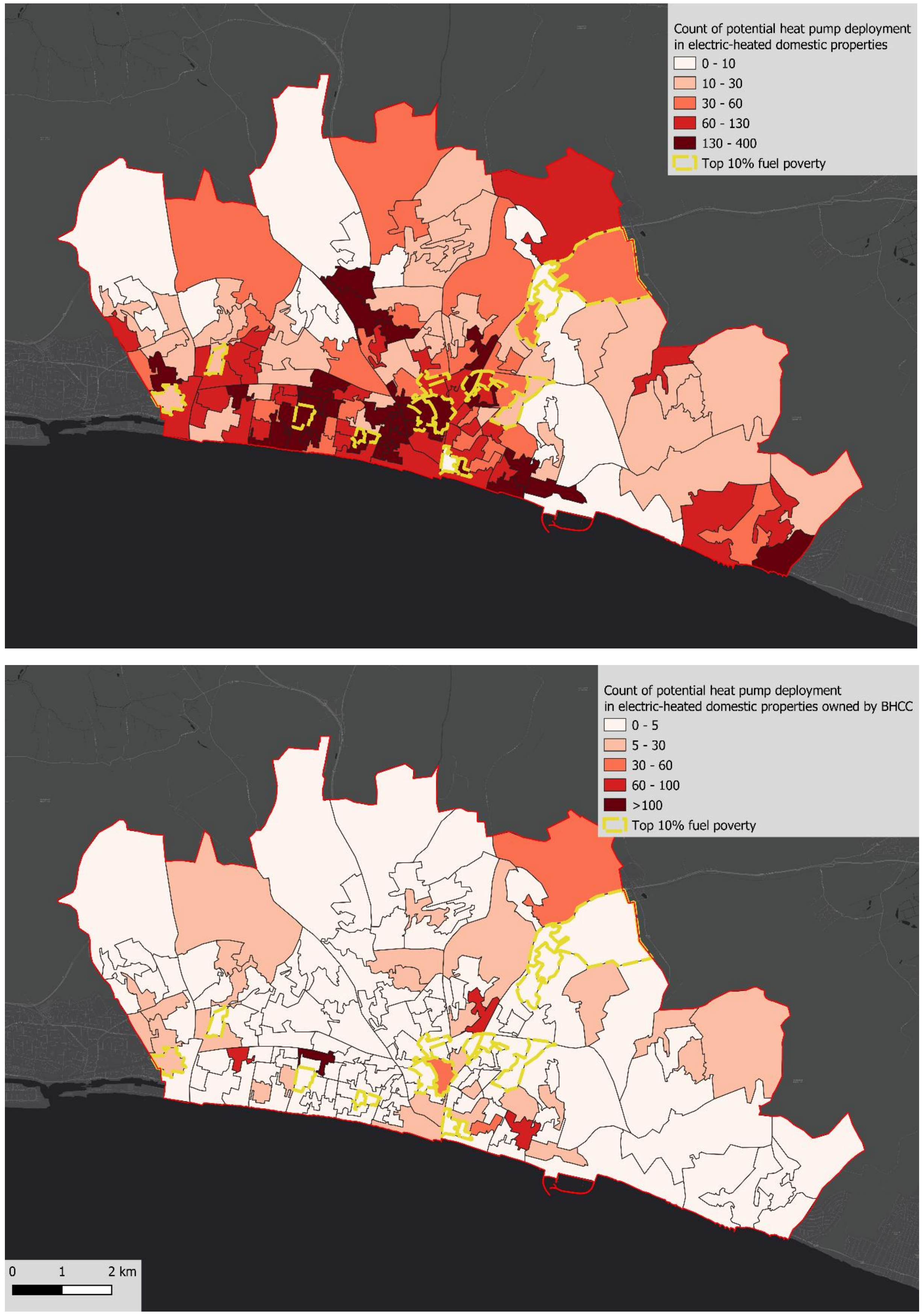


Figure 0—16 LSOA level count of potential heat pump installations in electrically heated domestic properties in Brighton & Hove (top) and in BHCC owned properties (bottom)

Available headroom / grid capacity in existing primary substations in the city would help reduce the lead time for the heat pump roll-out. The areas with high available headroom are suited better for immediate heat pump deployment. In general, headroom is not a constraint in Brighton & Hove, especially in the east and city centre area which are identified with high heat pump deployment, Figure 0—17 provide a map of grid spare capacity in Brighton & Hove.

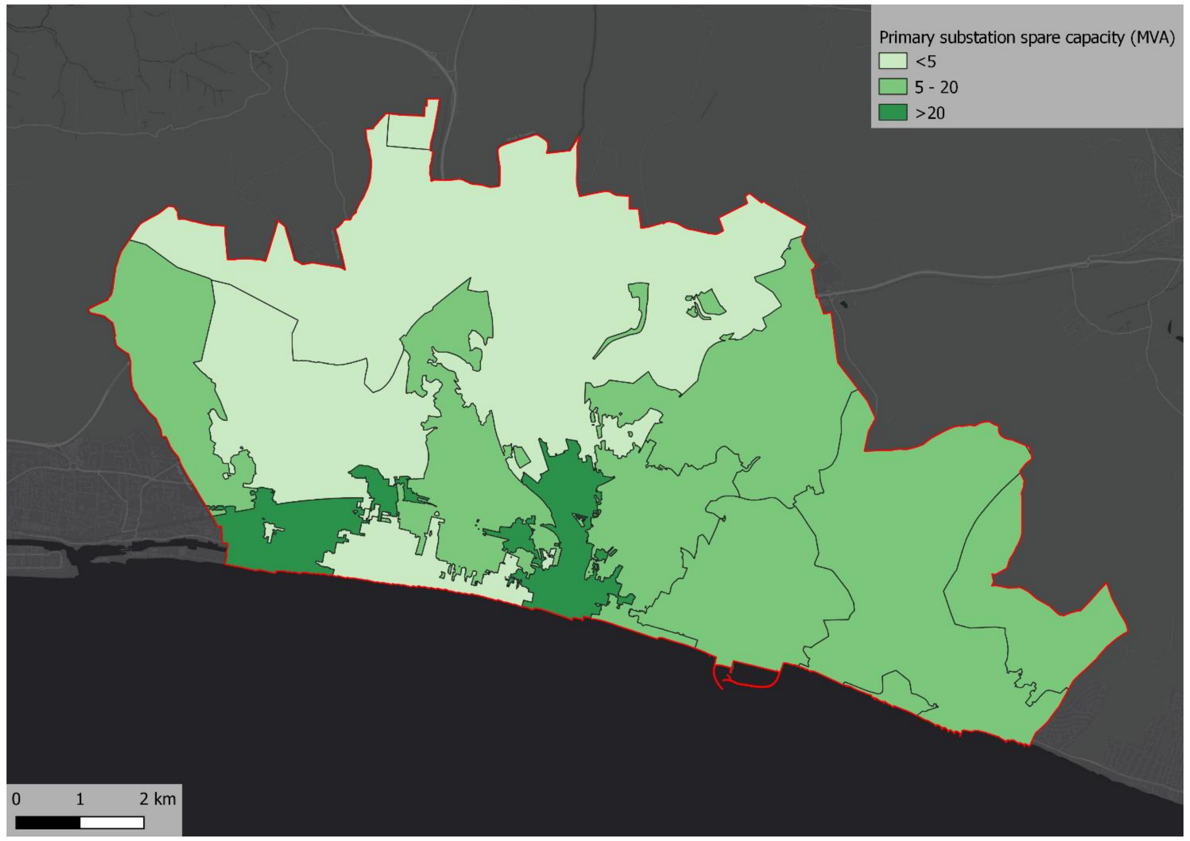


Figure 0—17 Spare capacity in primary substations supply area in Brighton & Hove

The headroom in relation to heat pumps is discussed further in section 0.

Domestic heat pumps priority projects

A summary of the key domestic heat pumps priority areas that were identified as early areas to consider is provided below and illustrated in Figure 0—18.

- **1 Woodingdean** is a mainly residential area with high potential for heat pump deployment. Specifically, there are 880 heat pump ready houses and 172 of those are owned by the council.
- **2, 3 Rottingdean and Ovingdean** are quite affluent areas (low fuel poverty and IMD) residential areas. The count of heat pump ready properties is quite low with respect to the area extension as the houses tend to be larger. The opportunity identifies 505 heat pump ready properties with a minor amount owned by the council.
- **4 Whitehawk** is a mainly residential area with a high potential for heat pump deployment. There are around 1400 houses ready for heat pump installation with around ~300 of those needing minor insulation measures as loft top up and cavity wall insulation. As 830 of those are owned by the council, Whitehawk should be prioritised for heat pump deployment given the significant amount of council owned houses. It is vital that fabric efficiency is high in these properties to ensure that heat pumps function cost effectively in an area with a high level of deprivation.
- **5 Coombe Road** is an area with quite significant levels of fuel poverty which could be a barrier for heat pump deployment. The opportunity consists of around 500 houses needing minor insulation measures to be heat pump ready, while other 240 which are already suited for heat pump deployment.
- **6 65**
- **7 Hollingdean** sees around 300 heat pump-ready properties and 550 needing minor insulation measures.
- **8 North Moulsecoomb** opportunity sees 160 heat pump-ready properties although a significant obstacle in the area is the very high fuel poverty.
- **9 Hollingbury** has good potential for heat pump deployment, with around 100 heat pump ready properties and 350 requiring minor insulation measures.
- **10 Westdene** Similar to areas 2 and, 3 the area has quite a low count of heat pump-ready properties due to larger homes and so lower density, around 220.
- **11 Withdean** is highlighted for high potential of heat pump deployment in electric-heated properties. Around 500 properties would be heat pump ready, with opportunities highlighted also for small and large-scale communal heat pumps systems.
- **12 West Blatchington** opportunity sees around 270 properties needing minor insulation measure for heat pump deployment, and a cluster of 100 heat pump-ready properties on the other side of Hangleton Road.
- **13 South Hangleton** is highlighted as an area with a high density of heat pump-ready properties, around 200. Unfortunately, it is also a very fuel poor area which is an obstacle for heat pump deployment.
- **14 Portslade and Mile Oak** is a very large area with high number of heat pump-ready properties. Around 600 properties are heat pump ready and around 770 needing minor insulation measures.
  15 Aldrington opportunity consists of around 530 heat pump-ready properties requiring minor insulation measures.
- **16 Central Hove , 17 City Centre and 18 Kemp Town** are the most central areas of the city With a high density of direct electric heated properties, heat pumps should be considered as a priority although the obstacle would be space constraints due to high density of buildings. Some small- and large-scale communal systems are also highlighted. There would be the potential in total of 5,500 direct electric heated properties to be converted to heat pumps.

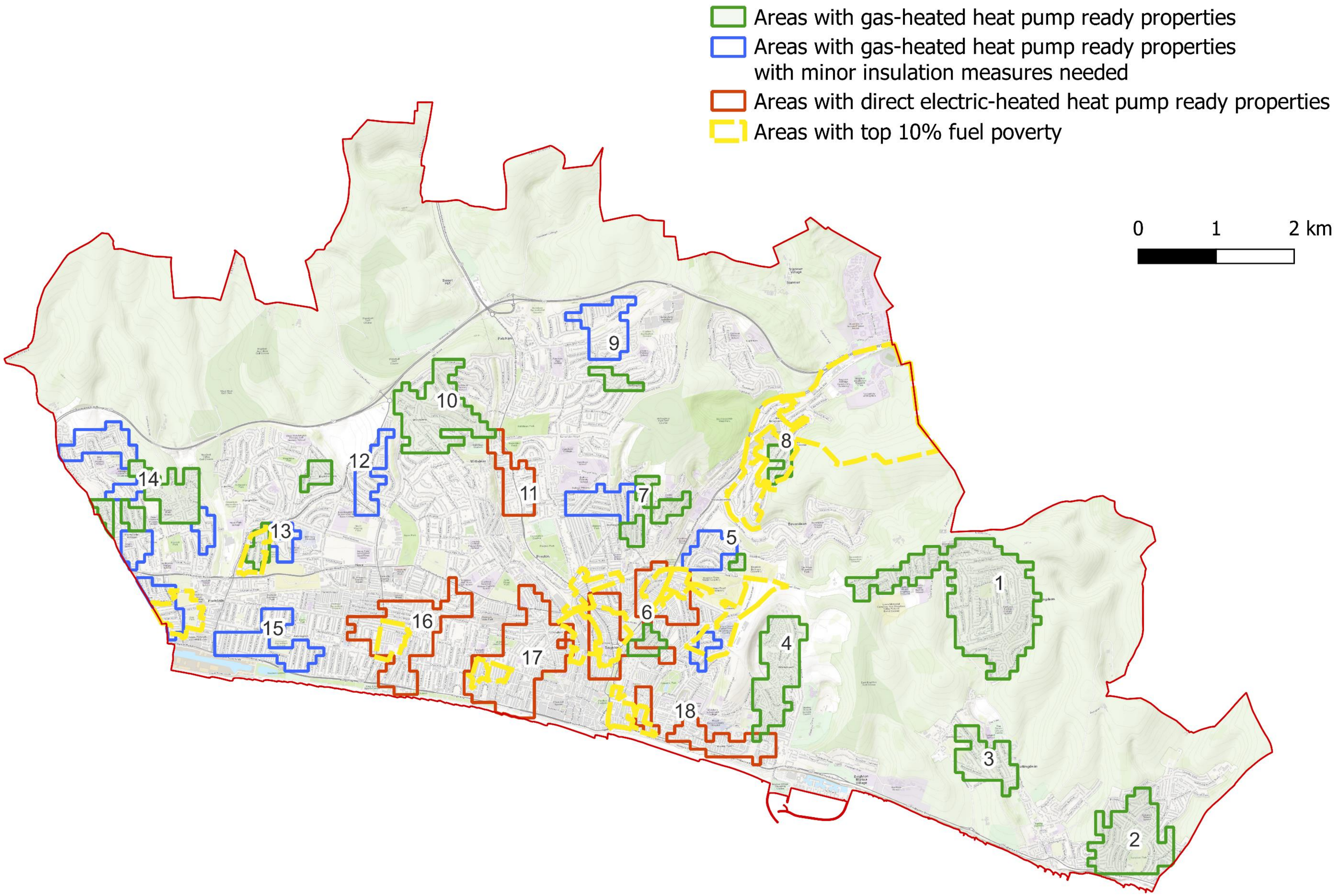
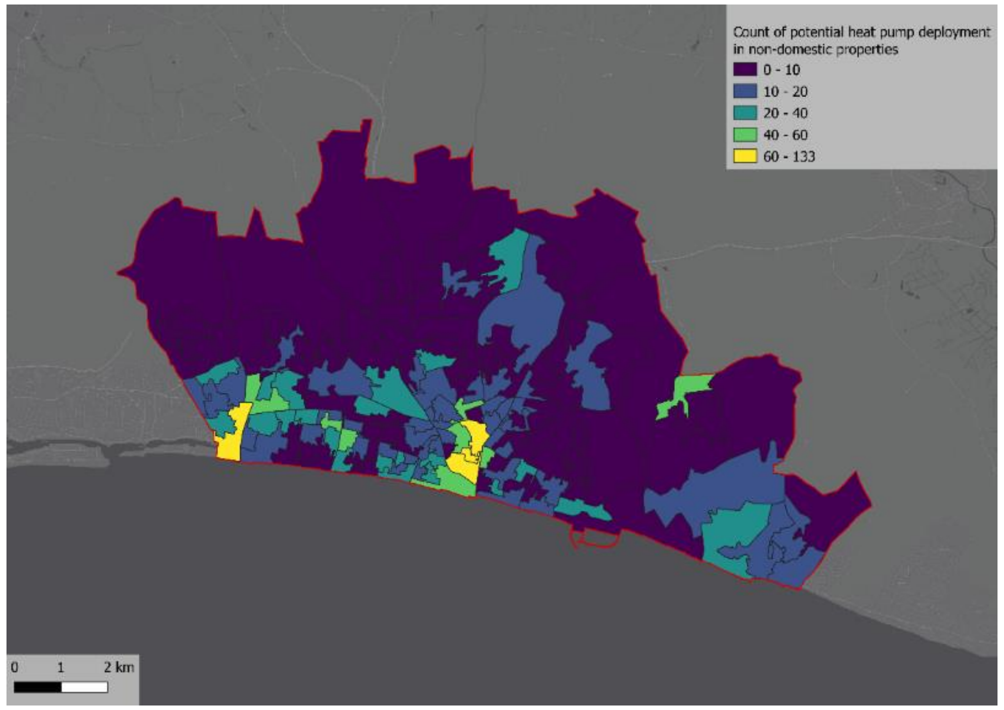


Figure 0—18 Domestic heat pumps opportunity areas identified in Brighton & Hove

Non-Domestic heat pumps

Figure 0—19 displays the LSOA level map of all non-domestic properties suitable for heat pump deployment.



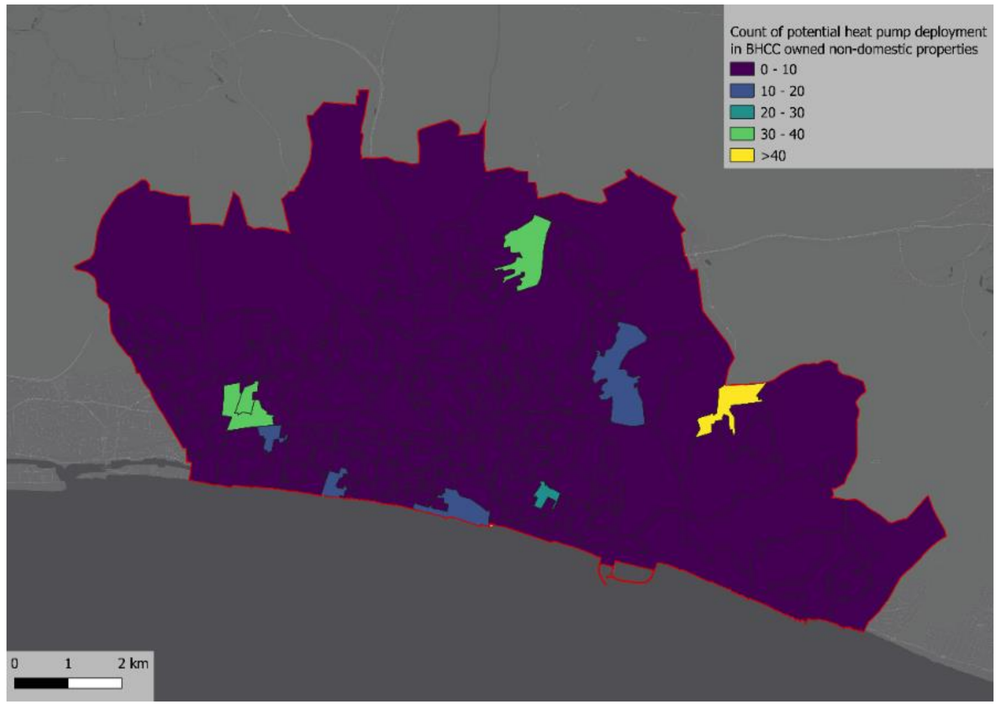


Figure 0—19 LSOA level count of potential heat pump installations in non-domestic properties in Brighton & Hove (top) and in BHCC owned properties (bottom)

The map in particular highlights areas in city centre, west, east and north-east with the highest possibility for deployment. The total number of properties identified as suitable for replacing their current heating system with a heat pump is about 2,480 in Brighton & Hove with around 490 of these properties being owned by BHCC and 800 of these are in conservation areas (mainly located in Brighton city centre).

Non-domestic heat pumps priority projects

A summary of the key domestic heat pumps priority areas that were identified as early areas to consider is provided below and illustrated in Figure 0—20.

- **1 Saltdean Lido** is highlighted as a heat pump priority area as has large heat demand (~700 MWh) currently on gas boilers and owned by the council. To the north of the Lido, the other opportunity is Apple Tree Montessori Nursery School, also owned by the council.
- **2 Rottingdean village centre** presents a few opportunities for heat pump deployment: care homes and a nursery school.
- **3 Ovingdean** Oxford International College Brighton is highlighted as a heat pump priority area as has a large demand (~200 MWh) currently on gas boilers and sits on council-owned land. In the area other opportunities are a nursery school and the Ovingdean Village Hall.
- **4 Woodingdean Business Park** is an opportunity for heat pump deployment, specifically the council-owned offices in the northeast area (The Brighton Office Campus). All of them are gas heated currently and recently built, which could be a leverage for heat pump deployment as well insulated properties but also an obstacle, as gas boilers would be early in their lifetime.
- **5 The Hyde Business Park** is an opportunity area for heat pump deployment especially in the Brighton Film Studios estate which is relatively new built and on gas boilers.
- **6 Bevendean** Primary School and Nursery (~400MWh) and Happy Valley Pre School are opportunities for heat pump deployment given the demand size, as well as is owned by the council.
- **7 Hollingdean** has an education hub which is an opportunity for heat pump deployment: The Hive (school that closed in 2018 but there are plans to reconvert to new secondary school), Central Hub Brighton, Hertford Junior School and Hollingdean Family Hub. The total heat demand is around ~500MWh.
- **8 South Hollingdean** has two schools which would be an opportunity for heat pumps: Downs Infant School and The connected Hub, both council owned and gas heated.
- **9 Hollingbury Business Park** has few buildings that are owned by the council and could be opportunities for heat pumps: Sussex House, St John Ambulance Aid Training and a warehouse complex with different small companies.
- **10 Hollingbury Learning Centre**, Carden Primary School, Hollingbury and Patcham Family Hub are located just south to the Business park and good opportunity for heat pump deployment. County Oak Medical Centre is an adjacent opportunity with ~100 MWh heat demand owned by the council.
- **11 Patcham High School** is a large school with high demand associated (~500MWh) which is the main opportunity for heat pump deployment. In the area also a community centre, a junior school and a nursing home.
- **12 Preston Drove** presents a few opportunities for heat pumps: two nurseries, a community centre and a care home.
- **13 Preston Park** area offers a few opportunities for heat pump deployment: Lancing College Preparatory School, Dyke Road Dental Clinic, Matlock General Practice Surgery and few care homes.
- **14 Dyke Road** Area with a high density of care homes as well as childcare facilities that are suitable for heat pump deployment, also BHASVIC is one of the larger public sector demands in the city.
- **15 Dyke Road Care Homes**: Victoria Chatsworth Care Home, Victoria Highgrove Care Home and Dane House Elysium Healthcare are opportunities for heat pump deployment.
- **16 Withdean Sports Complex** is quite a significant opportunity in terms of heat demand (~300MWh) and is owned by the council
- **17 Hove Centre** has Hove Library which is the main opportunity for heat pump deployment with a heat demand of ~200MWh.
- **18 Hove Nursery Hub** – high density of nurseries currently on gas suitable for heat pump deployment.

- **19 Hangleton:** opportunity to decarbonise Hangleton Library as well as Churchill House as both are owned by the council.
- **20 The Knoll Business Centre** is a large business space offering office space owned by the council with good potential for heat pump deployment as currently all gas heated.
- **21 New Church Road** area presents opportunities of heat pump deployment in the following buildings: Catering Deepdene School, The Garden Nursery and pre-School, GP Clinic and Dental Surgery.
- **22 South Portslade** area presents opportunities of heat pump deployment in the following buildings: St Mary's Catholic Primary School, South Portslade Community centre, and GP Practice.
- **23 Portslade** area presents opportunities of heat pump deployment in the following buildings: Brackenbury Primary School, Brackenbury Primary (both owned by the council) and St Nicolas CE Primary School.

Heat pump heating system summary

In total 73,000 properties are identified as having potential to switch to heat pumps, with 7,000 on BHCC owned land. The size of heat pumps varies from small domestic heat pumps with a 5 kWh heat pump to large non-domestic systems over an order of magnitude greater in size. There was, however, a general lack of very large (MW scale) non-domestic heat pumps identified, as the largest loads were generally connected to heat networks in the pathways analysis.

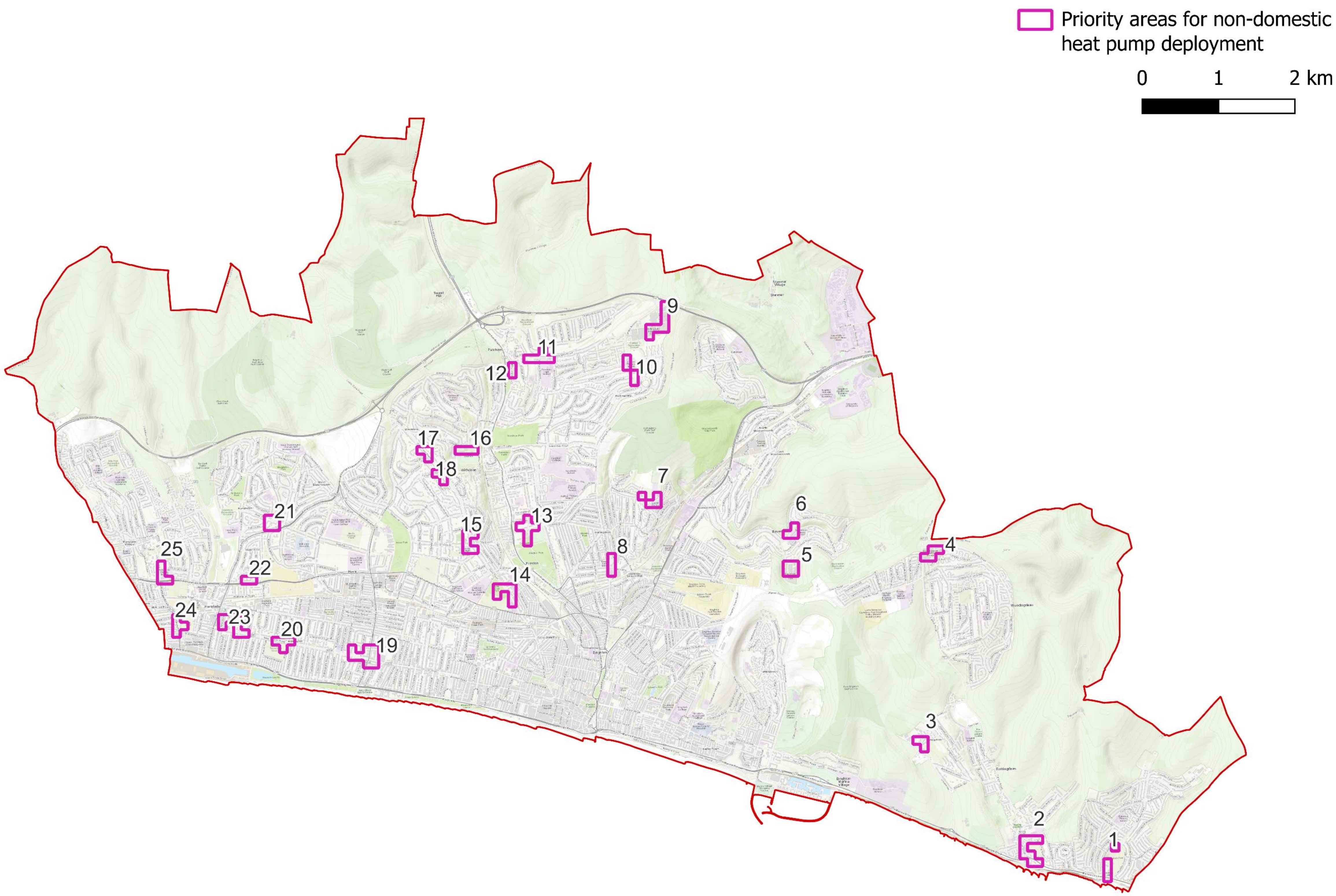


Figure 0—20 Non-domestic heat pumps opportunity areas identified in Brighton & Hove

Local power generation

The electricity grid decarbonisation is progressing rapidly as Figure 0—1, which is based on UK Government data shows.

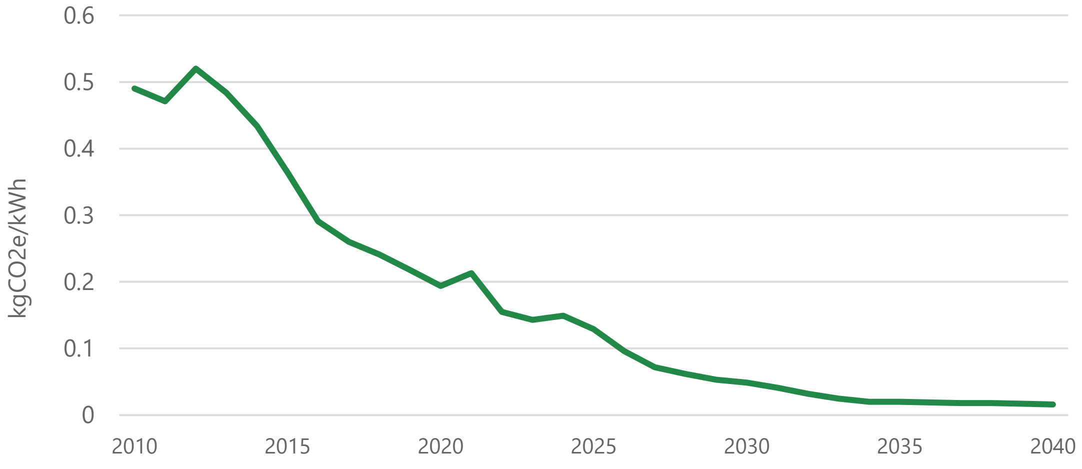


Figure 0—1 Electricity grid carbon emissions projection according to the Green Book[68]

Renewable sources are playing dominant role in decarbonisation of electricity grid to achieve net zero in the UK. Large scale renewables such as offshore wind turbines are the cost-effective way for electricity generation and the key enablers for grid decarbonisation as well as the localised deployments like solar PV. The localised generation like rooftop solar PV also has an important role in all the scenarios. Large scale renewable deployment was also considered but due to the various constraints is not a focus of local power generation. The deployment of local renewables is mainly informed by local deployment as well as Insight from the DFES scenarios.

Deploying solar PV can be highly beneficial in properties with poor energy performance as it reduces energy bills. The solar PV benefit can be maximised if it is integrated with battery storage. This allows to store the generated electricity during periods of excess generation (for example early afternoons) which can be used at peak hours when the electricity price is at its highest. Furthermore, it contributes to reducing the peak demand and provide flexibility to the grid through load shifting. Solar PV is particularly useful for electrically heated properties through offsetting electricity consumption associated with heating. If a heat pump is adopted, solar PV contributes to providing the electricity to run the heat pump.

Non-domestic buildings (for example, hospitals, universities, schools) could also benefit significantly from solar PV deployment. It decreases the carbon emissions and reduce the need to purchase electricity at peak hours from the grid.

Existing renewable generation in Brighton & Hove

As Table 0—1 indicates, that the existing installed renewable capacity[69] in Brighton & Hove is estimated to be around 15MW, with 12.7MW across circa 3700 installation in domestic properties[70]. Additionally, there is around 2.2MWp of installed solar generation with a capacity above 50kWp, according to the UKPN embedded capacity register[71].

Table 0—1 Existing installed solar PV

	Installed capacity (MWp)
Brighton & Hove solar PV installed capacity in domestic	12.7
Embedded capacity UKPN (between 50kW and 1MW)	2.2

Although the UKPN's embedded Capacity Register data (for installations above 50 kW) indicates a solar capacity of 2.2 MWp in Brighton & Hove, locally collected data suggests that the actual installed solar capacity is larger. This discrepancy might be due to the UKPN data not being recently updated. In the following, the details of some solar installations by community energy groups and the University of Sussex are provided.

The Community Energy Groups are actively involved in several solar PV projects in Brighton & Hove targeting schools, businesses, and flats. Brighton & Hove Energy Services Co-operative (BHESCo)[72] have so far installed circa 430 kWp rooftop solar PV on commercial and public buildings. Of this, circa 340 kWp has been installed on seven schools including Patcham junior school, Varndean College, Hill Park School. BHESCO has recently raised more than £400,000 for new solar projects on schools and since 2024 they have installed 490 panels in 4 schools (~125kWp) including Middle Street Primary School, Goldstone Primary School, Peter Gladwin Primary School, and Mile Oak Primary School[73].

Brighton Energy Cooperative (BEC) has been involved in over 90 solar projects in and around Brighton & Hove[74]. They have installed over 900 kWp on 13 schools and 4 University of Brighton Buildings in Brighton & Hove.

The University of Sussex has installed over 3100 solar panels on buildings at its Falmer campus which generates over 4GWh renewable energy annually (estimated capacity is around 1.7 MWp) for the campus[75].

The Council is planning to install solar panels on up to 800 council-rented houses and bungalows prioritising properties with EPC D and below[76] in the next few years, this is in addition to over 400 existing systems on Council-owned domestic properties. Council also supports Solar Together Sussex[77] which is a group-buying scheme that delivers cheaper installation of solar panels and battery storage systems for able-to-pay households including homeowners and landlords.

In partnership with EDF the Council is launching a trial to explore solar and storage solutions in social housing backed by the Alternative Energy Market Innovation Programme They will invite 50 customers living in social housing to take part in the trials some of whom will be provided with storage solutions too[78].

The Council also has recently completed a feasibility study for a 2.5-6.5MWp solar farm deployment. Alongside this 320 kW of rooftop PV installs on council properties are due in the summer of 2024.-

Rooftop PV generation potential

The land within the Brighton & Hove boundary was assessed for ground-mounted solar opportunities. Due to the dense urban nature of the area and the exclusion of all hard constraints[79] including the protected areas, and planned development sites, it was determined that there is not great potential for ground-mounted solar in Brighton & Hove.

There is a significant opportunity for widespread rooftop solar PV deployment in Brighton & Hove. Beyond the direct financial benefits for households, there is also a high ambition for solar deployment in the pathways. To maximise the

[68] https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal
[69] Solar Capacity is a measure of the maximum power that a solar installation can output, typically measured in MW or GW. Solar Generation refers to the actual amount of energy that a solar installation supplies to an electric grid over a given time period. It is usually measured in MWh or GWh.
[70] https://www.gov.uk/government/statistics/solar-photovoltaics-deployment
[71] https://ukpowernetworks.opendatasoft.com/explore/?disjunctive.theme&disjunctive.dublin-core.subject&sort=explore.popularity_score&q=embedded
[72] https://bhesco.co.uk/community-energy-projects-brighton-hove-sussex
[73] https://www.sussexexpress.co.uk/news/ps400000-raised-for-solar-power-on-brighton-hove-schools-4577688
[74] https://www.brightonenergy.org.uk/home/our-projects/
[75] https://www.cpre.org.uk/wp-content/uploads/2023/05/Rooftop-Revolution-Report.pdf
[76] https://www.brighton-hove.gov.uk/news/2023/hundreds-council-homes-switch-solar-power
[77] Brighton & Hove City Council, 2030 Carbon Neutral Programme Annual Report 2022-2023; See: Carbon Neutral 2030 annual report 2022 to 2023.pdf (brighton-hove.gov.uk)
[78] https://www.solarpowerportal.co.uk/brighton-and-hove-social-housing-in-new-solar-and-storage-trial/
[79] The hard constraints include Areas of Outstanding Natural Beauty (AONB), Local Nature Reserves (LNRs), National Nature Reserves (NNRs), Ramsar sites, Special Areas of Conservation (SACs), Sites of Special Scientific Interest (SSSIs) and Special Protection Areas (SPAs). It also includes heritage sites such as World Heritage Sites, Scheduled Monuments and similar sites.

advantage of solar deployment in grid decarbonisation, it is important that it happens early and rapidly. Figure 0—2 highlights the period with the maximised benefit of solar deployment for grid decarbonisation.

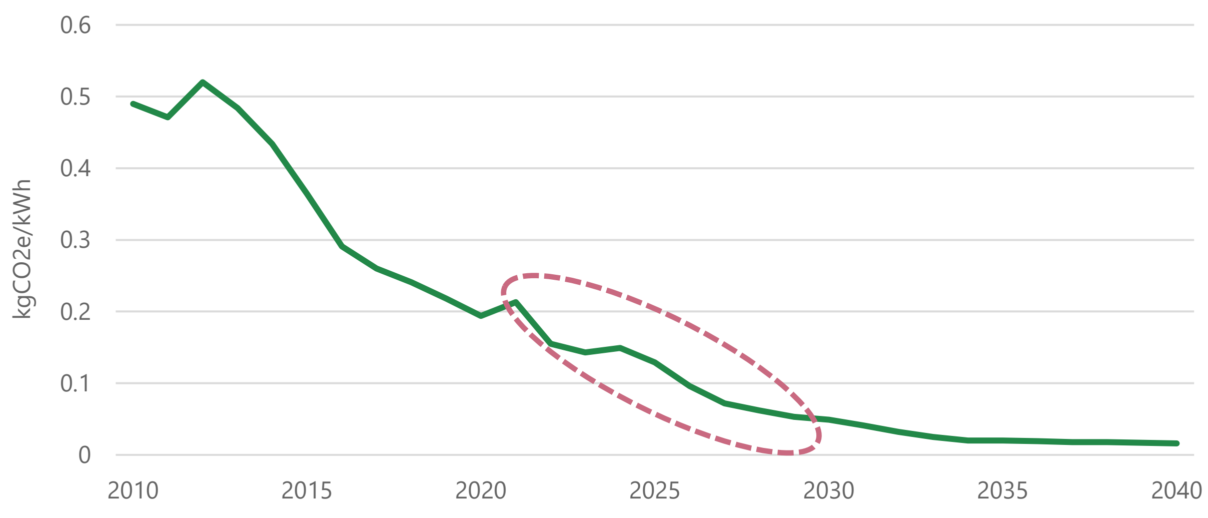


Figure 0—2 Electricity grid carbon emissions projection according to the Green Book highlighting the present of maximum benefit from large-scale solar deployment

Analysis of the potential of rooftop PV generation per building was modelled and the solar modelling steps can be summarised as follows:

- Screening out roofs of under $10m^2$
- Removal of roof segments with a solar irradiance below 800kWh/yr/m2
- Assumption of a percentage of useable roof area that is available for PV (this is typically up to ~50%[80]). This assumption is relatively conservative to account for other rooftop uses and to avoid overestimating potential. The non-suitable area corresponds to the required distance between the racks, access-maintenance space, and area covered by equipment such as water tanks and water meters
- Apply a PV power density to the available roof space based on solar panels currently on the market. This provides a theoretical installed capacity[81] ($175Wp/m^2$).
- Once the theoretical installed capacity is calculated roofs with an installed capacity of under 1.3kWp are removed.
- Listed properties were excluded due to increased complexity and barriers, and current planning constraints in some instances[82].
- It is worth noting that the model does not consider the roof condition and suitability for solar deployment. The roof survey needs to be done before solar installation to understand if it needs repair and maintenance.

If rooftop solar is fully developed, this could contribute to approximately 670MWp of generation in Brighton & Hove, covering 44% of rooftop areas. With a potential annual electricity generation of 621GWh, this equates to ~73% of annual electricity demand in Brighton & Hove. Table 0—2 provides an overview of the potential solar PV generation, and Figure 0—3 presents the LSOA level-proof top PV capacity for the whole of Brighton & Hove and for buildings located on Council-owned lands highlighting the areas with the largest solar output.

Table 0—2 Potential roof top solar PV generation

	Total in Brighton & Hove	Council owned (properties located on council owned land)
Annual Generation (GWh/yr)	621	96
Installed capacity (MW)	670	103

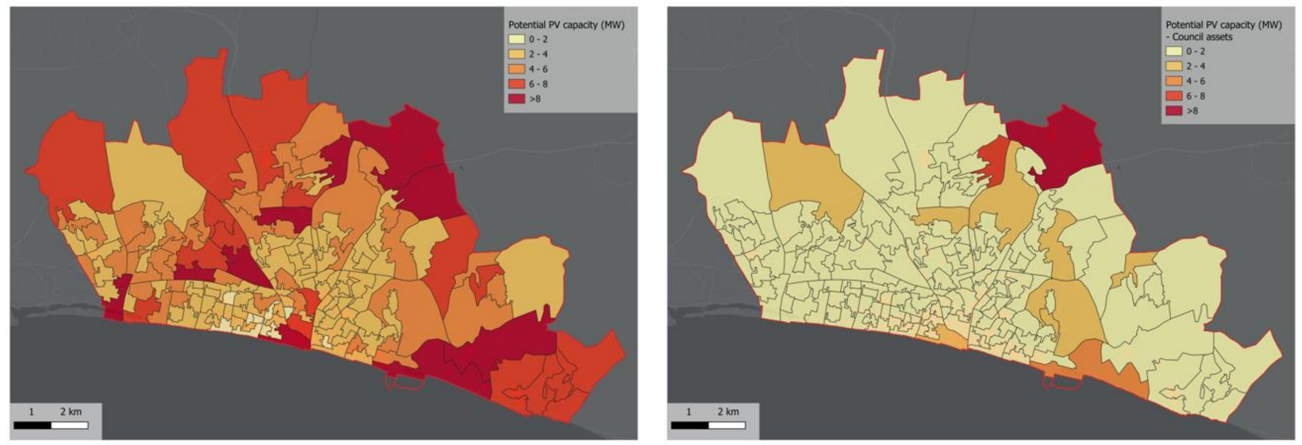


Figure 0—3 Potential roof top solar PV capacity (MW) in Brighton & Hove (left) and in Council assets (right)

Table 0—3 lists some of the buildings with largest PV potential capacities.

Table 0—3 Buildings with largest PV potential capacities (kWp)

Building Name	Total roof area (m2)	PV potential (kWp)	Typology
American Express Stadium	17737	1826	Leisure
Brighton station depot (Combined Engineering Deport)	15520	1358	Workshop/storage
Asda, Crowhurst Road	17737	939	Retail
Sainsbury, Old Shoreham Road	8966	785	Retail
University of Brighton Falmer sport centre	8635	756	Leisure
Booker Brighton, Fairway Trading Estate	8501	744	Retail/workshop
Southern House, Falmer, Brighton	6000	525	Office

One of the buildings identified with a potential for large PV installation is the Cardinal Newman Catholic School. BEC has recently commissioned solar installations across ten roofs at this school with a total of 324 kWp[83].

Table 0—4 provides and overview of the solar opportunity in some of the buildings that are on council owned land and over which the Council might have control. The focus has been on identifying the school, community centres and leisure centres that currently do not have solar PV installed.

[80]Bodis et al, 2019, A high-resolution geospatial assessment of the rooftop solar photovoltaic potential in the European Union, See: https://www.sciencedirect.com/science/article/pii/S1364032119305179#bib19

[81] The average solar panel system is around 3.5-kilowatt peak (kWp). Most panel systems typically cover between 10 to 20m2 of roof surface area. See: https://energysavingtrust.org.uk/advice/solar-panels/

[82] It is worth noting that the applications will be considered in terms of the extent to which the proposal harms the historic significance of the building. see: https://www.brighton-hove.gov.uk/planning/heritage/improving-energy-saving-and-sustainability-conservation-areas-and-listed-buildings#tab--solar-panels

[83] Brighton Energy Cooperative is installing roof top PV at Cardinal Newman Catholic School, see: https://www.brightonenergy.org.uk/2023/11/brighton-energy-winter-solar-news-2023/.

Table 0—4 Buildings with largest PV potential capacities (kW) at Council owned lands

Building Name	Total roof area (m2)	PV potential (kWp)	Typology
Brighton Aldridge Community Academy	6759	591	Education
The Brighton Centre, King's Road (roof maintenance is required)	6754	591	Community
Varndean School, Balfour Road	6120	536	Education
Patcham High School (old roof)	5700	505	Education
King's School Hove	5673	490	Education
King Alfred (roof area adjusted)[84]	5249	367	Leisure
Longhill high school (roof maintenance is required)	4095	358	Education
Hove Park Nevill Campus	3861	338	Education
Dorothy Stringer School, Science building, Loder Road	3587	313	Education
Moulsecoomb primary school	2585	213	Education
City Academy Whitehawk, Whitehawk Road	2240	196	Education
Downs Infant School, Ditchling Road	2218	194	Education
Brighton Jubilee Library (roof area adjusted)	2075	150	Community
Carlton Hill Primary School, Sussex Street	1185	103	Education

Solar installation has already been planned or commissioned in a number of properties on the Council-owned lands. These include a 100kWp installation at Hill Park Upper School by BESCo, a 130kWp installation at the Prince Regent Swimming complex, a 36 kWp solar installation at the Moulsecoomb Community Leisure Centre. and a 21 kWp at the Portslade Hub at Mile Oak Road.

Table 0—5 provide a breakdown of the potential solar PV generation by typology if fully developed in Brighton & Hove. It is estimated that above 75% of rooftop solar PV generation comes from domestic buildings, with houses providing the largest potential for solar PV deployment with up to 383 MWp solar capacity. This highlights that the houses could be considered for identifying the early opportunities for solar PV deployment. Among non-domestic typologies, retail properties have the highest total potential, followed by education buildings, including schools and universities.

Table 0—5 Breakdown of solar PV capacity by typology and sector

Typology	Potential PV capacity (MW)	Share
Retail	41	6.1%
Storage	14	2.2%
Community, arts and leisure	11	1.7%
Industrial	15	2.3%
Education	28	4.2%
Office	21	3.2%
Hospitality	14	2.1%
Health	8	1.3%
Emergency services	1	0.1%
Flat	132	19.7%
House	383	57.2%
Total	**669**	**100%**

[84] It is worth noting that, there is a plan to redevelop the King Alfred Leisure Centre, either by redeveloping the current site or by using an alternative site to build the new leisure centre. See: https://www.brighton-hove.gov.uk/city-regeneration/major-developments/king-alfred-development

Decarbonisation pathways scenarios for rooftop PV deployment

The theoretical potential for roof top Solar PV is circa 670 MWp, however this is highly ambitious and not expected to achieve with the supply chain and electricity infrastructure being two limiting factors.

Table 0—6 provides an insight into projected rooftop PV capacity installation in DFES scenarios adjusted to 2040, along with the estimated deployment cost. Following the DFES scenarios, PV panels are projected to cover up to 5.2% of roof areas in Brighton & Hove.

Table 0—6 UKPN DFES roof top solar PV installed capacity

UKPN scenarios	Installed Capacity (MWp)	Equivalent of roof top area %	Cost m£
Leading the Way	74	5.2%	129
Consumer transformation	74	5.2%	129
High heat networks (system transformation)	38	2.8%	67
Falling short	20	1.5%	35

It is projected that Brighton & Hove has a much larger potential to benefit from solar PV deployment. Moreover, considering the cost-effectiveness of solar PV (for rooftop PV displacing onsite electricity consumption an ROI of 7.5 years can be expected), its rollout is a low-regret option, and Brighton & Hove could be more ambitious than the DFES scenarios. It is important to note the DFES actually underestimated the amount of PV currently installed so adaptions were required to the scenarios to account for this difference.

Figure 0—4 shows the required deployment rate to achieve the proposed 74MWp roof top solar deployment by 2040. This could be achieved through installing roof top PV on circa 7050 houses and flats and 577 non-domestic buildings.

The potential for solar deployment is estimated at circa 80.5MWp, which includes the DFES Leading the Way scenario as well as 6.5MWp solar deployment in the solar farm planned by the Council. The projected cost for this is approximately £135m including the cost of solar farm.

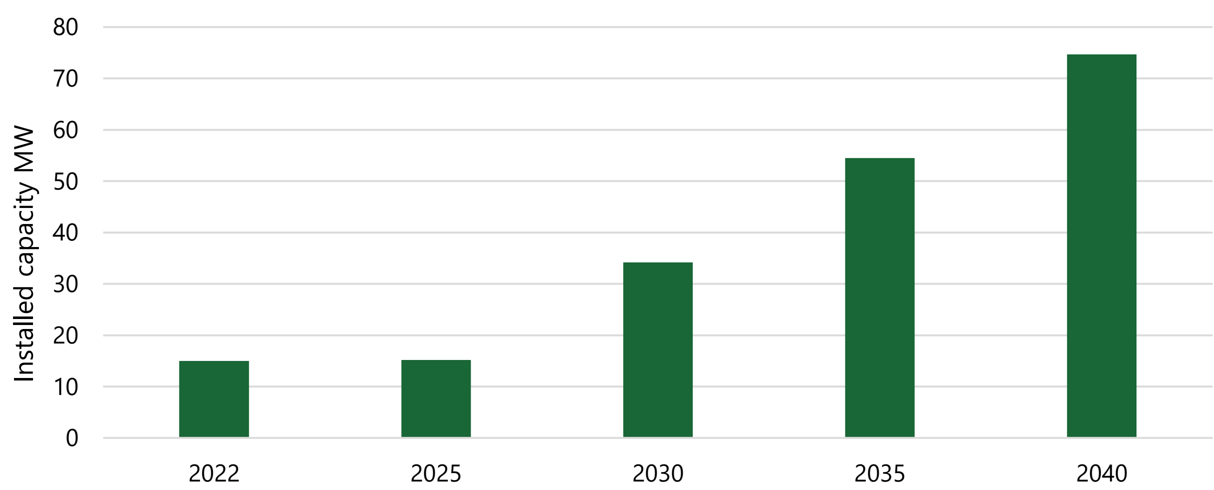


Figure 0—4 Solar PV deployment rate adopting target deployment by 2040

For the large-scale rollout of solar PV, it's essential to assess the existing electricity network, infrastructure, and headroom capacity to understand if there's enough capacity in the grid for additional solar connections. Figure 0—5 shows the current headroom in UKPN primary substation supply areas. Currently, all primary substation supply areas have a demand RAG of green, indicating a headroom over 5%. This suggests that there is currently sufficient capacity in the grid to accommodate additional solar connections. However, as solar deployment increases, it is crucial to monitor grid capacity and consider grid reinforcement measures to ensure continued reliability and stability of the electricity network.

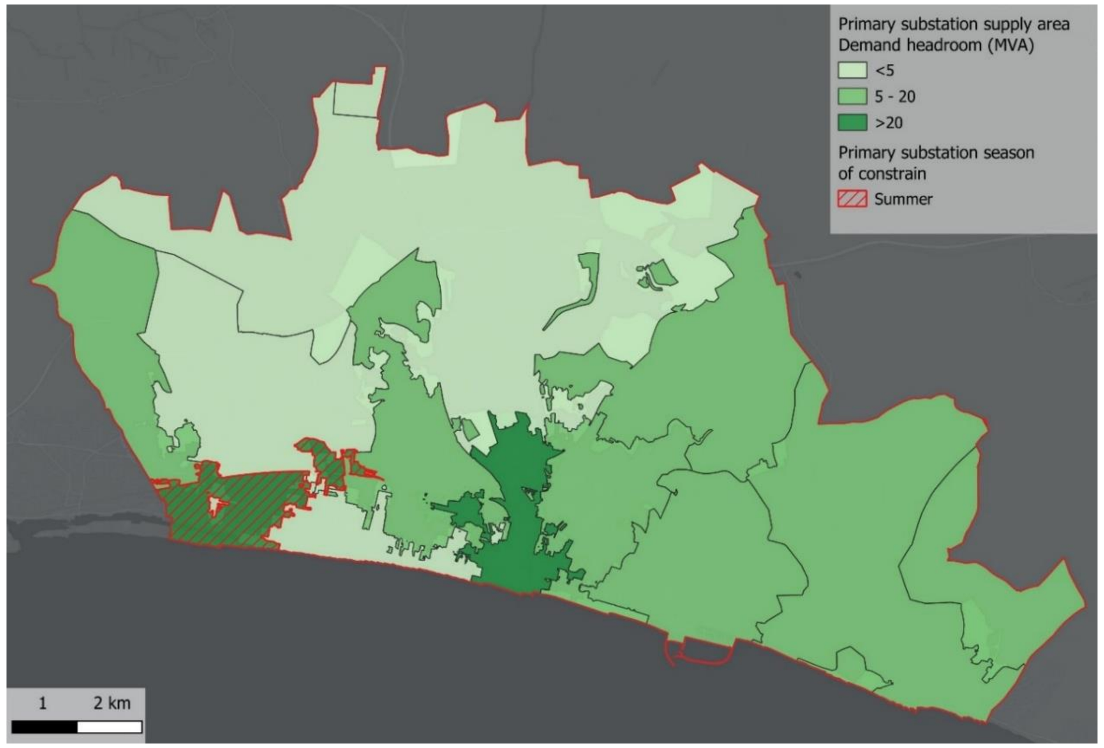


Figure 0—5 Primary substation supply area headroom

With a high number of properties relying on gas as heat supply and considering the higher solar generation in warmer months, solar generation can be utilised more effectively during this period. Particularly in building with air conditioning, where the electricity demand is higher due to cooling demand in summer. Therefore, the areas where the grid constraints are prevalent in summer could be prioritised for solar deployment. Currently only one primary substation has summer as the season of constraint (as shown in Figure 0—5), suggesting that solar PV could play an important role in reducing the demand locally in that area.

With electrification of heating, the demand pattern could shift, with increased electricity demand expected in winter. Coupling solar PV with battery storage could support the grid flexibility through demand shifting and reducing the peak demand. It could also reduce the need for grid reinforcement in long term by providing localised solution for managing the fluctuations in demand and supply.

Priority areas for PV deployment

A number of areas have been identified as potential priority areas for solar deployment. To identify priority areas for roof top solar deployment, multiple factors are considering as follows:

- LSOA level solar capacity map (see Figure 0—3)
- 100m x 100m grid level solar capacity map for the whole Brighton & Hove and for the buildings on Council owned lands. Which provides finer resolution of the areas with higher solar capacity (Figure 0—6 and Figure 0—7)
- Fuel Poverty map with focusing on the 10% areas with worst fuel poverty, as these are the vulnerable households that could benefit greatly from the solar deployment through reducing their energy bill (however, it is also depending on how the PV installation is paid for)
- Council ownership map, as the Council has already planned to increase the number of solar deployments on its own houses prioritising areas with EPC D and below. Moreover, identifying the school s and community centres and leisure facilities on the Council lands for early deployment.
- Council plan for large scale solar deployment such as solar farm.
- Areas with high number of private ownership and owner-occupied houses as solar deployment deemed as a good investment with proved return of investment. The roof top PV can be also prioritised in houses with EPC D and below as they can take advantage of solar to reduce their energy bill.
- Electricity grid constrains prioritising areas with higher headroom and with summer as season of constraint.
- The areas with a high number of privately rented housing are not considered initial priority areas. This is because funding for solar PV becomes complicated when the building owner is not responsible for the energy bill.
- The Priority areas also includes the areas that could benefit from the Council scheme such as Solar Together Sussex[77].

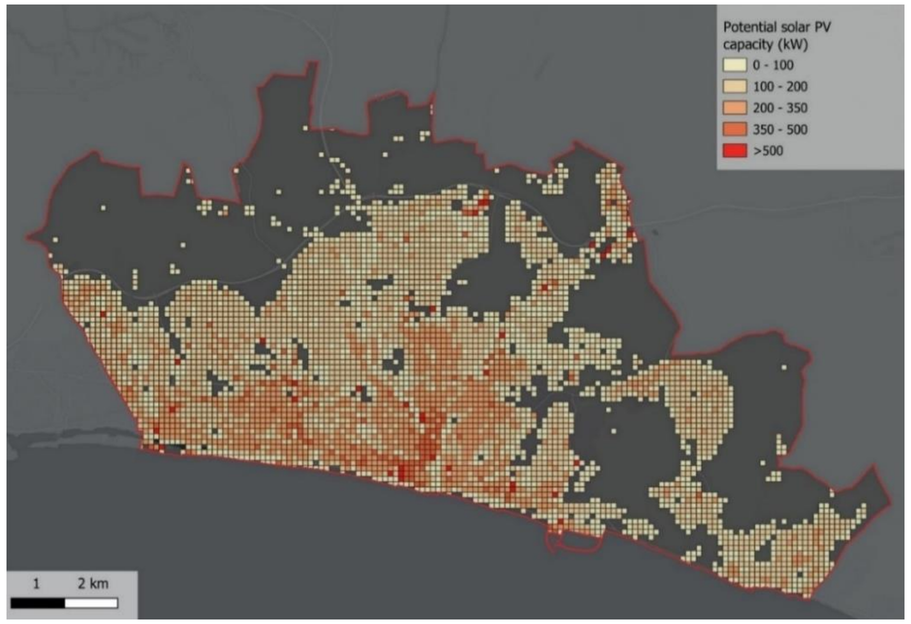


Figure 0—6 100m grid level potential solar capacity in Brighton & Hove (kW)

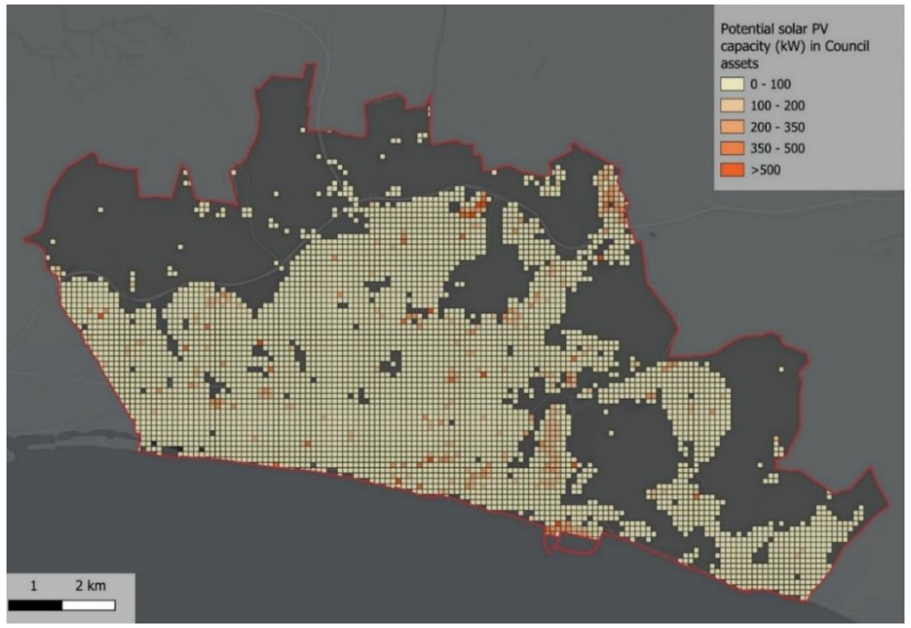


Figure 0—7 100m grid level potential solar capacity in Council assets (kW)

Figure 0—8 presents the priority areas for solar deployment, considering the outlined factors. The figure provides a summary of the major solar priority areas identified as early areas to consider in the analysis. The remaining areas are listed below and can be linked to the figure using the corresponding numbers on the map, with Table 0—7 providing an accompanying summary.

Table 0—7 Potential priority areas for solar deployment

No	description
1	**Woodbourne Ave** comprises a high number of **detached and semi-detached privately owned** houses. With majority of them having EPC D. This indicates the potential benefit from **rooftop Solar PV** to reduce their energy bills. Moreover, the households may be eligible to apply for Solar Together Sussex Scheme.
2	The area around **Moulsecoomb Way and Newick Rd** comprises over 700 Council housings, with above 50% having EPC D. In addition to reducing carbon emissions, this is a low-income area with high rate of fuel poverty and household could greatly benefit from roof top solar to reduce their energy bills. The Solar PV program has been rolled out in several houses in Newick Rd early 2024.
3	Council has a plan for developing a 2.5-6.5MW **solar farm**.
4	Potential for **Rooftop solar** and **PV canopies**[85] deployment in the **Hollingbury retail park**. The retails, offices, and warehouses present great potential for roof top solar installation. While these buildings are on the Council land, it remains unknown if they are under Council control. Th area consists of high number of car parks that could benefit from Solar Canopies. This shows a great location for integration of EV charging stations which can be coupled with solar and battery storage as well.
5	The area near **Warren Rd** is primarily privately occupied detached and semi-detached houses. The majority of properties have EPC D and below, indicating potential benefit from **rooftop Solar PV** to reduce their energy bills. The area is also suitable for heat pump deployment, and coupling with solar PV could provide great benefit. Moreover, the households may be eligible for Solar Together Sussex Scheme which offers discounted installation of solar panels and battery storage systems for able-to-pay households including homeowners and landlords.
6	There is a potential for circa 350kW **Rooftop solar** on the **Longhill High School** which is under local authority control. Roofs need to be surveyed and some may require replacement before solar deployment.
7	There is a potential for **roof top solar and Solar Canopy** deployments in **Brighton Marina.** The lands in Brighton Marina are owned by the Council; however, it is not clear if the Council has control over them. Moreover, roof top solar on the **Asda supermarket, shopping centres and a few blocks of flats**, there is a potential for **Solar Canopies in Brighton Marina and Asda car parks.** Coupling Solar Canopies with battery storages and EV charging stations could significantly reduce the charging carbon emissions. The proximity to the sea could reduce the panel lifespan and efficiency due to sea grime, and corrosion and this needs to be considered.
8	The **Whitehawk** is predominantly made up of Council housing. While the area already has large number of rooftop solar, blocks of flats and houses could still benefit from rooftop solar. As a low-income area, **coupling solar with battery storage** could lead to a significant reduction in households' energy bills. Coupling with battery storage could also lower any issue with the grid generation constraint.
9	The **Hyde Business Park** is accommodating a number of factories, workshops, and storages with large roofs suitable for solar deployment. These building are located on the Council land, but it is unknow whether they are under Council control. The industrial area could benefit from solar deployment, reducing their energy bills and powering their fleet. It is worth noting that, the roofs need to be surveyed before solar deployment.
10	The properties around the **Pankhurst Ave** are mainly semi-detached properties, with over 100 properties owned by the Council. In addition to reducing carbon emissions, this is a low-income area with high rate of fuel poverty and household could greatly benefit from roof top solar to reduce their energy bills.
11	There is a potential for roof top solar deployment in **Eastern Rd**, which consists mostly Council housing (over 60%) comprising of high-rise and low-rise flats as well as a number of terrace houses. This is a low-income area which could greatly benefit from solar deployment.
12,13	There is a potential for **solar deployment** on the Council owned buildings including **Brighton Centre**, **Jubilee Library**. Moreover, there is potential for **Solar Canopies on the NCP Theatre Car Park** to be integrated with battery storge and EV charging stations.
14	There is a potential for roof top solar in the mid-rise flats owned by the Council in **Clarendon Rd** including Clarendon House, Conway Court, Ellen House, and Goldstone House. This area is characterized by a high number of electrically heated flats, and integrating rooftop solar can substantially reduce household energy bills. It is worth highlighting that multiple ownership could lead to issues and complexities related to the ownership and practicality of deploying solar PV on the roof of block of flats. Legal arrangements must be carefully addressed to ensure successful implementation.
15	The **Aldrington area** comprises a high number of terrace houses and low-rise flats, mostly privately- occupied or privately rented. With the majority of them having EPC D and below, roof top Solar PV could be a great opportunity, particularly for privately occupied houses, to reduce both emissions and energy bill. However, the roofs condition needs to be reviewed, as the area has large number of old houses, and the roof might need replacement before solar deployment.
16	The area around **Hangleton Way** primarily consist of **Council owned low-rise flats and houses** which could benefit from Council plans for solar deployment. This is a low-income area and particularly poor energy performance properties (EPC D and below) could greatly benefit from solar deployment. The **king's School Hove** is a key building with great potential for rooftop solar PV.
17	There is a potential for **roof top solar on a number of low-rise flats,** majority council owned, including Wish Court, Jordan Court, Stevens Court, Benson Court and other buildings in **Ingram Crescent West**.
18	There are over 200 Council owned terrace and semi-detached properties around **Egmont Rd**, with high count of EPC D and below. These properties could benefit from roof top solar. However, the roof orientation might not be optimal to achieve highest solar output ins some properties. Currently, 49 properties have already been identified for the Council current solar program in this area.
19	**Graham Ave** primarily consists of privately-owned/occupied semi-detached houses. Most properties have EPC D (above 60%), along with low disruption fabric improvement such as loft top up, they could benefit from whole house package including **rooftop solar PV** coupled with Battery storage and heat pump. Moreover, the households may be eligible to apply for Solar Together Sussex Scheme.
20	There is a potential for **roof top solar deployment** in the properties around **Trafalgar Rd**. The area consists of 60% privately-owned property and 20% Council housing. Besides lowering the carbon emissions, the households in this low-income area with high fuel poverty could benefit from roof top solar to reduce their energy bill.
21	In an industrial area in **Portslade**, there are several factories, workshops, and offices with large roofs suitable for solar deployment. However, these roofs need to be surveyed before solar deployment. The area experiences the grid constrains during summer and could greatly benefit from solar generation during summer.

[85] Solar canopies typically found in outdoor areas such as parking areas and open areas. They provide both shade and shelter while simultaneously generating clean energy.

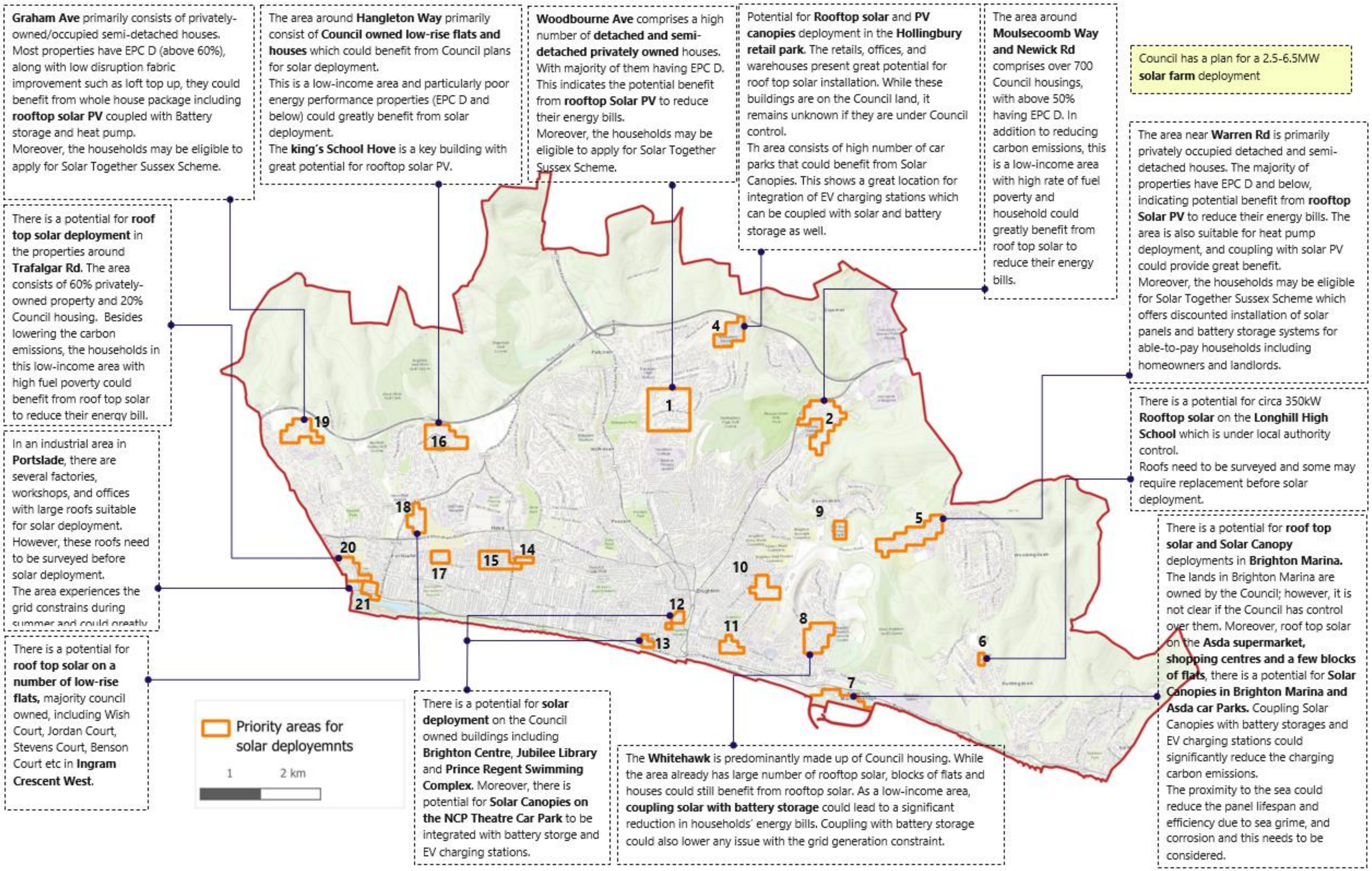


Figure 0—9 Priority areas for solar deployment

PV costs and support

The DESNZ (2023) solar deployment cost[86] data has been utilised to estimate the roof top solar deployment cost across different DFES scenarios as outlined in Table 0—6.

The roof top solar cost has seen a significant fluctuation recently, including a large increase in 2022/23. According to DESNZ cost data, the cost of large (10-50kW) system is about 55% of the cost of small system (0-4kW). The median cost of small system has been £2237 per kW solar output. However, through bulk purchase it might be possible to achieve lower cost per kW. Table 0—8 lists the cost data has been used for solar cost calculations.

Table 0—8 The roof top solar deployment cost adopted from DESNZ 2023[86]

Roof top solar size	Cost £/kW
0-4 kW	2237
5-10 kW	2077
11-50 kW	1226
>50[87]	1104

The total cost of roof top solar deployment is estimated circa £129m for 74MW solar installations by 2040 in the DFES "Leading the Way" scenario. Moreover, there is going to be an additional cost of ~£1m per MW for the Council planned solar farm.

Non-solar renewables

Although, solar is the focus of the renewable reporting it is not the only renewable that was considered. Energy from waste and anaerobic digestion were considered but the incinerator in Newhaven process much of Brighton & Hove's waste which would be suitable from energy recovery (it is also questionable the extent to which energy from waste is renewable). There is also no obvious additional source of waste for anaerobic digestion.

Offshore renewables were considered to be out of scope, although the Rampion wind farm is close by to Brighton & Hove. This leaves onshore wind for consideration. The neighbouring Shoreham Port does have wind turbines, which are functioning very efficiently. However, the character of the seafront of Brighton & Hove, including the marina, is not as suitable for wind deployment in terms of impact on activity and place. Outside of the coastal areas all the remaining areas which are suitable fall on protected downland and National Park. With the best resource being on the eastern downland this is explored in Figure 0—10 which uses data from Technical University of Denmark's Global Wind Atlas[88]. It explores wind speeds at a 50 m hub height, as large scale 100 m hub height turbines have not been installed in the South Down National Park. For context any windspeed of 7 m/s or above would be considered viable for turbine deployment.

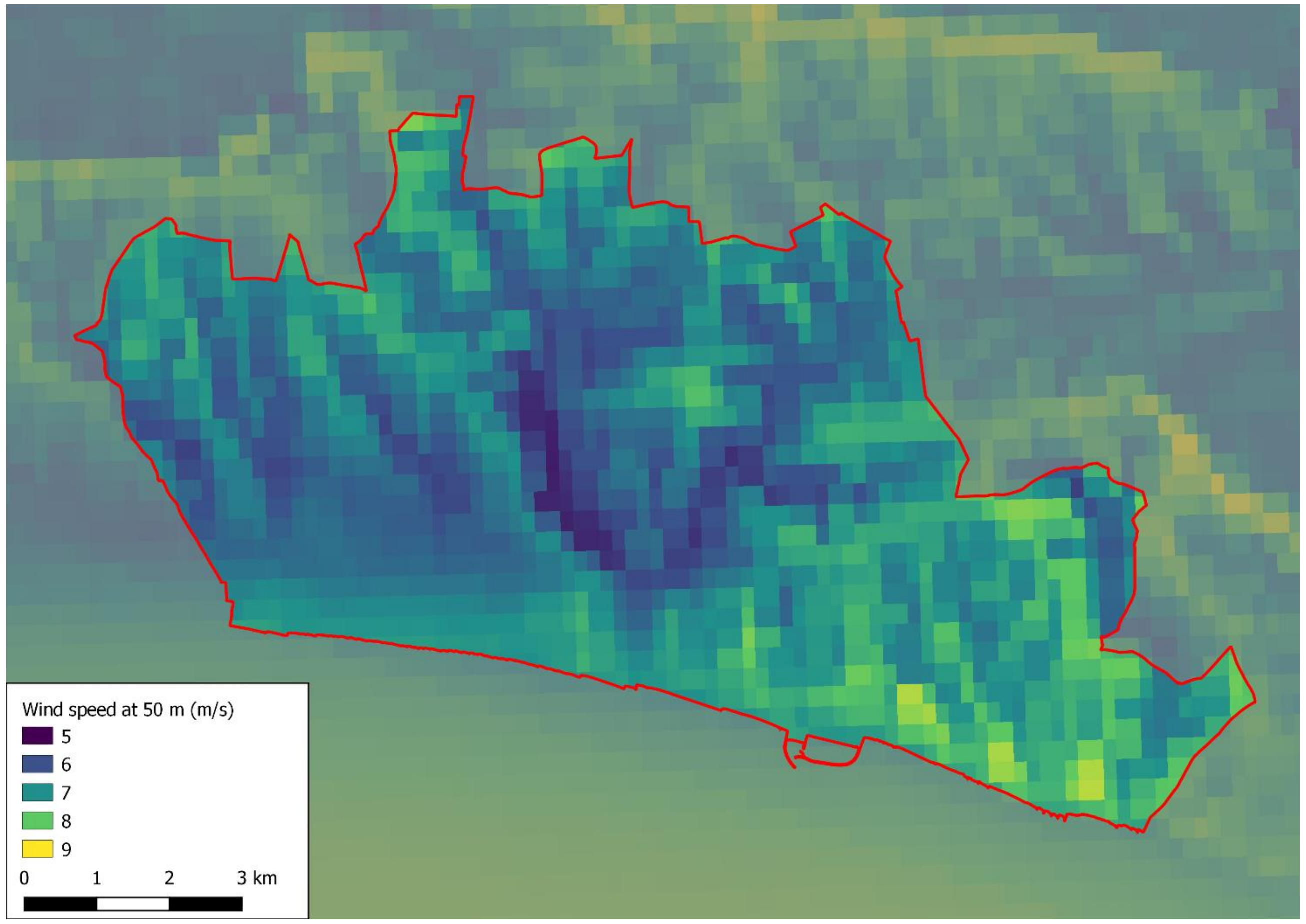


Figure 0—10 Wind speed at 50 m above ground level.

Although there is a relatively local instance of a wind turbine being constructed in the National Park (at Glyndebourne), it was deemed to be too great a planning risk to include for Brighton & Hove. Also, as the grid continues to decarbonise and the likely length of the planning process for a wind turbine development, unless there is a local private wire opportunity, it was not considered a viable technology.

[86] https://www.gov.uk/government/statistics/solar-pv-cost-data
[87] It is assumed 15% lower than the cost of 11-50kW systems
[88] https://globalwindatlas.info/en

Transport

The focus of transport analysis for the decarbonisation pathways is on the enabling infrastructure for electric vehicle (EV) deployment. Brighton & Hove City Council are developing an updated Local Transport Plan (LTP). This covers a fuller examination of the decarbonisation of transport across Brighton & Hove, ranging from EV deployment and associated charging infrastructure, to modal shift towards public transport and active travel. The shift towards active travel and public transport use are recognised by the Committee of Climate Change as being key to achieve early decarbonisation in the transport system. The principles of the LTP will align with the Committee on Climate Change's Sixth Carbon Budget rather than Distribution Future Energy Scenarios (DFES) which is the greater basis for this pathways analysis. However, they are generally compatible, particularly with the electric vehicle elements, which is the focus of this pathway analysis. What is clear from all scenarios aiming for early decarbonisation is that decarbonising the transport sector needs to be a focus before the UK Government's policy of banning new petrol and diesel cars comes into place in 2035 and not waiting until this milestone date.

This shift towards electric vehicles will result in increased efficiency of the transport sector in relation to energy usage. Existing internal combustion engines are very inefficient converting 12%–30% of fuel energy in petrol vehicles. Electric vehicles however typically convert 77-80%[89] of the electrical energy from the grid to power at the wheels. So, whilst electricity has a lower carbon footprint than petroleum this effect is multiplied by lower energy requirement per mile.

Current transport system

The current transport system within Brighton & Hove is summarised in Figure 0—1, taken from the 2021 public consultation on Brighton & Hove's direction of travel for their fifth Local Transport Plan (LTP5)[90].

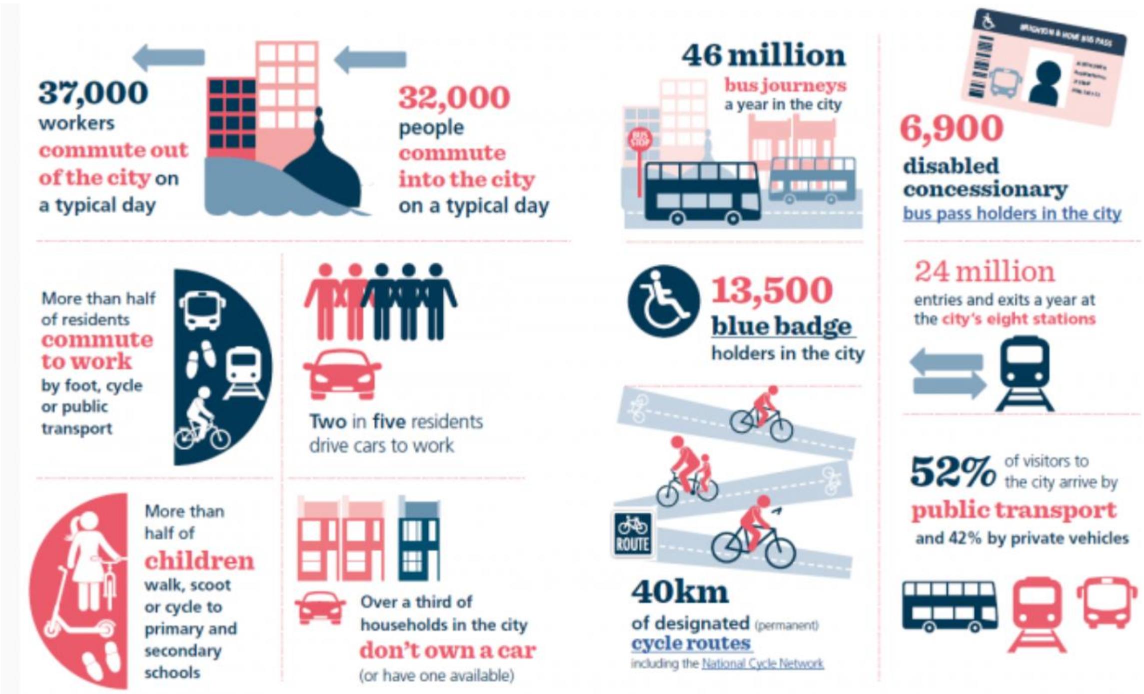


Figure 0—1 Transport and Travel Today

The use of cars for commuting (40%) is notably lower than the national average of (68%[91]), with lower proportions typical for more urban environments, with these often having more substantial public transport infrastructure. A shift towards public and active travel for commuting is a positive change in consumer behaviour aiding in reducing emissions within the transport sector.

The use of cars by 'visitors' Increases reliance with 42% of 'visitors' arriving to Brighton & Hove via their own private vehicles. With the large number of tourists Brighton & Hove receives annually (11.5 m per year in 2022[92]), this poses a challenge to the electrification of transport, as the charging of visitor vehicles will require provision.

Public transport is already heavily embedded in the transport system within Brighton & Hove, with buses contributing to 38.8 million bus journeys a year in the city for 2023[93], although below pre-covid levels of 48.6 million journeys in 2020, 2023 statistics outline Brighton & Hove as having the highest passenger journeys per head outside of London with 140.3 journeys per head. Brighton & Hove Buses were engaged during the pathways process, highlighting substantial electrification plans, with a key challenge for electrification being the lack of charging outside of depots (which are away from the main bus stations).

Although the rail network plays a significant part in Brighton & Hove's transport system it is not included in this analysis. This is because it requires a national or regional approach to decarbonizing trains (most often through track electrification but train level solutions exist). Furthermore, the southeast of England has some of the highest levels of track electrification in the country[94] – meaning that from the national perspective, it is relatively well progressed.

Shoreham and Newhaven ports are key hubs for marine traffic along the south coast. Newhaven and the vast majority of Shoreham Port (including the largest emitters) fall outside of Brighton & Hove. Thus, even though there is marine traffic associated with Brighton & Hove it falls outside the direct remit of the city and as such is excluded from analysis.

Vehicle numbers

As the shift to electric vehicles is the key focus of the transport element of the pathways analysis it is important to understand how the number of vehicles will change over the course of the pathway. This focus on vehicles is due to the energy infrastructure led approach to the pathways analysis. Mode shift has a very important part to play, particularly for enabling early reductions. However, this complex issue is best considered in the dedicated transport plan being developed by BHCC.

[89] https://www.ucl.ac.uk/bartlett/news/2021/aug/energy-efficiency-first-fuel

[90] https://www.brighton-hove.gov.uk/sites/default/files/2021-09/7156%20Local%20Transport%20Plan%20consultation%20WEB.pdf

[91] https://www.gov.uk/government/statistics/transport-statistics-great-britain-2023/transport-statistics-great-britain-2022-domestic-travel#:~:text=Travelling%20to%20work%3A%20Commuting%20by,much%20lower%2C%20at%2029%25.

[92] https://www.visitbrighton.com/dbimgs/Economic%20Impact%20of%20Tourism%20-%20%20Brighton%20and%20Hove%20Report%202022.pdf

[93] https://www.gov.uk/government/statistical-data-sets/bus-statistics-data-tables#local-bus-passenger-journeys-bus01

[94] https://www.networkrail.co.uk/running-the-railway/looking-after-the-railway/track/third-rail/#:~:text=We%20have%20the%20largest%20third,the%20South%20East%20of%20England.

Baseline numbers

Brighton & Hove had a 2023 (Q4) licensed road vehicle count of 111,260[95]. Cars were the dominant vehicle type with ~83% of the vehicle count at ~92,300. The second highest vehicle type by count was light goods vehicles (LGVs) corresponding to ~11% of all vehicles at ~11,900. Both vehicle types require very similar infrastructure for the switch to electrified solutions. As detailed in Figure 0—1 a third of households do not have (or don't have access to a car), this is important as compared to the resident population of 277,200 for Brighton & Hove, the total number of licensed vehicles equates to 1 vehicle per 2.5 residents indicating there are a large number of households with multiple cars.

A breakdown of the percentages of licensed vehicle types in Brighton & Hove for 2023 (Q4) is provided below:

- Cars = 83.0%
- LGVs = 10.7%
- Motorcycles = 4.7%
- Buses and coaches = 0.7%
- HGVs = 0.3%
- Other vehicles = 0.5%

Please note that the above statistics are based on the registered keeper (private owner's or company's registered address) of the vehicle located within Brighton & Hove. The address does not necessarily reflect where the vehicle is actually located. This is especially true for large fleets kept by companies involved with vehicle management, leasing or rentals. For reference, 8.6% of the 111,260 vehicles (9,542) have a 'Company' assigned keepership. The exact number of vehicles registered in a different local authority but located within Brighton & Hove is unknown.

Although relatively few in number, the scale of buses, coaches and HGVs means they require substantially larger charging infrastructure. As an indication of this, in a standard domestic setting, the typical charger rating for a car would be 7 kW whilst a bus or HGV could be closer to 250 kW – meaning each bus/coach/HGV charger would equate to ~36 domestic chargers in terms of installed capacity.

2030 projected numbers

Vehicle projections for Brighton & Hove used in this pathway analysis come from the National Electric Vehicle Insights and Support (NEVIS[96]). These indicate a very minor increase in the total vehicles licensed within the local authority, with an increase of +0.1% up to 112,150 an estimated increase of only 130 vehicles in the next 7 years.

Brighton & Hove's Joint Strategic Needs Assessment (JSNA)[97] estimates future 'resident' populations based on ONS population projections for the region and estimates a population increase of 3.9% totalling 303,000 residents by 2030. This higher increase in population versus vehicle statistics causes the number of 'residents' per vehicle to increase from 1:2.5 in the baseline to 1 vehicle per 2.7 residents.

Although it is slight, this increase of vehicle numbers could present challenges for decarbonisation. With no ban on new fossil-fuelled vehicles, this could slow decarbonisation of the transport system. Improved efficiency of newer vehicles will likely offset this growth, but to maximise decarbonisation it is important to reduce the use of these personal vehicles. As well as reducing the direct emissions from fossil fuel cars, the electricity grid has a higher carbon intensity in 2030 than afterward (see Figure 0—1) meaning the carbon impact of EVs will be lower after 2030.

[95] https://www.gov.uk/government/statistics/vehicle-licensing-statistics-july-to-september-2023
[96] https://nevis.cenex.co.uk/login
[97] https://www.brighton-hove.gov.uk/files/sites/bhconnected/files/brighton-and-hove-population-jsna-dec-2021.pdf

2040 projected numbers

NEVIS vehicle projections for 2040 also indicate very low growth, with an increase of +0.3% versus the 2023 baseline to 112,336 total vehicles, an increase in only 316 vehicles in 17 years from 2023 and 186 vehicles in the 10 years from the estimated 2030 NEVIS projections.

Based on resident population projections within the JSNA forecasting towards 2040, a 'resident' population of 319,143. Is estimated for 2040 This equates to a net reduction in vehicle ownership per head of the population, with the population estimated to increase by 9.4% and vehicles only by 0.3% from 2023 – 2040. This highlights the importance of the role of modal shift and strong public transport provision to ensure this reduction in personal vehicle ownership does not result in transport poverty.

Vehicle mileage

Vehicle mileage within Brighton & Hove has reduced in recent years, with the Department for Transport's (DfT) road traffic statistics[98] estimating 747.5 million vehicle miles for vehicles registered within the local authority. For consistency changes in vehicle mileage are considered against UK Government national scenarios for vehicle mileage (extracted for the South East region), these are presented in Figure 0—2 and are available from the DfT[99].

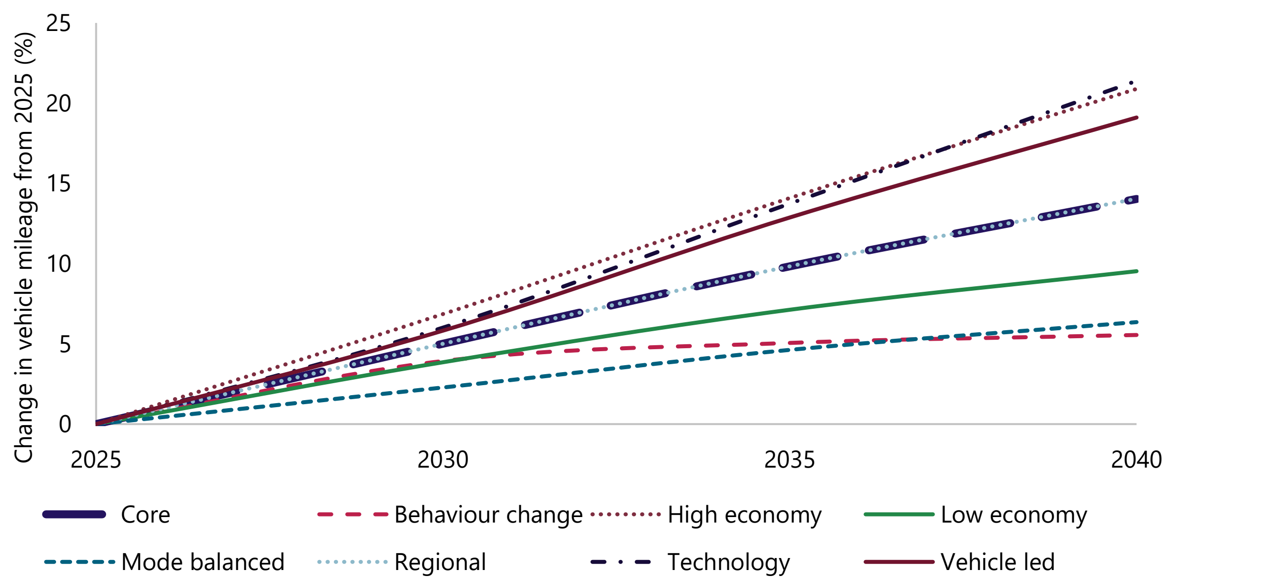


Figure 0—2 Overall percentage change in road vehicle mileage in the South East, compared to 2025.

All scenarios show some increase from the first timestep on the graph to 2040. The behaviour change and mode-balanced scenarios show the lowest overall increase in mileage <6.5% between 2025 and 2040. These two scenarios also have the most in common with the Consumer Transformation and Leading The Way Scenarios. The mode shift is shown to be particularly important in the early years, highlighting the importance of a holistic overall transport strategy.

From a mileage perspective mode balance is used within this analysis. It should be noted that improved vehicle efficiency means the impact of the increased mileage on demand is very low, even before the switch away from petroleum to electricity as the main fuel source.

[98] https://roadtraffic.dft.gov.uk/downloads
[99] https://www.gov.uk/government/publications/national-road-traffic-projections

Electric vehicles

In Brighton & Hove, the DfT's (DfT) vehicle statistics[100] identify 3,080 EVs registered within the local authority, equating to 2.8% of all vehicle numbers, up from 0.85% in 2020. The breakdown of vehicle type and number of electric vehicles is provided in Table 0—1. Similar to total vehicle numbers, the number of EVs registered in a different local authority but located within Brighton & Hove is unknown.

Table 0—1 Baseline EV statistics (Q4 2023)

Vehicle type	EV Count	Percentage of all EVs	Percentage of Vehicle type
Cars	2,817	91.5%	3.1%
Light goods vehicles	136	4.4%	1.1%
Motorcycles	85	2.8%	1.6%
Buses and coaches	36	1.2%	4.4%
Heavy goods vehicles	3	0.1%	0.9%
Other vehicles	3	0.1%	0.5%
Total	**3,080**	**100%**	**2.8%**

Cars are the dominant form of EVs by vehicle type by a significant margin of over 2,800 vehicles, with LGVs second with a count of 136 vehicles. The spatial distribution of registered electric vehicles within Brighton & Hove by Lower Layer Super Output Area (LSOA) is presented in Figure 0—3.

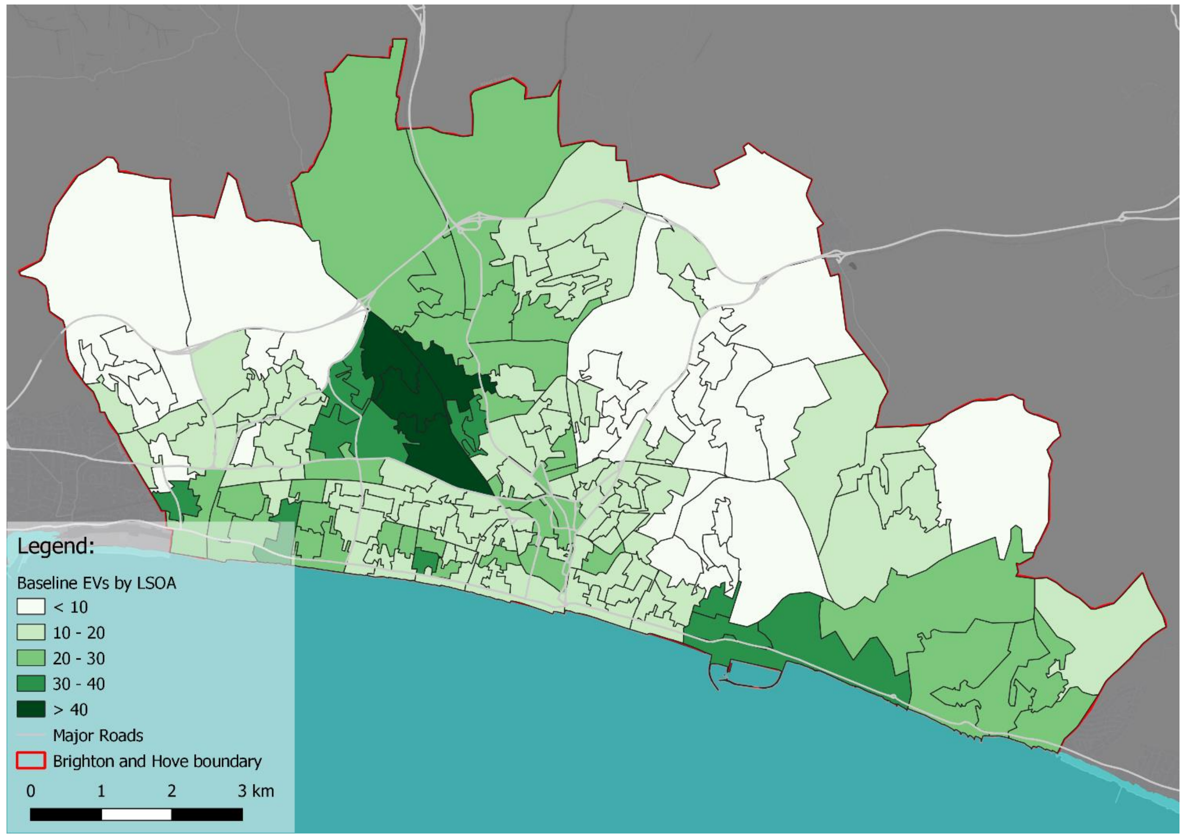


Figure 0—3 EV numbers by LSOA

Four LSOAs currently have a registered EV count greater than 40 with these locations between the areas of Prestonville and Withdean. Central Brighton would be expected to have relatively low numbers of EVs due to lower car ownership. Related to car ownership and the price of EVs there is a strong relationship between a low number of EVs and a high level of deprivation (a map of indices of multiple deprivation is provided in Figure 0—18). This presents a challenge as it is important for a just transition that all communities can cost-effectively transition towards net zero. It should be noted that the cost of vehicles is not accounted for in the pathways, with the enabling infrastructure instead being the focus. This is common practice for reporting within Local Area Energy Plans.

2030 electric vehicle numbers

Electric vehicle projections for Brighton & Hove have been undertaken as part of the Quantifiable Carbon Reduction (QCR) Tool that Transport for the South-East are currently developing. These EV figures and projections for Brighton & Hove will be used in the further development of the council's Local Transport Plan 5 (LTP5).

QCR provides three core 'EV ready' projections which generally align with Brighton & Hove's ambitions, rather than select one pathway an average of these three projections is used. They indicate that in 2030, 29.75% of vehicles will be EV, equating to a total of 33,365 EVs. However, in comparison, the QCR "Business as Usual" scenario indicates that by 2030 only 17.09% of vehicles will be EVs, this is outlined in Figure 0—4.

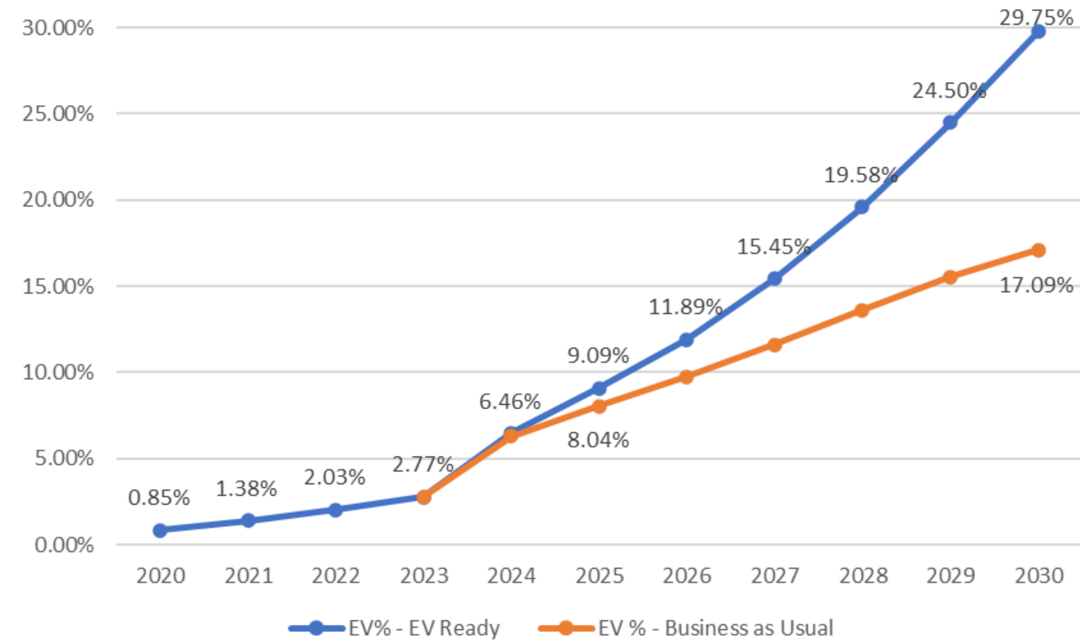


Figure 0—4 QCR 2030 EV projection

The divergence between the averaged "EV Ready" scenario and the "Business as Usual" scenario highlights the scale of the challenge. It is important that even though the scale of change is ambitious that enabling infrastructure does not hold back this shift, as is recognised by the Local Government Association – who states charging infrastructure needs to be in place to give consumers and businesses the confidence to switch to EVs[101].

2040 electric vehicle numbers

QCR EV projections are modelled to 2050, however the target of 2040 means a far faster switch will be required. Thus, for the 2040 scenario, EV roll-out will be fast-tracked so that nearly 96% of vehicles will be EV, equating to a total of 107,449

[100] https://www.gov.uk/government/collections/vehicles-statistics

[101] https://www.local.gov.uk/electric-vehicles-whats-going-out-there#:~:text=One%20of%20the%20greatest%20challenges,confidence%20to%20purchase%20an%20EV.

EVs. The required uptake rate required to reach ~96% EVs by 2040 is similar to the 2023-2030 QCR projections, as shown in Figure 0—5.

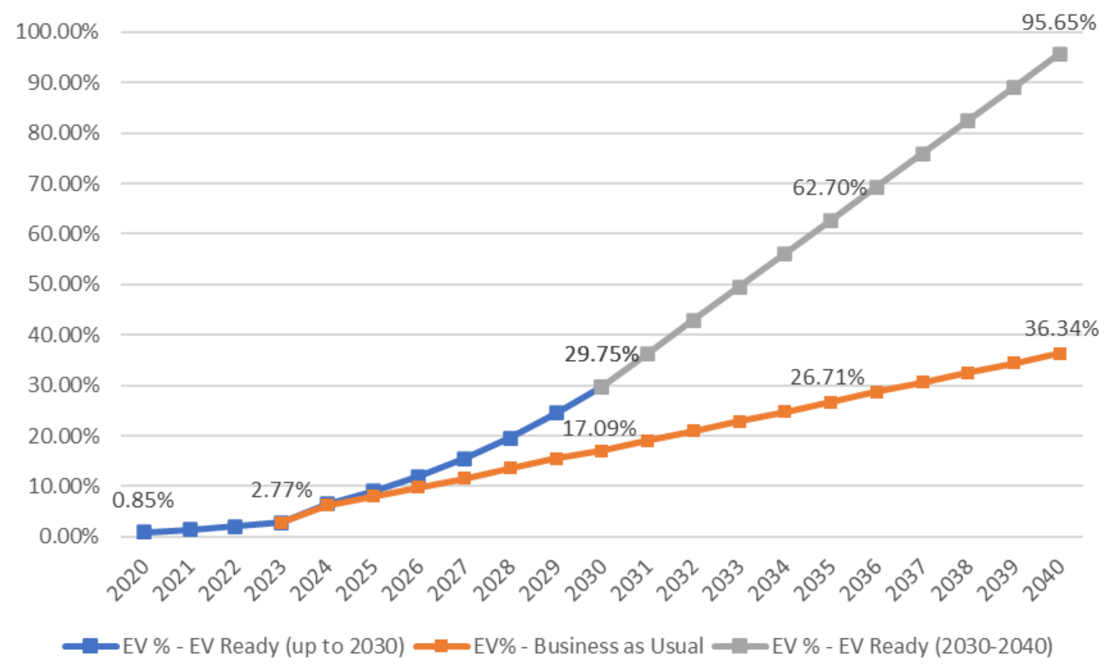


Figure 0—5 QCR 2040 EV projection.

To support this extensive uptake of electric vehicles will also be an extensive installation of required electric vehicle charging infrastructure (EVI).

Electric vehicle infrastructure

The deployment rates of EVI are based on 29.75% of vehicles being EVs by 2030 and 95.65% by 2040.

On-street charging

On-street charging refers to electric charging which is often pavement side. It can provide charging to all vehicles but the large-scale transition to EVs is of most significance in areas where residents do not have access to off-street parking (and thus potential charging). Local authorities will tend to have a far greater influence on this than off-street (although this may be relevant in some council properties), so it will be a greater focus for their charging provision. The UK Government recognise the importance of this challenge and are supporting local authorities through the On-Street Residential Chargepoint Scheme (ORCS)[102] and Local Electric Vehicle Infrastructure (LEVI[103]) funding.

Current on-street charging

The current status of public on-street electric vehicle charge points within Brighton & Hove is taken from the Department for Transport EV public charging infrastructure statistics dataset[104] and data provided by BHCC. Within the city (as of Q4 2023) there are a total of 432 publicly available charge points, with 96% of these being classified as below 50 kW. The number of charge points within Brighton & Hove has increased considerably in recent years, with 205 new installations of public charge points since Q4 2020, and an additional 126 already planned by the council. The 432 publicly available charge points have a combined installed capacity of 2.7 MW following engagement with BHCC. The distribution of these charge points by Lower Layer Super Output Area (LSOA) is presented in Figure 0—6.

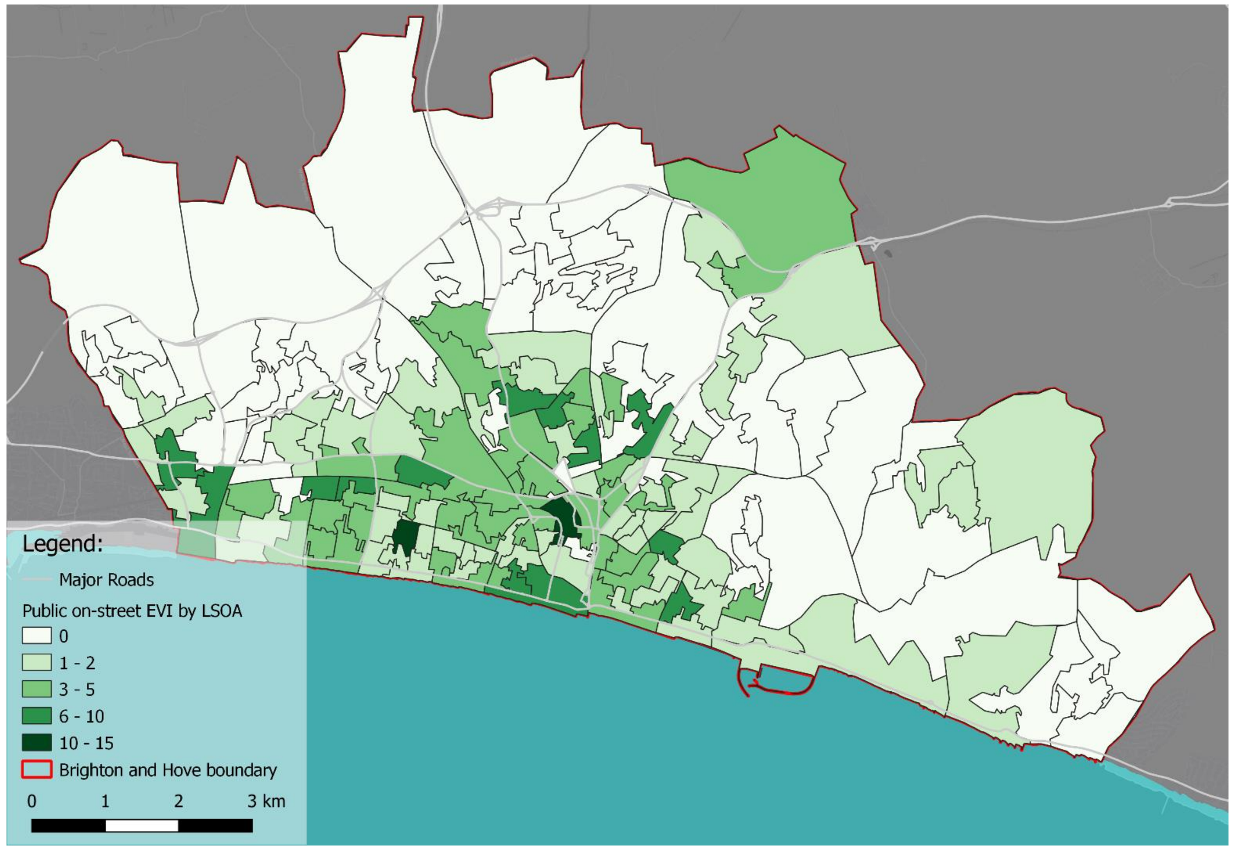


Figure 0—6 On-street EVI by LSOA

The deployment of publicly available on-street EV charge points is important to facilitate the uptake of electric vehicles for households which have no access to off-street parking or their own private residential charger. Innovative ways to support this transition include utilising existing street lighting infrastructure as hubs for electric vehicle charging, which has already been undertaken in Brighton & Hove[105].

Brighton & Hove is currently a leading figure in publicly available electric vehicle charge points within the South East, with 156.3 chargers per 100k population[106], while the South-East average is only 62.9 and the national average 73. In the South-East, outside London, only Milton Keynes has a higher count with 515 EV chargers.

2030 on-street charging

Forecasted estimates for Brighton & Hove (from NEVIS) show that by 2030, there will be a total of 2,498 publicly available EV charge points, split by 7.9% categorised as a 'high capacity' >25 kW charger, and 92.1% being 'low' capacity < 25 kW charger. This would require an increase of ~2,000 additional EV chargers in the next 7 years until 2030, an increase of 295 installations per year.

For 'low capacity' chargers a 50:50 split of 3.6 kW and 7.5 kW chargers are utilised in this modelling. This is because 3.6 kW chargers are already installed within lamp posts in Brighton[107], with these charging an EV in roughly 9-15 hours, as

[102]On-Street Residential Charge point Scheme supports local authorities in the UK to deliver electric vehicle charging infrastructure for residents without off-street parking, See: https://www.gov.uk/government/publications/grants-for-local-authorities-to-provide-residential-on-street-chargepoints/grants-to-provide-residential-on-street-chargepoints-for-plug-in-electric-vehicles-guidance-for-local-authorities
[103] The Local EV Infrastructure Fund supports local authorities in England to plan and deliver charging infrastructure for residents without off-street parking, See: https://energysavingtrust.org.uk/grants-and-loans/local-electric-vehicle-infrastructure-scheme/
[104] Electric vehicle public charging infrastructure statistics: April 2024 - GOV.UK (www.gov.uk)
[105] https://www.brighton-hove.gov.uk/travel-and-road-safety/electric-vehicle-ev-charging
[106] https://www.gov.uk/government/statistics/electric-vehicle-charging-device-statistics-october-2023
[107] https://electricbrighton.com/news/considerations-for-lamp-post-charging-infrastructure-in-brighton-hove

well as proposals in Brighton looking at 7.5 kW lamp post charger installations[108]. A 7.5 kW charger would typically charge an electric vehicle in approximately 4 to 5 hours.

For 'high capacity' chargers a 2:1 ratio of two 50 kW chargers per one 22 kW charger is used in this modelling. This ratio was chosen to align with the three existing 'rapid charging hubs' within Brighton & Hove at Ashton Rise (in the Tarner area near the city centre, Preston Park Avenue and Victoria Road (Portsalde), all consisting of six 50 kW[109] chargers and three 22 kW chargers. These hub sites provide dedicated bays for electric taxis, as well as EV-only bays for general public use, with a further two 'rapid charging hubs' planned at Elm Grove and Pankhurst Avenue[110]. A 22 kW charger will charge an EV in 3-4 hours, while a 50 kW charger will achieve this in 30 minutes to an hour.

A modelled electrical capacity of 20.82 MW would be required for these chargers:

- 'low capacity' – 2,300 chargers = 12.77 MW
  - 1,150 X 3.6 kW = 4.14 MW
  - 1,150 X 7.5 kW = 8.63 MW
- 'high capacity' – 198 chargers = 8.05 MW
  - 66 X 22 kW = 1.45 MW
  - 132 X 50 kW = 6.60 MW

In summary for 2030 the total number of on-street chargers required is 2,498 with a capacity of 20.82 MW.

2040 on-street charging

Forecasted 2050 NEVIS projections fast-tracked to be achieved in 2040 to align with the take up of EVs. By 2040 a total of 5,278 publicly available EV charge points are projected, split by 6.5% as a 'high capacity' >25 kW charger, and 93.5% being 'low' capacity < 25 kW charger.

NEVIS projects that by 2040 a smaller % of 'high capacity' chargers for 2040 versus 2030 (6.5% versus 7.9%). However, to incorporate an uplift in demand due to tourists and visitors into Brighton & Hove utilising public on-street parking, the 2030 7.9% 'high' capacity and 92.1% 'low' capacity charger proportions will be utilised as visitors and tourists would be more likely to use 'fast' chargers as destination charging.

This would require an estimated electrical capacity of 32.08 MW, an increase of 11.26 MW from 2030, and 29.48 MW from the baseline:

- 'low capacity' - 4,862 chargers = 26.98 MW
  - 2,431 X 3.6 kW = 8.75 MW
  - 2,431 X 7.5 kW = 18.23 MW
- 'high capacity' – 416 chargers = 16.91 MW
  - 139 X 22 kW = 3.06 MW
  - 277 X 50 kW = 13.85 MW

In summary for 2040 the 5,278 on-street chargers would have a capacity of 32.08 MW.

[108] https://electricbrighton.com/news/considerations-for-lamp-post-charging-infrastructure-in-brighton-hove
[109] https://electricbrighton.com/victoria-road-rapid-hub
[110] https://www.brighton-hove.gov.uk/parking/parking-annual-report-2022-2023/2-electric-vehicles

Off-street charging

The most common form off-street charging is a house with a driveway, allowing for at-home charging, as well as flatted developments with allocated parking.

Current off-street charging

The transitional shift to EV uptake will also result in a substantial requirement for residential charging infrastructure at a household level. Baseline figures surrounding the current number and capacity of off-street chargers is unknown due to the lack of private figures.

The number of households with off-street parking within Brighton & Hove is estimated at ~61,000 which is ~50% of all households. This figure is derived from national percentage proportions with 'on plot'/'off-street' parking per housing typology from the English Housing Survey[111], ranging from 27% for flats, to 96% for detached properties. This proportion (based on national estimates) is similar to a separate figure of 46% of properties have off-street parking availability for the whole local authority in an independent research and analysis undertaken by Field Dynamics[112] utilising 2022 data.

2021 Census numbers[113] indicate that for Brighton & Hove over a third of households (37%) in the city do not own a car, while 19.8% own two or more. This compares to the South East average of 19.4% of households not owning a car or van and 36% owning two or more such vehicles. These 2021 Census figures for Brighton & Hove also outlined that 20% of houses or bungalows did not own a car or van, while for flats, maisonettes, and apartments this figure was 55%. The number of households with off-street parking and a vehicle is outlined in Table 0—2.

Table 0—2 Assumed off-street parking numbers

Building Typology	No. Residences	% Off-Street Parking	No. Residences with off-street parking	2021 Census (% car ownership)	No. Residences with off-street parking AND a car
Terrace	28,074	41.5%	11,651	80%	9,088
Semi Detached	22,006	82%	18,045	80%	14,075
Detached	7,989	96%	7,669	80%	5,982
Flat	73,676	27%	19,893	45%	8,952
Bungalow	4,888	77%	3,764	80%	2,936
Total	**136,633**		**61,022**		**41,033**

These figures can be used to infer the number of off-street charger opportunities across Brighton & Hove, this is done in Figure 0—7. In these areas, EV charging infrastructure would tend to be at the household level and consequently, not as great a focus for intervention by Brighton & Hove City Council.

[111] https://assets.publishing.service.gov.uk/media/5d2ecf5e40f0b64a8099e1b8/EHS_2017-18_Energy_Report.pdf
[112] https://onstreetcharging.acceleratedinsightplatform.com/
[113] https://www.ons.gov.uk/datasets/RM001/editions/2021/versions/1

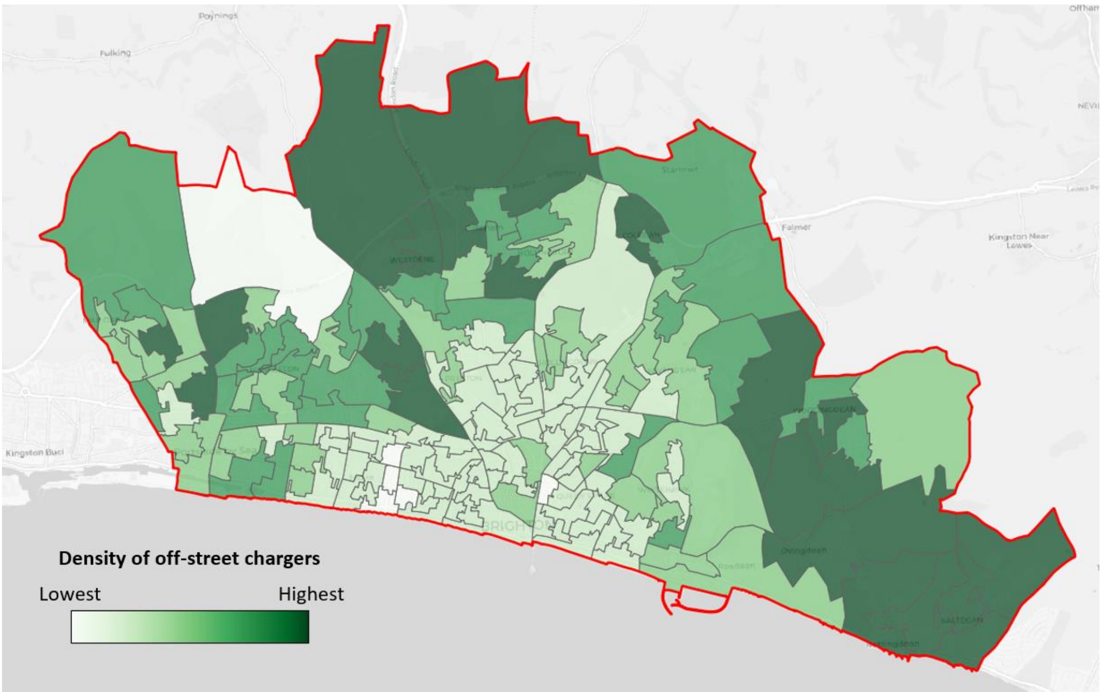


Figure 0—7 Indicative density of off-street charger opportunities across Brighton & Hove.

The areas with the lowest density of off-street chargers should be the focus for on-street solutions. This is broadly reflected in the current deployment of existing on-street EV charging infrastructure (see Figure 0—6).

Future off-street charging

Household level off-street chargers to align to 'low capacity' on-street chargers at 7.5 kW as this broadly representative of devices currently on the market. Based on the projections discussed in 0 and the estimates of off-street charging potential in Table 0—2 the assumed domestic off-street EV chargers is provided in Table 0—3.

Table 0—3 Summary of off-street chargers in 2030 and 2040.

Year	Number of chargers	Installed capacity (MW)
2030	12,200	91.6
2040	39,250	294.3

Whilst the increase in installed capacity is very high it is also subject to a high level of diversity and flexibility under the Leading The Way and Consumer Transformation scenarios, thus reducing the stress it places on the grid and associated electrical infrastructure.

Car park charging

The transition to EVs will also be supported by extensive EV charger requirements at workplace, public car park and destination charging (such as chargers in hotel car parks and leisure centres), with car parks presenting an excellent opportunity for early deployment of EV chargers. As with on-street charging this charging infrastructure has a greater level of influence from Brighton & Hove City Council than compared with off-street.

Baseline car park charging

Within Brighton & Hove, 56 car parks and 1 park & ride site (Withdean) were captured in the baselining, with a combined total of 14,167 spaces, these car parks are mapped in Figure 0—8. This includes a combination of private, public, and council-run car parks with no sole tenure targeted, to identify the potential capacity for increasing EVI overall.

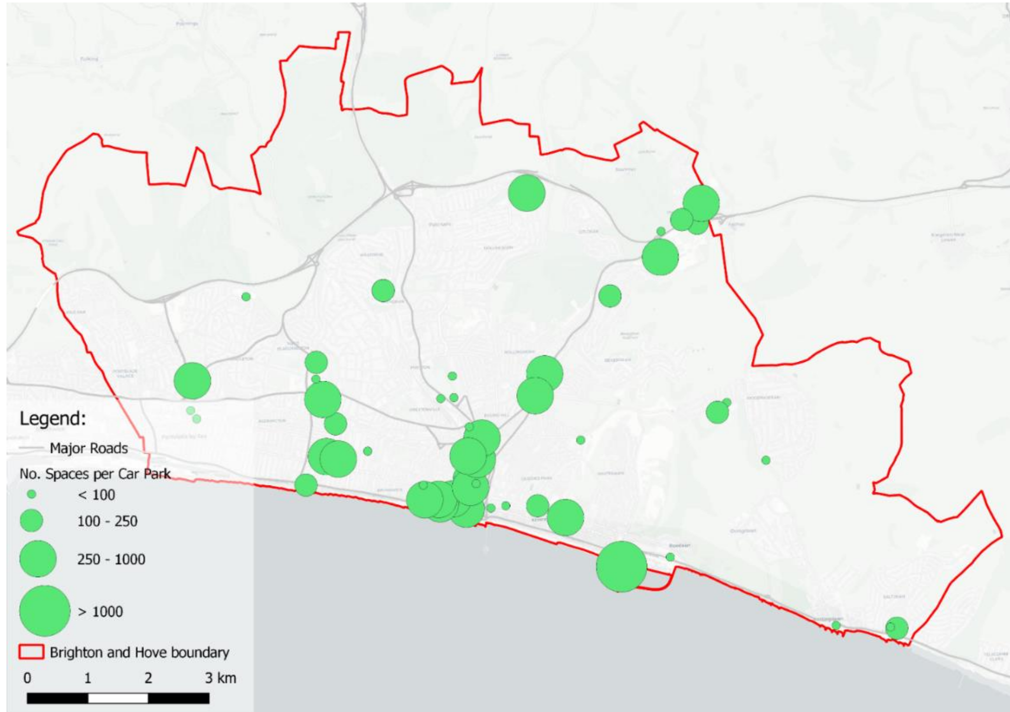


Figure 0—8 Current car parks in Brighton & Hove

The three largest car parks by capacity are:

1. Marina Village – 1,500 spaces
2. Churchill Square – 850 spaces
3. Bridge Car Park – 700 spaces

The largest overall hotspot areas (based on the density of number of car parks and associated spaces) from Figure 0—8 for existing car parks within Brighton & Hove are the areas of the City Centre, Denmark Villas, Falmer, or the Marina.

This analysis incorporates the existing 56 car parks and one park & ride site (Withdean) within Brighton & Hove (14,167 total car spaces).

Future car park charging

Car park charging is currently under review in Brighton & Hove following Fire Safety concerns within multi-storey car parks. It is worth noting that Brighton & Hove are not currently progressing with any new installations at Council multi-storey car parks due to these concerns. This section on future car park charging however assumes that by 2030 and 2040 respectively these concerns are no longer an issue and that multi-storey EVI deployment can occur.

The policy for car park charge points within this section relates to 'Part S – Infrastructure for charging electric vehicles[114]' which has been introduced into the Building Regulations and came into force June 2022. 'Part S' included new requirements for EV chargers in new-build and retrofitted properties of more than 10 parking spaces.

[114] https://assets.publishing.service.gov.uk/media/6218c5d38fa8f54911e22263/AD_S.pdf

Requirements state "a minimum of 1 charging point and cable routes for at least 20% of the remaining spaces". Following this requirement 30% of car park spaces have thus been utilised for the required number of charging points.

The council is undertaking a review of potential sites for Park + Ride. If a suitable site(s) is agreed, this would also provide an opportunity to increase EVI for the city, focused on visitor/longer distance journeys. Solar canopies to supplement charging, lighting and other power demand would be beneficial at these sites.

Charger capacity assumptions for the car park EVI analysis include that:

- Car spaces = 7.5 kW or 50 kW – Aligning to Section 0 "On-street" whereby in 2030 ~8% of public chargers are categorised as 'low capacity' (<25 kW) and ~92% as 'high capacity' (> 25 kW). 7.5 kW chargers are already being utilised as the typical charger capacity in car parks within Brighton[115] with the 2:1 ratio of 50 kW to 22 kW chargers for 'high capacity' aligning to that of the current 'rapid charging hubs' within Brighton & Hove.
- Coach spaces = 180 kW – aligning to analysis within Section 0 "Transport hub"

To align with Section 0 "On-street", an uplift in demand due to tourists and visitors into Brighton & Hove 7.9% of 'high capacity' chargers have also been used for 2040. Robust charging networks allow tourists to explore beyond their immediate vicinity, opening up more travel possibilities[116]. The availability of charging infrastructure reduces range anxiety, making tourists more confident in their EVs. A summary of the charger numbers and their associated capacity is provided in Table 0—4.

Table 0—4 Summary of car park chargers in 2030 and 2040

Year	Number of chargers	Installed capacity (MW)
2030	1,465	17.9
2040	4,884	59.8

The distribution of this capacity in 2040 by LSOA is provided in Figure 0—9.

[115] https://electricbrighton.com/russell-road-ncp-car-park

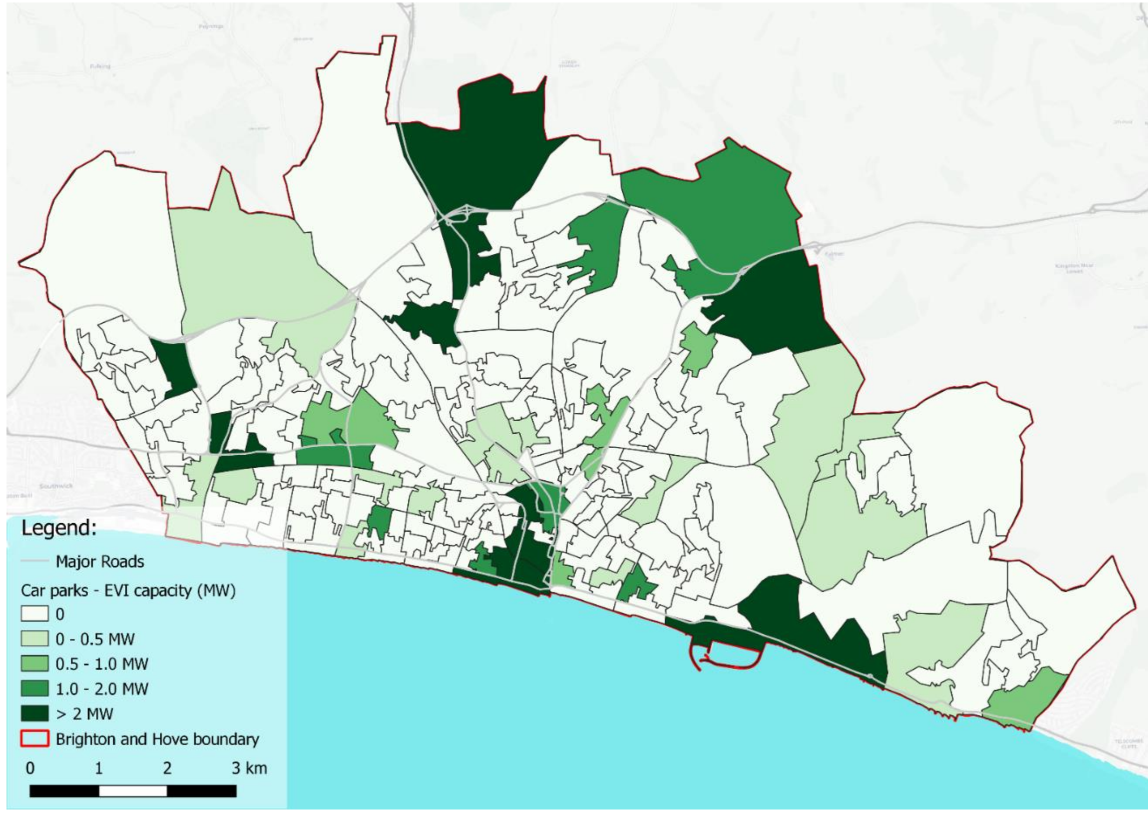


Figure 0—9 Car park EVI capacity per LSOA

The LSOA with the highest car park EVI capacity includes the Churchill Square Shopping Centre, this LSOA has a modelled EVI capacity of 8.1 MW.

PV canopies could also be integrated into these car parks, with electricity either being fed into the surrounding buildings, the grid or to charge the cars in the car park. In the case of the latter batteries are sometimes integrated, allowing for faster charging – whilst limiting the increased strain on the electricity network. The park and ride sites could benefit from considering coupling with the most. The city is a year-round destination, but peak tourism is in the summer, which also aligns with maximum PV output. As well reducing the carbon of the electricity used for charging and a revenue stream it also provides an opportunity to reduce the grid infrastructure required for EV charging on these sites.

Transport hub charging

For this study, transport hubs are defined as being locations where centralised charging infrastructure is or could be provided for key public services and large vehicles like HGVs. Whilst the number of these sites and number of vehicles is often small, they will tend to have a relatively high installed capacity of chargers to allow for electrification (due to large capacity chargers). These sites would also be the most likely focus for any hydrogen charging infrastructure in Brighton & Hove. This does not include transport hubs relating to ports and railways, for reasons previously discussed.

Within Brighton & Hove, 20 transport hubs were identified (Figure 0—10), split between seven categories:

- Ambulance Station = 3
- Fire Station = 3
- Hospitals = 3
- Police Station = 2
- Bus & Coach Depot = 5
- Waste Fleet Depot = 1

[116] https://cyberswitching.com/electric-car-charging-infrastructure-in-tourist-destinations/

- Large Industrial Estates[117] (with an area greater than 10 acres) = 3

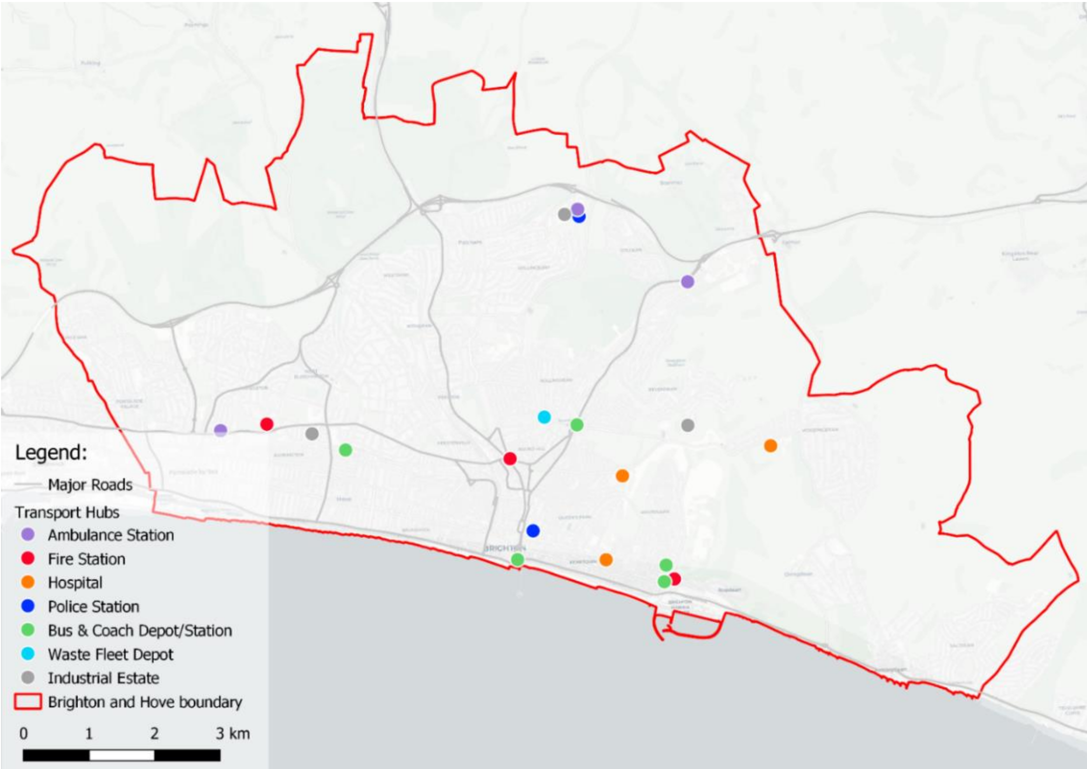


Figure 0—10 Transport hubs within Brighton & Hove

While smaller EV vehicles will typically utilise smaller capacity slower chargers up to 7 kW, transport hubs will typically utilise larger capacity chargers due to either charging larger road vehicles or the need to charge vehicles quicker.

The seven 'transport hubs' identified and their typical EV charger capacity requirement per charger is outlines as:

- Ambulance Station – 50 kW[118]
- Bus & Coach Depot – 180 kW[119]
- Fire Station – 150 kW[120,121]
- Hospital – 50 kW
- Police Station – 22 kW
- Waste Fleet Depot – 22 kW[122]
- Industrial Estates – 350 kW[123]

A summary of what this equates to for the scenario requirements in 2030 and 2040 is provided in Table 0—5.

Table 0—5 A summary of transport hub charger capacity

Year	Number of chargers	Installed capacity (MW)
2030	1,465	17.9
2040	4,884	59.8

The distribution of this capacity in 2040 among the 20 transport hubs identified is provided in Table 0—6.

Table 0—6 Transport hub breakdown

Transport Hub	Site	No Chargers	Site Capacity (kW)
Hospital	Royal Sussex County Hospital	4	200 kW
	Nuffield Health Brighton Hospital	1	50 kW
	Brighton General Hospital	2	100 kW
Fire Station	Roedean Community Fire Station	2	300 kW
	Preston Circus Community Fire Station	4	600 kW
	Hove Community Fire Station	2	300 kW
Police Station	Brighton Crowhurst Rd Police Station	3	66 kW
	Brighton Police Station	15	330 kW
Bus & Coach Depot/Station	Whitehawk Bus Depot – Brighton & Hove Buses	4	720 kW
	The Big Lemon (former Brighton Gasworks - Kemp Town)	4	720 kW
	Lewes Road Bus Garage	13	2,340 kW
	Brighton & Hove Bus (Conway Street)*	9	1,620 kW
	Pool Valley coach station	2	300 kW
Ambulance Station	East Sussex Medical Events Service	1	50 kW
	SECAmb Brighton Make Ready Centre	15	750 kW
	St John Ambulance First Aid Training Brighton	6	300 kW
Waste Fleet Depot	City Clean, Upper Hollingdean Road	24	528 kW
Industrial Estates	Hollingbury Industrial Estate	10	3,500 kW
	St Joseph's Business Park	8	2,800 kW
	The Hyde Business Park	2	700 kW

Electric Vehicle Infrastructure (EVI) summary

A summary of the number of required chargers and their combined electrical capacities within this chapter is captured in Table 0—7.

Table 0—7 EVI summary table

Category	No. EV Chargers		MW Capacity	
	2030	2040	2030	2040
On-Street	2,498	5,278	20.8	32.1
Off-Street	12,207	39,248	91.6	294.3
Car Parks	1,465	4,884	17.9	59.8
Transport Hubs	39	131	4.9	16.2
Total	**16,209**	**39,541**	**135.2**	**402.4**

This represents a large level of charger deployment in Brighton & Hove to achieve the 2040 decarbonisation target. It is important to note that these will vary slightly to values from the BHCC Electric Vehicle Strategy which is under development. The next Local Transport Plan (LTP5), which is also under development, will provide additional insights for actions that will help reduce the carbon footprint of the transport system. The focus of this section is to provide an energy rather than a transport system perspective of the transition, hence the energy infrastructure being the basis of the modelling.

[117] https://www.brighton-hove.gov.uk/sites/default/files/migrated/article/inline/downloads/economicdevelopment/Industrial_Estates.pdf
[118] https://www.was-vehicles.com/en/innovation/was-500-electric-ambulance.html
[119] https://www.heliox-energy.com/solutions/e-bus
[120] https://www.rosenbauer.com/en/int/rosenbauer-world/vehicles/municipal-vehicles/rt
[121] https://energybyentech.com/project/portland-fire-rescue-emobility-charging/
[122] https://www.autocar.co.uk/car-news/move-electric/first-ride-lunaz-upcycled-electric-vehicle-bin-lorry
[123] https://www.sseenergysolutions.co.uk/news-and-insights/first-electric-hgv-charging-hub

In terms of focus for Brighton & Hove City Council, apart from Council-owned properties, the off-street infrastructure is outside of their focus apart from securing EVI for new developments. This accounts for the greatest number of chargers and installed capacity. The Council's primary focus will be on on-street charging, these areas are highlighted in Figure 0—11. Whilst the installed capacity and charger numbers are lower in these areas they will be used more frequently and also enable all vehicle users to decarbonise. Also, as previously discussed, public infrastructure is key to building consumer confidence for the uptake of EVs.

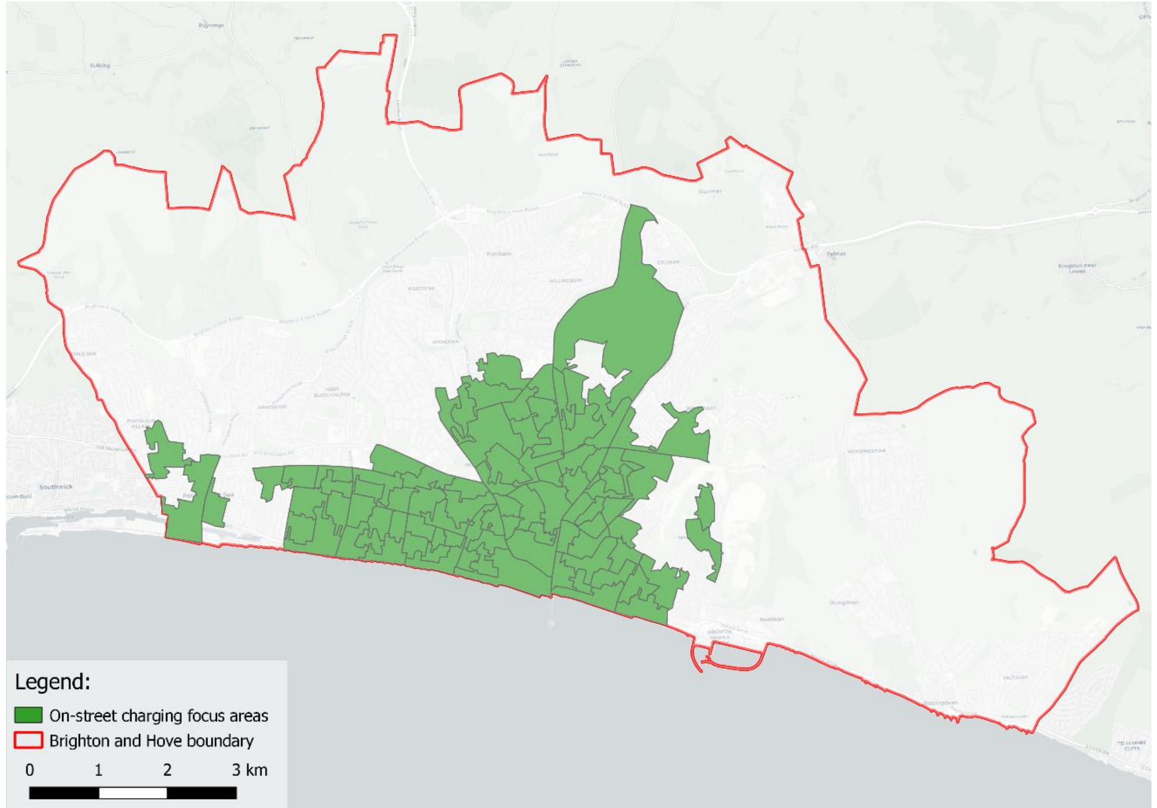


Figure 0—11 Focus LSOAs for car park and on-street EV charger deployment.

Energy networks

This section provides a brief background to the gas and electricity networks in Brighton & Hove. The latter is the focus of the section as it has a greater impact on the decarbonisation pathways.

Gas network

Natural gas is currently the single biggest source of energy in Brighton & Hove. The network in the area is operated by Southern Gas Networks (SGN). Whilst it does not form a component of the decarbonised energy system considered in this pathways analysis, understanding the system to an extent is important context for the baseline and direction of travel for the pathways.

Current status

Natural gas meets 85% of domestic heating needs in Brighton & Hove, with some commercial demand and very little industrial demand (for details of consumption figures see section 0). The distribution of demand throughout Brighton & Hove for different sectors is provided in Figure 0—1[124].

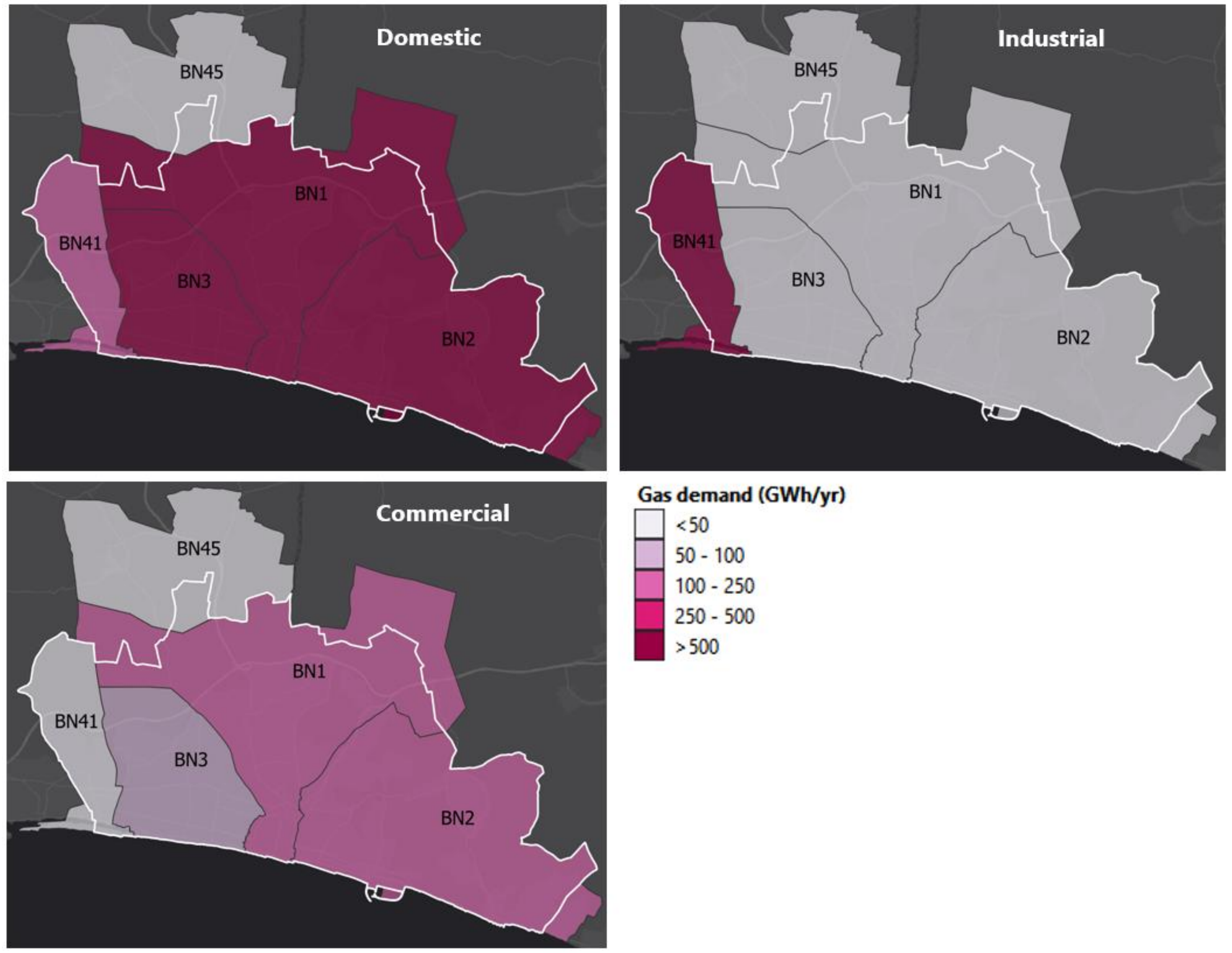


Figure 0—1 Gas demands for postcode districts in Brighton & Hove.

[124] Gas demand figures are from https://www.sgn.co.uk/open-data-sharing-portal

Domestic heating by gas is widely spread throughout Brighton & Hove, showing this will be a focus across the whole city. In the case of commercial gas demand (this includes the majority of non-domestic demands such as public buildings), this is more dominant in Brighton than Hove. This spread of commercial demand is reflected in the heat network opportunities identified – which tend to be driven by large non-domestic heat demands.

The only large industrial demand for gas comes from a power plant in Shoreham Port, however, whilst part of the postcode district falls within Brighton & Hove the industrial demand is outside the local authority boundary. As such it is not considered in this decarbonisation pathways analysis. Apart from this one site industrial demand is negligible in Brighton & Hove, again this supports the lack of hydrogen in scenarios – as large industrial demands are often seen as the major pull for hydrogen.

Impact of decarbonisation pathways on the gas network

As discussed in 0 hydrogen is not considered for standard heating applications in this decarbonisation pathways, this requires a drop in gas consumption to essentially zero by 2040 in order to meet decarbonisation targets. Biogas and biomethane blending into the gas grid could help provide some near-term reduction in gas carbon footprint but this would not result in a zero carbon solution.

The removal of gas will be a huge challenge with costs outside the roll-out of electrified heating and the associated electricity network reinforcement. From the gas sector side this would either be from the removal or backfilling of assets with concrete to prevent threat of subsidence (which has a high associated carbon footprint).

Alternative uses for the gas infrastructure such as repurposing for heat networks or aligning removal with laying new cables for electricity reinforcement (avoiding digging up the same road twice) have been considered in national scenarios. Such approaches can help reduce the burden of cost associated with decommissioning. However, these novel approaches and/or the cost associated with removal or back filling the gas networks are not considered here as the cost burden would fall outside Brighton & Hove.

The reduction in gas usage will mean the price of gas for those remaining on gas heating is likely to increase, due to the costs of network maintenance and similar factors falling on fewer customers. This could present a risk to those in fuel poverty and should be monitored as properties shift away from gas. Gas network operators are exploring the impact of electrification in different decarbonisation scenarios on their networks and the associated costs, this includes live projects from Ofgem and Innovate UK's Strategic Innovation Fund[125].

Electricity network

UK Power Networks run the electricity networks in Brighton & Hove, they operate as both a Distribution Network Operator (DNO) and a Distribution Service Operator (DSO). The DNO element focuses on traditional elements of the network, such as connecting new demands and generators, managing and maintenance of assets and reinforcement. The DSO part of UKPN has been in place since April 2023, this element is focused on using smart technology and increasing transparency to better deliver network capacity. This more whole system orientated approach, rather than just the distribution network infrastructure (which is the DNO element), should help enable faster transition towards decarbonisation of the energy system. This is enabled through better understanding of long-term decarbonisation aspirations and pathways, as well as schemes like flexibility services described in 0. However, first of all it is important to understand the current electricity network in Brighton & Hove.

Current electricity network

The electricity network in Brighton & Hove has capacity for additional demand, however, the level of available capacity varies across the network – as shown in Figure 0—2.

[125] https://www.ofgem.gov.uk/strategic-innovation-fund-sif

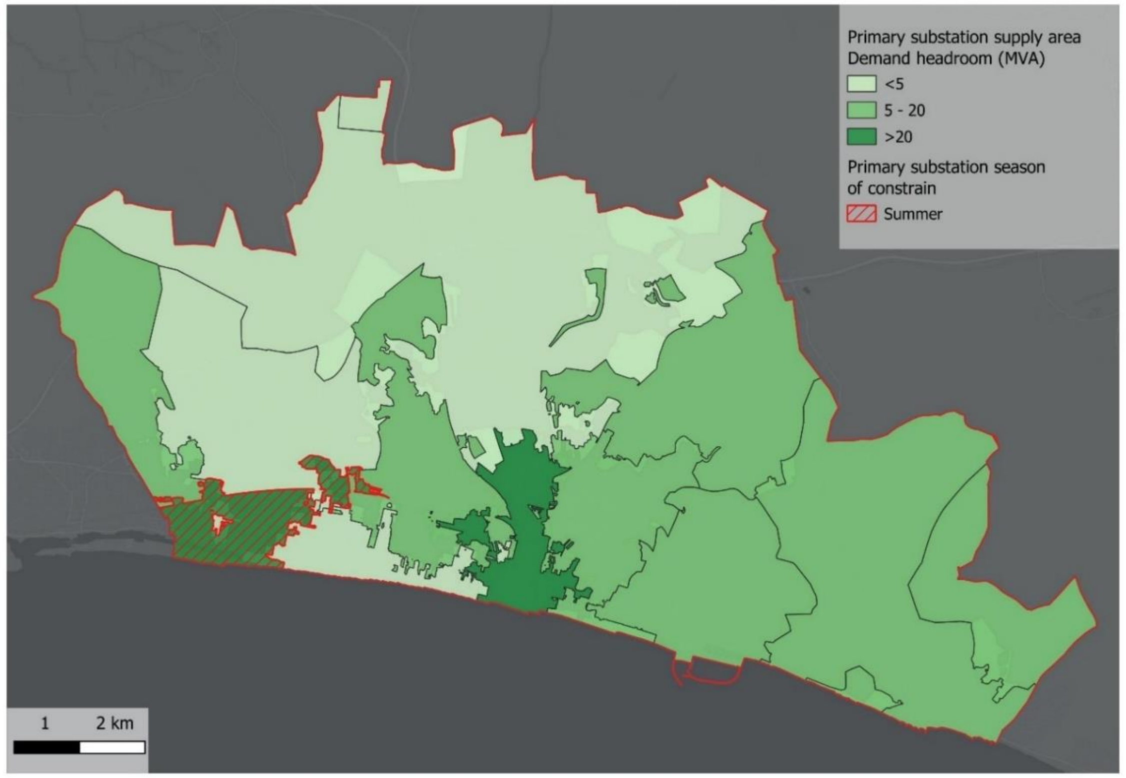


Figure 0—2 Primary substation supply headroom.

The areas with the least headroom will generally be able to absorb the least additional technology before upgrades are required. It is interesting to note that peak demand for electricity tends to be in winter across Brighton & Hove, with only a small area in the southwest of Hove peaking in summer. A peak in summer often indicates a high level of air conditioning, with climate change the requirement for this is increasing and in some London boroughs demand is already peaking in summer. However, with a shift to electrified heating even though demand for conditioning is likely to increase in Brighton & Hove peak demand is likely to remain in the winter.

For context of the demand headroom a new domestic heat pump would generally require a connection of under 3 kVA[126], 5 MVA would translate to capacity for ~1700 domestic heat pumps. However, with a diversity factor[127] of 0.8 applied, which is the minimum considered for heat in the decarbonisation pathways this rises to ~2125 domestic heat pumps, illustrating the value of demand diversity as highlighted in section 0. For comparison to full pathway roll out of heat pumps, a primary substation area could have a target heat pump deployment of ~6000.

It is not just heat which is electrified in the pathway. Many of the properties with individual heat pumps will also be those to have off street parking and individual EV chargers. In 2030 ~92 MVA of off-street EV chargers are required in the high decarbonisation pathways. However, studies from UKPN[128] indicate that a diversity of 0.2 is suitable for EV charging at home. This means the home based off-street charging infrastructure would require ~18.4 MVA in 2030.

The greatest costs and capacity constraints are generally seen below the primary substation level, in the cables and secondary substations connecting properties to the primary substations. Information on the capacity of these elements of the electricity network is far more limited meaning detailed reinforcement conclusions are hard to draw. However, the data generated through the pathways analysis will be provided to UKPN, which will enable greater insights into this – through integration into their workflows.

In summary Brighton & Hove appears well suited to some immediate electrification of both heat and transport but reinforcement of the electricity grid will be needed. The areas that are most likely to need reinforcement early are parts of Withdean and Portslade, as well as Hangleton and the seafront in Hove.

Flexibility

Flexibility[129] is a key enabler of electrification and thus decarbonisation. Whilst the widespread electrification of heat and transport in Brighton & Hove will require reinforcement of the electricity supply, flexibility can help increase the amount of electrification before reinforcement is required. The role of flexibility is increasingly being recognised by UKPN, particularly from the DSO perspective, with various services being offered – these are described in Table 0—1. Prices associated with flexibility opportunities will vary, up to date information can be found on the UKPN website[130].

Table 0—1 Summary of UKPN flexibility services that can be participated in.

Service	Description	Application in pathways context
Demand turn up HV & LV (for both low voltage and high voltage assets, all connections)	In times of excess generation demand is increased. In the current system excess generation is often mitigated by curtailment or reduction of flexible generation connection, the service thus helps reduce payments going to generators to stop producing power. In these times of excess generation, the grid will normally have a large share of renewables, meaning use the electricity will tend to have lower associated carbon emissions.	A cheap time to charge batteries and storage systems, essentially receiving payment for charging. As well as electrical storage this can also include charging thermal stores. For example, if a heat pump system includes a hot water tank, which the heat pump could charge in times of excess generation. The same principle, at a larger scale, exist for heat networks – where large thermal stores and electric heating technologies present multi MWs of flexibility.
Demand reduction HV & LV (for low voltage and high voltage assets, all connections)	This is set up to help reduce demand at times of peak. The flexibility provider must be able to reduce demand from a historic baseline for at least 30 minutes.	This can either be not using a technology such as charging EVs (although as this is based on a historic baseline, opportunities for EV charging are likely to be somewhat limited) or through reducing demand by use of onsite generation or batteries.
Demand reduction LV (low voltage assets only, only small connections – such as domestic)	This is similar to the demand reduction for HV & LV but is purely focused for smaller electricity users.	Likely to be the most accessible to residents. Helps enable deployment of heat pumps and EV chargers at a local level without grid reinforcement. Opportunities are similar to the HV & LV context. Switching from inefficient direct electric heating to more efficient electric heating technology could in some contexts also enable the reduction required for participation.

Flexibility is considered in this pathways analysis using the network information, alongside the low carbon technologies and opportunities across Brighton & Hove. For example, a large house with a driveway (and EV charger) as well as heat pump and PV has a large opportunity for flexibility. By having PV panels batteries become an increasingly cost-effective technology, further adding to the flexibility opportunity.

BHCC are already actively exploring flexibility options. A key example, being deployment of batteries in multiple domestic properties, with the customers then testing a new flexibility tariff. Such approaches are scalable and will help maximise early decarbonisation of the energy system, before additional electricity network reinforcement is needed.

[126] This is based on various sources (and unit specifications) including National Grid https://www.nationalgrid.co.uk/downloads-view-reciteme/128938
[127] The diversity factor is a measure of what portion of devices are likely to use their maximum power demand at any one time. For example, if a room has four 10 W light bulbs but only three are ever turned on at the same time the diversity will be 0.75 and the diversified power demand will be 30 W (10 W x 4 x 0.75 = 30 W).
[128] https://d1oyzg0jo3ox9g.cloudfront.net/app/uploads/2023/10/UKPN_Project-Shift_2022_Web-PDF-v2.pdf

[129] As described in 0 flexibility refers to the ability to change generation or consumption/demand patterns to support the electricity network.
[130] https://dso.ukpowernetworks.co.uk/flexibility#:~:text=In%20general%2C%20Providers%20submit%20a,x%201%20hour%20%3D%20%C2%A3200.

Decarbonisation pathways summary

Pathways summary

A summary of required install rates for the Leading the Way pathway is provided in Table 0—1, this was established as the preferred option in conversations with BHCC as it best matches their ambitions (it should be noted it is also very similar to the Consumer Transformation pathway.

Table 0—1 Summary of key technology install and actions to achieve Leading the Way.

Item	Current status/context	Requirement 2027	Requirement 2030	Requirement 2035	Requirement 2040
Domestic fabric improvement	35,000 properties with some single glazing, 40,000 properties with uninsulated cavity walls, up to 72,000 with uninsulated roofs and 56,000 uninsulated solid walls (not a priority).	Retrofit a total of up to ~14,300 properties.	Retrofit a total of up to ~44,700 properties.	Retrofit up to ~95,500 properties.	Retrofit up to ~105,000 properties.
		~2,400 of which are on land in BHCC ownership.	*~6,100 of which are on land in BHCC ownership.*	*~6,700 of which are on land in BHCC ownership.*	*~6,700 of which are on land in BHCC ownership.*
Non-domestic fabric improvement	3,300 properties with an EPC of D and 3,600 properties with an EPC of E-G Progress is reported in GWh, 1% of non-dom heat demand is ~4.8 GWh/yr	Retrofit saving up to 5 GWh/yr heat demand	Retrofit saving up to 17 GWh/yr (heat demand	Retrofit saving up to 37 GWh/yr heat demand	Retrofit saving up to 42 GWh/yr heat demand
		4 GWh/yr saving from properties on land in BHCC ownership.	*11 GWh/yr saving from properties on land in BHCC ownership.*	*12 GWh/yr saving from properties on land in BHCC ownership.*	*12 GWh/yr saving from properties on land in BHCC ownership.*
Property level heat pumps	Currently 360 domestic heat pumps in Brighton & Hove based on Parity data – although this appears somewhat low. The DFES indicates ~1,100. Limited information for non-domestic.	Total of ~8,000 additional property level heat pumps installed.	Total of ~28,000 additional property level heat pumps installed.	Total of ~49,000 additional property level heat pumps installed.	Total of ~73,000 additional property level heat pumps installed.
		~2,500 of which are on land in BHCC ownership.	*~7,000 of which are on land in BHCC ownership.*	*~7,000 of which are on land in BHCC ownership.*	*~7,000 of which are on land in BHCC ownership.*
Communal and district heat networks[131]	The large heat network at the University of Sussex and 1280 domestic properties connected to communal systems or small heat networks.	Total of ~1,300 additional properties connected to communal systems or heat networks.	Total of ~4,700 additional properties connected to communal systems or heat networks.	Total of ~23,800 additional properties connected to communal systems or heat networks.	Total of ~44,000 additional properties connected to communal systems or heat networks.
		~800 of which are on land in BHCC ownership.	*~3,800 of which are on land in BHCC ownership.*	*~8,500 of which are on land in BHCC ownership.*	*~8,500 of which are on land in BHCC ownership.*
Electric vehicle infrastructure	430 publicly available EV charge points currently installed.	Total of 1,200 additional publicly available EV charge points.	Total of 3,530 additional publicly available EV charge points.	Total of 6640 additional publicly available EV charge points.	Total of 9,730 additional publicly available EV charge points.
Solar PV installation	~15 MW of current PV capacity	Minimum of 14MW of total additional PV capacity installed.	Minimum of 33 MW of total additional PV capacity installed.	Minimum of 56.5 MW of total additional PV capacity installed.	Minimum of 66.5 MW of total additional PV capacity installed.
		At least 5.5 MW is on land in BHCC ownership.	*At least 15.5 MW is on land in BHCC ownership.*	*At least 26.5 MW is on land in BHCC ownership.*	*At least 26.5 MW is on land in BHCC ownership.*

The heat networks and communal systems listed in Table 0—1 do rely predominately on heat pump technology in some form, however, the figures captured in this section for heat pumps and in following cost summaries only capture property level solutions. The cost of the centralised heat pumps for communal systems and heat networks is captured in the overall cost, alongside factors like pipework and connections.

The impact of different parts of the decarbonisation pathways on emissions is better explored in Table 0—2. These emissions are based on UK Government Green Book emission factors (for more details see section 0). It should also be reiterated at this point that the decarbonisation pathways analysis only focuses on scope 1 and 2 emissions. For context the current carbon emissions for Brighton & Hove is 768 kt/CO_2/yr.

Table 0—2 Approximate carbon savings (tCO_2e) associated with the different low carbon technology deployment at key points in Leading the Way.

Item	2027	2030	2035	2040
Domestic fabric improvement	4180	13070	27930	30700
Non-domestic fabric improvement	1010	3430	7460	8400
Property level heat pumps	17020	62730	116650	174250
Communal and district heat networks	3250	12330	65980	122900
Electric vehicles and reduced mileage	18320	41970	110340	167130
Solar PV	1820	2040	1240	1120
Total tCO2e	**45,600**	**135,570**	**329,600**	**504,500**

The reduced impact of PV in later years due to grid decarbonisation (despite greater installed capacity), is illustrated in Table 0—2 with 2040 having the lowest saving. However, it is still an important 'enabling' measure for decarbonisation, as grid decarbonisation requires this widespread renewable deployment.

An even more significant enabling measure is the fabric improvement of buildings. For low carbon heating systems to function most efficiently in many of Brighton & Hove's properties some additional insulation is required. This is because optimised heat pump operation is at a lower temperature than gas boilers. Running heating systems at low temperatures is challenging in poorly insulated houses, potentially requiring new pipework or as minimum larger radiators.

Alongside the carbon savings listed in Table 0—2 decarbonisation of the electricity grid provides substantial additional carbon savings. These savings are applied to current electricity demand figures and creates an additional ~166,000 tCO_2e of carbon savings, leaving ~30,000 tonnes of residual CO_2e emissions which would require some form of offset or balance from land use (for example sequestration on BHCC Downland Estate). It should be noted that this means there is an additional ~50,000 tCO_2e not captured in this reporting but which appears in national figures. The vast majority of these are from additional transport, particularly HGVs, that are challenging to capture in Brighton & Hove figures. The infrastructure requirement for these is accounted for in the decarbonisation pathway but not their fuel usage. Thus, the plan provides the enabling infrastructure, but reporting treats them as an externality.

Capital investment and operational costs

Investment in the Leading the Way decarbonisation pathways will bring additional benefits beyond cutting carbon. This includes improving air quality, which brings health benefits and associated savings for health services. At a consumer level the pathways will help reduce fuel poverty, improve resilience to the impacts of climate change (such as heat waves) and improve comfort in the home (this is not only thermal but also factors like noise due to improved insulation). From a Brighton & Hove perspective, the Leading the Way pathway would bring additional investment and an associated increase in jobs, with ~2500 additional jobs being estimated to complete the pathway. However, the pathway will require a large amount of investment; it should be noted that even the Falling Short scenario will also carry a financial burden (including replacement of existing heating systems). The capital investment required is explored in Figure 0—1.

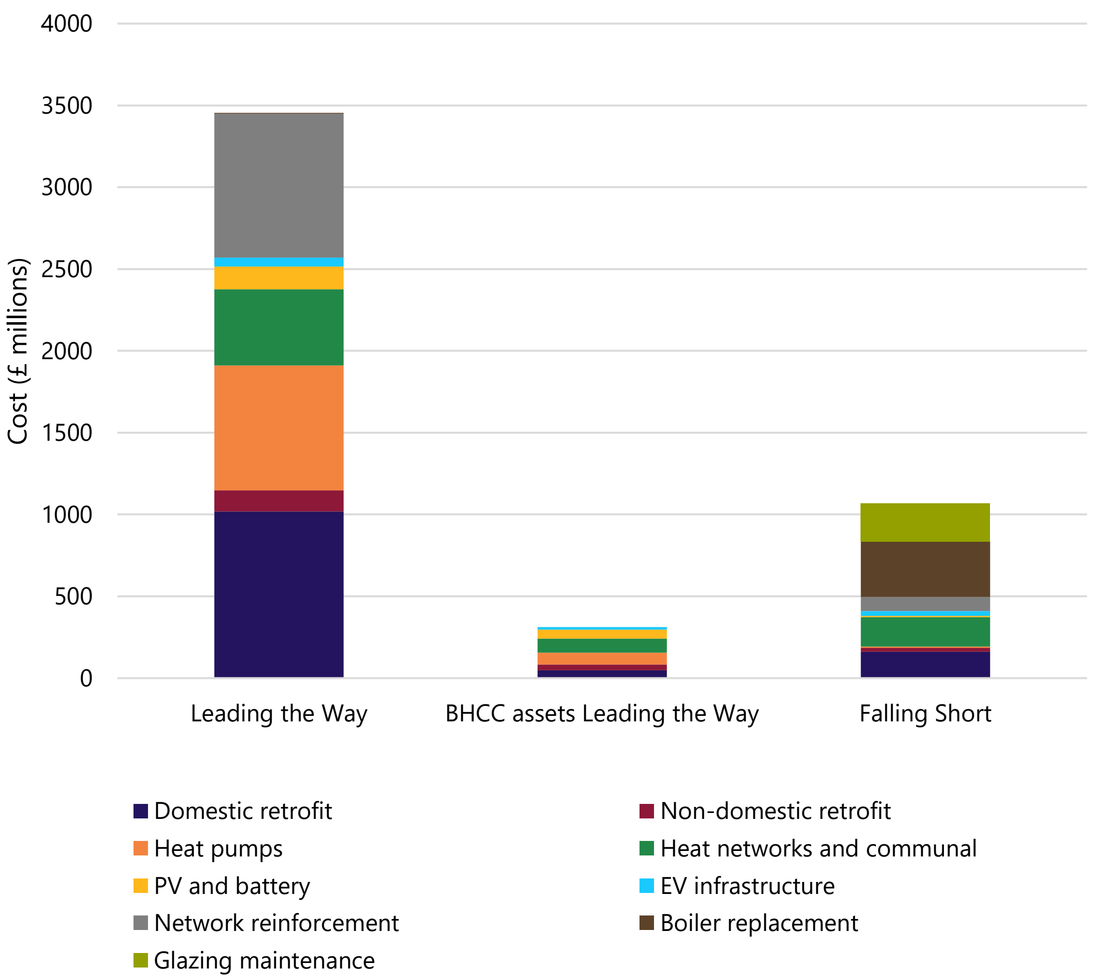


Figure 0—1 Capital investment required to 2040 for the Leading the way scenario, the BHCC assets for the Leading the Way, and Falling Short.

The retrofit in the Falling Short scenario falls below improvement from ongoing maintenance of properties, notably replacement of old double glazing. This is captured in Figure 0—1 to give a more accurate reflection of the costs in Falling Short.

Residents in Brighton & Hove, who are owner occupiers, will need to contribute part of this overall investment but a significant portion of it would come from other sources. The spend on heating systems is an example where in a large number of cases much of the investment is unlikely to be met by residents, due to high prevalence of heat networks and communal systems – where many of the upfront investments would likely be met by a central provider.

Although the upgrades to the electricity network are a major cost, and important to include for the overall pathway analysis, the majority of these upgrades will not be paid by the residents of Brighton & Hove. In nearly all cases for domestic properties costs of upgrades are socialised across the UKPN area. If the network upgrades are excluded from the scenario costs the difference between the two scenarios falls from £2,380 million to £1,587 million. Flexibility is critical to managing and potentially reducing reinforcement costs (see 0).

The investment in PV (the majority of which is rooftop) is relatively high due to recent increases in panel price (although these are assumed to reduce somewhat overtime) and the inclusion of batteries with some systems to optimise the value of the generation.

Whilst the capital investment required is high it does result in savings in operational costs for the energy system. An overview of the different operational costs, based on fuel and carbon, for the Leading the Way scenario and Falling Short are provided in Figure 0—2. These values are based on the Green Book data tables published by DESNZ[132], using the medium retail scenarios for energy and carbon price, these carbon prices are likely to be somewhat conservative given the growing body of economic studies of the cost of climate change[133]. Maintenance costs are assumed to be similar across both scenarios and is thus excluded from the analysis.

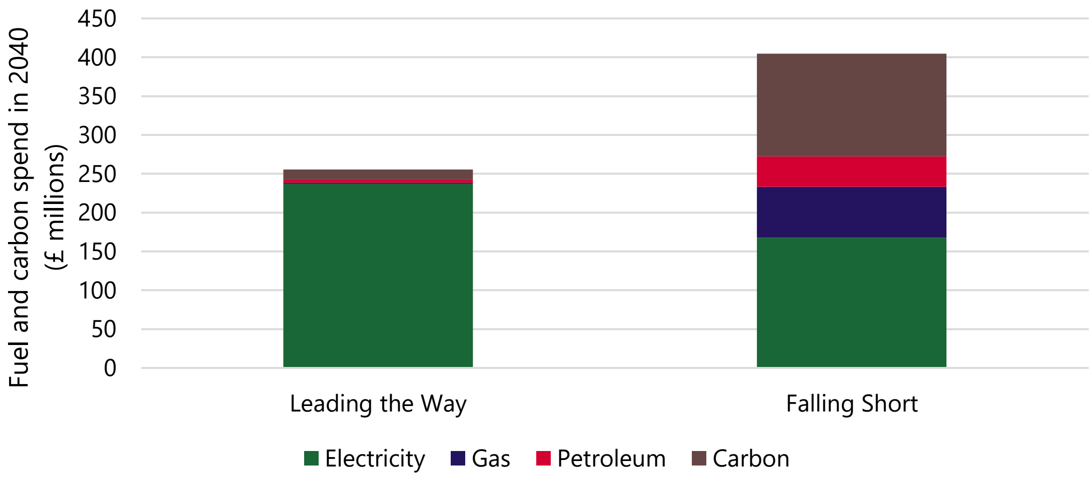


Figure 0—2 Fuel and carbon costs[134] for the Leading the Way and Falling Short.

There are some savings purely based on fuel costs (£30 million) in 2040 for the Leading the Way scenario. However, these savings occur from the additional cost of fuel for petroleum vehicles over electric. From a heating system perspective, the Leading the Way Scenario actually costs marginally more than Falling Short. This is because even though Falling short has more thermally efficient buildings the price of commercial electricity is ~3.4 times that of gas[135]. The variability in the relative cost of electricity compared to gas is explored further in Figure 0—3.

[131] There is a high degree of sensitivity in the relationship between communal and district heat networks. This includes some communal networks connecting to wider heat networks, uncertainty in data cataloguing for current systems, the varying scale in heat networks identified and the marginal cost difference between communal and heat networks in the model outputs.
[132] DESNZ, 2023: Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal. https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal
[133] https://www.businessgreen.com/news/4209930/research-global-cost-climate-change-times#:~:text=Economic%20damages%20from%20climate%20change,fresh%20research%20by%20US%20economists.
[134] All costs are based on Green Book central scenarios for retail energy prices and carbon costs.
[135] Commercial prices are used as they are more suitable for communal systems and heat networks that will provide the majority of heating system capacity.

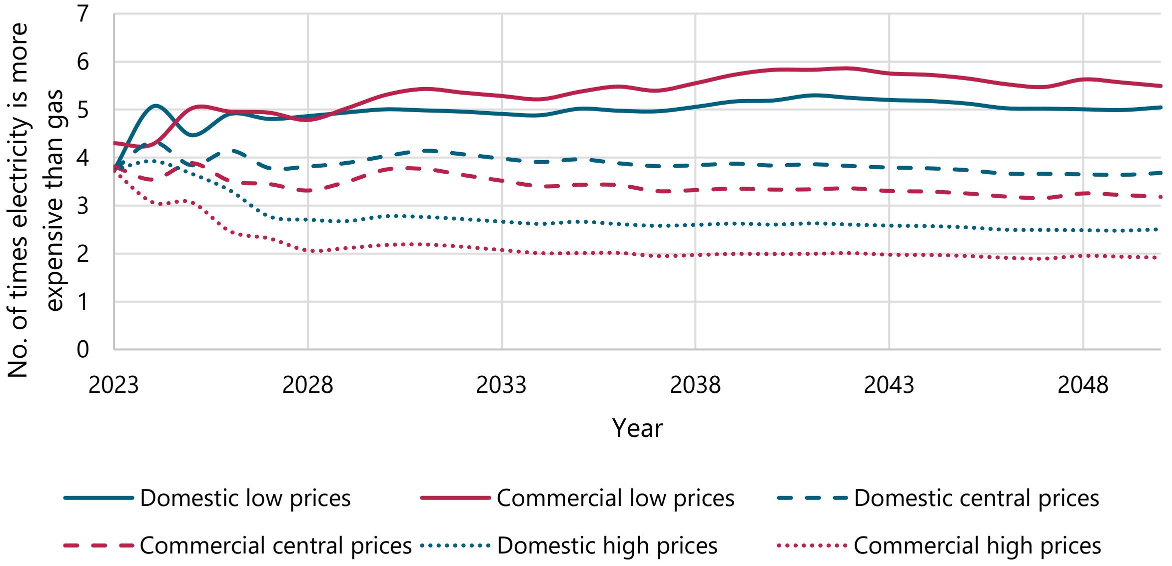


Figure 0—3 Comparison of the relative cost of electricity compared to gas in the UK Government Green Book for domestic and commercial consumers.

In later years the Green Book does show a greater separation between electricity and gas prices (particularly for commercial consumers), however, gas maintains a lower price than electricity across all scenarios. This highlights the importance of considering a costing of carbon for decarbonisation scenarios. There is still the possibility that electricity prices will drop in the future relative to gas through reduction in levies – which could give the opportunity to reduce tariffs – but there is no guarantee on this so cannot be relied on[136].

Summary of action plan and next steps

Through the development of this net zero pathway and reporting, a list of recommended short- and long-term actions has been presented, alongside a focused set of priority opportunities. These precise opportunities are listed in sections 0 to 0, numbering 110 projects in total. A brief summary of key actions and priorities are provided by theme in sections 0 to 0, with 0 providing an overview of the plan and 0 some core delivery approaches.

Fabric improvement

The greatest concentration of short-term domestic fabric improvement follows the A270, due to the combined factors of poor fabric condition and a high level of fuel poverty. The pathways analysis identified 16 initial opportunity areas, these are a mixture of private and social housing.

In general, the focus of low-risk fabric improvements will be windows, cavity walls and loft insulation. Focusing on these as initial actions is key as they are common across and all scenarios. Also, the need for intrusive solid wall insulation for low carbon heating systems is becoming less necessary in some instances – due to heat pump technology improvements.

Various funding streams are identified to assist with deployment. Pursuing and promoting these to relevant homeowners would be a key action. Streams identified include the Social Housing Decarbonisation Fund, the Great Britain Insulation Scheme and the Home Upgrade Grant 2. Whilst BHCC have a large role to play in this action there is the opportunity to use the expertise of local community energy groups, which are some of the most active in the country.

The non-domestic improvement focuses on properties with an EPC of E and below. The information on the non-domestic is less complete and thus the precision of actions is lower than domestic. The action plan identifies nine priority opportunities for fabric improvement, with a focus on public sector buildings. This includes accounting for the University of Brighton's ambitions for decarbonisation through fabric improvement (the key action for Sussex University is heating system based). As well as large individual stakeholders there is an action to engage with the Brilliant Brighton Business Improvement District, to explore a combined approach for fabric improvement in the city centre. Historic England also provide guidance on how to retrofit in historic buildings, like those in the conservation area at the city centre.

Heat networks and communal systems

A large number of heat networks are identified through this analysis. They are characterised by non-domestic properties and flats, with a relatively strong focus on BHCC assets – as many of the demands from these are most relevant for heat network connection. The analysis identifies 24 heat networks of varying size. Actions include decarbonisation of the existing heat network at Sussex University (which is already being explored).

A large heat network along the seafront in the city centre is the largest opportunity and is also an opportunity identified in the UK Government Heat Network Zoning approach. Exploring this network through various stages of feasibility and then potentially delivery is thus a key action. However, this large heat network would be complex with a large number of non-public sector stakeholders. A smaller and simpler heat network to consider is identified in Woodingdean. These would be the initial focus of heat networks to be pursued through the government-led Heat Network Zoning activity and the Heat Network Delivery Unit. Alongside new developments, such as Toads Hole Valley and the old Gas Works site, three other heat networks which should be considered early are:

- The Brighton General Hospital area, with the redevelopment of the hospital site being a key opportunity for wider connection to a heat network. With the stages of development this is a project with time sensitivity.
- Millview Hospital the surrounding care homes are very suitable typologies for a heat network, with consistent high demands and a large public sector influence.
- Varndean is identified as an initial focus area as although the heat density is relatively low it is made up of a large number of public sector buildings (predominantly schools). It is a priority to explore in feasibility as if a heat network is not viable it would become a priority for individual non-domestic heat pump roll out.

However, given the high number of BHCC assets in the identified heat networks an internal review will be important to confirm the priority areas – in line with general estate strategy.

In most instances communal systems are the preferred solution in flats outside of heat network areas. If there is one owner of the block of flats (particularly if it is BHCC) mass conversion of heating systems may be tenable. However, if there are multiple owners and not just occupiers this becomes complex. For communal systems there are three key actions, an early focus on conversion of gas heated flats to communal systems to reduce carbon emissions, consider conversion to communal systems in direct electrically heated flats to help reduce fuel poverty, explore methods for shifting to communal systems in flats with multiple property owners. The first two would focus on BHCC owned flats, the final point would be more widespread – including the private sector. This latter point can be complex as it will range from blocks of flats to smaller mixed domestic and non-domestic buildings.

As an immediate action decarbonisation of existing communal systems (generally through heat pumps) is a priority action. As it decarbonises multiple properties without the need for action at the individual dwelling level.

Property level heat pumps

Domestic heat pumps are the main selected technology outside of the city centre. They are generally focused on houses than flats, which means the percentage of BHCC properties served by individual heat pumps is lower than the communal/heat network – meaning BHCC has less overall influence. The analysis identifies 16 priority areas for domestic heat pumps. Initial deployment focuses on properties with a high level of fabric efficiency, as these properties are better suited to heat pump solutions. It is important for properties to have a high fabric efficiency to minimise the risk of heat costing more, due to the relative difference between gas and electricity prices explored in Figure 0—3.

[136] https://www.citizensadvice.org.uk/Global/CitizensAdvice/Energy/Balancing%20act%20(4).pdf

Woodingdean and Whitehawk are two areas identified as priority areas for heat pumps, as they have a high level of fabric efficiency and BHCC ownership. The BHCC ownership means the Social Housing Decarbonisation Fund could be pursued to help fund delivery of the technology. Non BHCC properties in the area could use the government Boiler Upgrade Scheme to help fund decarbonisation. Properties in the same area are likely to be of a similar typology and similar deployment strategy, meaning area-focused approaches could drive economies of scale.

Several areas are identified for relatively straightforward fabric upgrade, which would then make them suitable for heat pumps. Deploying multiple technologies at once can be more cost effective, Gardener Street and Graham Avenue in Hove are identified as opportunities for this approach. This whole house approach is also prioritised for historic properties. These schemes could benefit from multiple funding streams but would focus on the Boiler Upgrade Scheme and the Great British Insulation Scheme.

For widespread heat pump uptake the approach is to encourage the selection of a heat pump at end of life of current heating systems rather than replacing new efficient combi-boilers. This means the most polluting boilers will be replaced first and avoids wasted capital investment by homeowners. A key task is to make sure the supply chain and information is available to home owners to encourage them to pick heat pumps when replacing their heating system.

Heat pumps are not only identified for fossil fuel heated properties. This is due to the significant reduction in operational costs due to the relative efficiency of heat pumps compared to direct electric system. Several areas are highlighted that would benefit from this in section 0.

A large number (22) of small clusters for non-domestic heat pumps were identified. The majority of decarbonisation of non-domestic heating systems is based on heat network solutions but these smaller systems provide opportunity for early decarbonisation. The opportunities fall outside the wider heat network zones and focus on BHCC assets and business parks. The best way to progress most of these sites would be an initial review by Council officers, to check alignment with overall strategy and then replace the systems with heat pumps as the current heating systems reach or near end of life.

Local power generation

Brighton & Hove is well positioned for solar photovoltaic (PV) deployment, having a strong local supply chain. It is suggested that deployment could exceed the levels outlined in the DFES. Maximising deployment in the early years is a key target as this is when the greatest carbon savings occur (before increased decarbonisation of grid electricity).

A large number of specific opportunities on BHCC assets are identified and 22 focus areas. One of these areas in Portslade is a focus due to the current demand constraint of the electricity grid being in summer (most likely due to a high cooling demand), meaning solar in this area will be of most value to the network.

The majority of PV generation in Brighton & Hove is rooftop. This is due to the lack of available land and by being rooftop it maximises the value of electricity as it can be directly used to displace grid-supplied electricity (this avoided cost has significantly greater economic benefit than selling to the grid). Where possible other technologies such as battery storage and off-street EV charge points should be deployed alongside rooftop PV, to maximise the value of the electricity generated.

A challenge with this model is that, if all technologies are installed at once, it results in a very large capital outlay. Exploring mechanisms to enable this strategic approach should be explored, with BHCC properties being an opportunity to develop a standardised approach to the co-delivery of solar PV, battery storage and off-street EV charge points.

A large number of the solar projects identified are on BHCC assets and as mentioned above for these to be of the most value, early deployment is key. One of the BHCC sites considered is the largest single renewable opportunity considered in Brighton & Hove, being the potential solar farm. Early engagement with UKPN will be key for timely delivery of this scheme as sites of this size have a different delivery process than smaller rooftop arrays. From Buro Happold's recent experience in solar projects in southern England, a National Grid, rather than UKPN, grid constraint is causing a substantial bottleneck in renewable deployment. Early engagement on the grid side is thus key to establish likely delivery timescales.

Transport

The next Local Transport Plan will provide a more detailed decarbonisation pathway for transport in Brighton & Hove, including details on key early decarbonisation routes - such as reducing car usage through public transport and active travel. However, several early actions and priority areas are established in this analysis relating to charging infrastructure for electric vehicles (EVs).

On-street charging, particularly in the city centre, will be key to giving the public confidence in switching to electric vehicles. Outside the city centre there is greater opportunity for off-street EV charging, which generally falls outside the Council's remit. Various government support mechanisms / funding (notably LEVI and ORCS) exist for the on-street areas that are already being tackled by BHCC.

Alongside on-street EV charging, car park charging will be an area with greater influence from BHCC. The large number of tourists that visit Brighton & Hove makes these assets particularly significant. The feasibility pf potential park and ride sites are being considered to help intercept longer distance journeys; these will be enable a further major focus for charging infrastructure – as visitors are likely to have travelled relatively long distances. Solar PV should be considered alongside large-scale EVI deployment as the electricity can be sold on site, increasing the value of the PV. This approach would probably be of the most benefit to any large park and ride sites, as their use is likely to be highest during summer months when PV generation is at its highest.

Electricity network

Engagement with UKPN is key to ensuring electricity network capacity is available for decarbonisation. As part of this pathways analysis the outputs will be provided to UKPN. This will allow them to integrate it into their own systems and potentially run their own analysis on these pathways. This will be more accurate than that run in this pathways report, as very limited information was available at the lower voltage levels (which would be the majority of the costs). If BHCC buy-in to the decarbonisation pathway it can help inform UKPN's long term investment strategy.

It is useful for BHCC to report levels of certainty for future projects shared with UKPN. If BHCC decided to pursue the pathway outlined, it should be made clear over which projects and strategy items BHCC has most control, as these would have the highest likelihood for deployment.

BHCC is already working on an innovative approach towards flexibility, with deployment of domestic batteries with the home owners trialling different tariffs. This kind of approach will be key to maximising delivery of heat and transport electrification in the near to mid-term, delaying the need for network reinforcement.

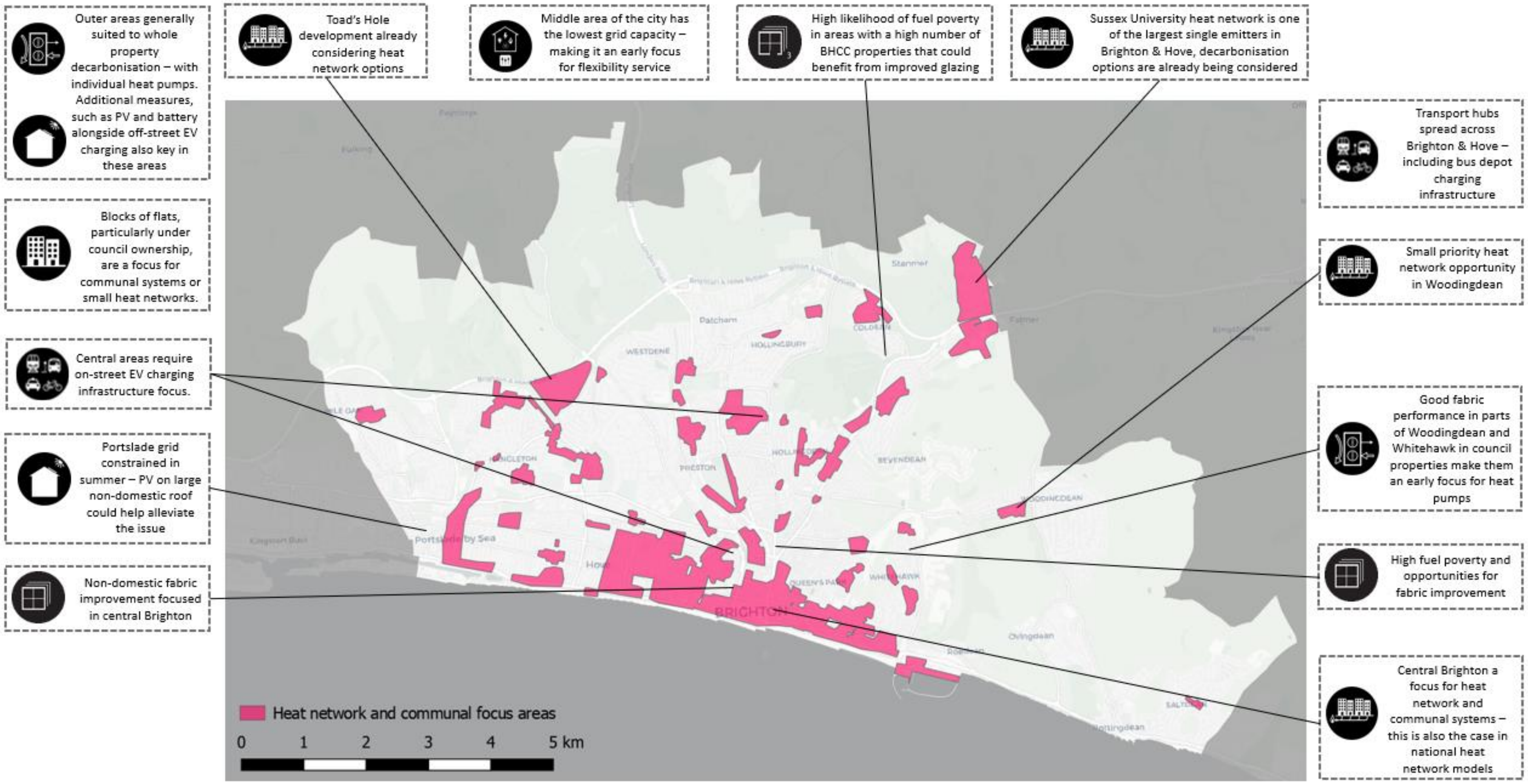
Overarching actions and plan on a page

Alongside the specific actions and strategies considered above there are some overarching themes for early action from BHCC:

- Review this pathways analysis and decide whether to adopt the pathway or key elements of it to take forward. This should be based on a consideration of the analysis alongside ongoing BHCC strategies.
- The pathway analysis has created rich data, which (where possible) should be available to stakeholders.
- To identify a lead within BHCC to continue to drive the agreed elements of the decarbonisation pathway forward. This is a significant role which requires continued engagement with both internal and external stakeholders.
- Keep the pathways updated and measure progress against the targets. The early opportunities and priority projects identified create an initial focus for this, moving away from a broad strategy to a project pipeline.
- Brighton & Hove benefits from having many active stakeholders. Strategies should be developed for how they can effectively be engaged to deliver the plan. Community groups such as BHESCo and Brighton Energy Co-op have successfully delivered projects across all themes considered in the pathways analysis. Effectively engaging them with a pipeline of work (based on the priority projects) could be a mechanism to help deliver early decarbonisation.

- Multiple funding mechanisms are considered and outlined above, which can help support near- term decarbonisation. For the scale of the challenge of the decarbonisation pathways a broader delivery approach is required, some options for this are outlined in sections 0.

A summary of the overall strategy and some of the main priority opportunities is provided in Figure 0—4. This ‘plan on a page’ gives context to the summary of actions provided in the preceding sections, as well as being a useful tool for stakeholder engagement.



Domestic fabric improvement	Non-domestic fabric improvement	Property level heat pumps	Communal and district heat networks	Electric vehicles and reduced mileage	Solar PV	Flexibility
Retrofit up to ~105,000 properties.	Retrofit saving up to 42 GWh/yr heat demand	Total of ~73,000 additional property level heat pumps installed.	Total of ~44,000 additional properties connected to communal systems or heat networks.	Total of 9,730 additional publicly available EV charge points.	Minimum of 66.5 MW of total additional PV capacity installed.	Not treated as a standalone technology but considered alongside other technologies
30,700 tCO_2e saved in 2040 compared to present	8,400 tCO_2e saved in 2040 compared to present	174,250 tCO_2e saved in 2040 compared to present	122,900 tCO_2e saved in 2040 compared to present	167,130 tCO_2e saved in 2040 compared to present	1,120 tCO_2e saved in 2040 compared to present	Allows for deployment of other technologies

Figure 0—4 Plan on the page summary of the Leading the Way decarbonisation pathway.

Delivery approaches

Historically decarbonisation projects tend to be delivered on an individual basis, for example, a heat network project is delivered in a single location in isolation from a transport or retrofit project. Several local authorities are starting to bring Delivery Partners in to deliver at scale with alternative Joint Venture (JV) approaches to scaling delivery with Public Private Partnership (PPP) investment. For example:

Bristol City Leap

Bristol City Leap is a 20-year partnership between Bristol City Council and Ameresco / Vattenfall Heat UK that will accelerate green energy investment in Bristol and help towards decarbonising the whole city by 2030.

Bristol City Leap will bring in over £1bn of investment to rapidly increase the scale and pace of investment in low-carbon energy infrastructure such as wind energy, solar energy, low-carbon heat networks as well as other energy efficiency measures and smart energy systems. Ameresco has contractually committed to the following Key Performance Indicators (KPIs) over the next five years (amongst other commitments around jobs, training and community energy support)[137]:

- c140,000 tonnes of carbon saving.
- c.180MW of zero-carbon generation assets contributing to net zero carbon by 2030.
- c327GWh of zero carbon energy generated.
- c£22m of energy efficiency measures deployed.
- £61.5m of social value including c£50m of contracts delivered by local supply chain.

An initial prospectus of projects (worth £1bn) was published in May 2018 with the preferred bidder awarded in May 2022. Whilst the procurement for this delivery model cost several million pounds and took circa 3 years, this was the first of its kind and there are substantial learnings that can be taken from this process to deliver a more efficient procurement. Bristol are working with DESNZ and others with the potential for replication to create a playbook or suite of technical guidance documents to enable replication.

A key next step would be to pursue these funding and delivery approaches further. However, this is likely to be a major job and as such could require a dedicated member of staff. The Greater South East Net Zero Hub would be a key body to engage and there are also insights that could be gained by authorities further down their decarbonisation pathway. Alongside Bristol the Greater Manchester Combined Authority is one of the pioneering authorities in this space.

3Ci – the Cities Commission for Climate Investment - Net zero neighbourhoods

3Ci has been looking for projects to be included in a new National Net Zero Neighbourhoods Programme, which will support and raise the profile of pilot schemes looking for local investment. An illustration of the 3Ci approach is provided in Figure 0—5.

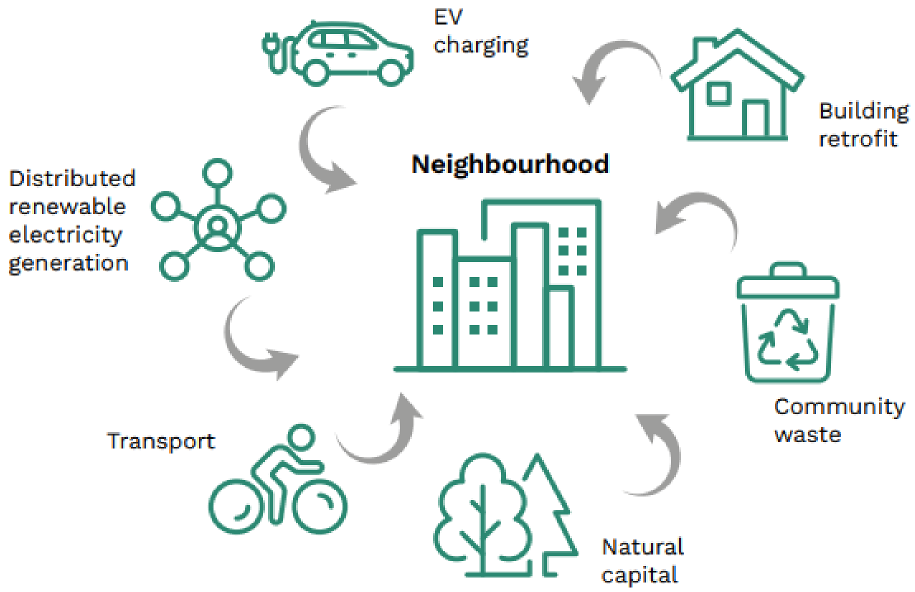


Figure 0—5 3Ci NZN programme intervention schematic[138]

Net Zero Neighbourhoods (NZN) is a place-based concept with some similarities to the Bristol City Leap approach. The 3Ci NZN programme approach combines a blended finance mechanism, designed to leverage private sector capital on top of public finance, with practical place-based implementation. This delivers a range of technical interventions together, that are collectively needed to decarbonise population centres.

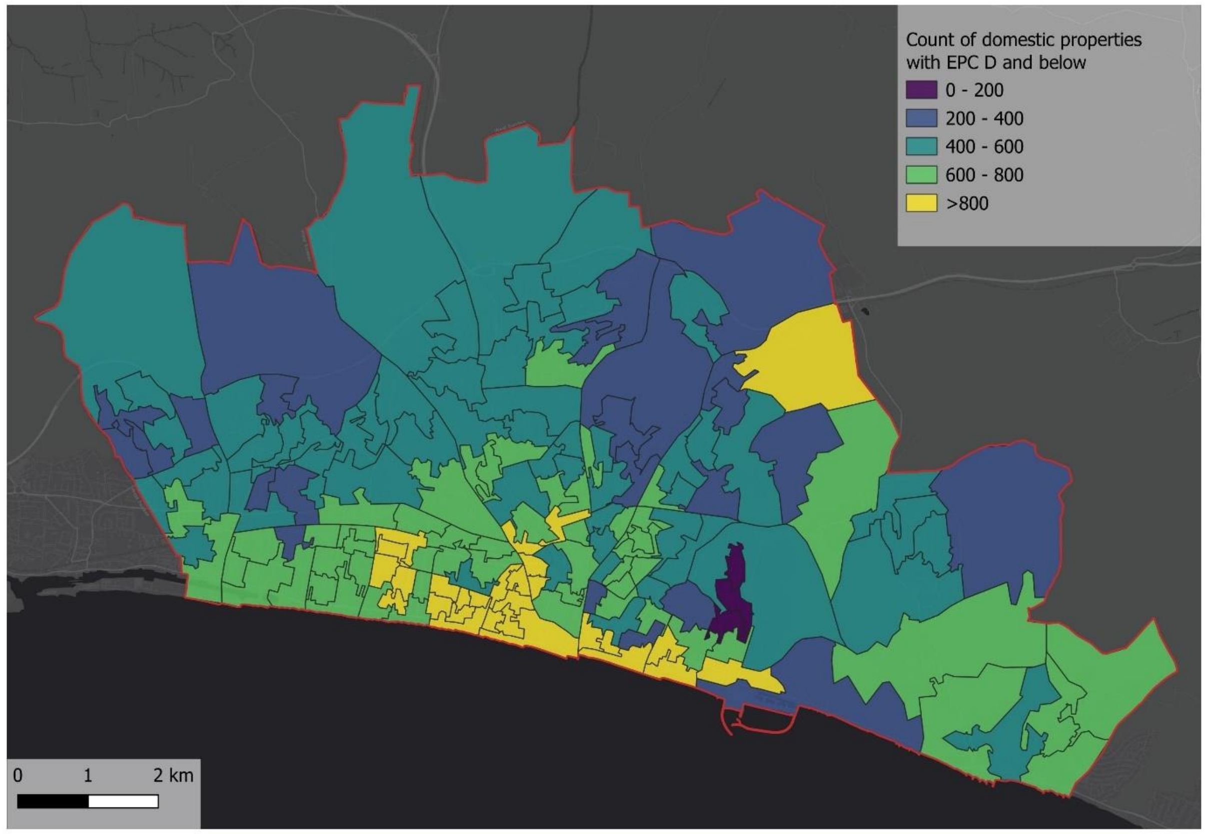
Proposals accepted have been incorporated into a UK Net Zero Neighbourhood ‘pitchbook’ to be shared across Government departments and potential investors forming the basis of a potential first wave of a national programme, subject to funding being secured.[139]

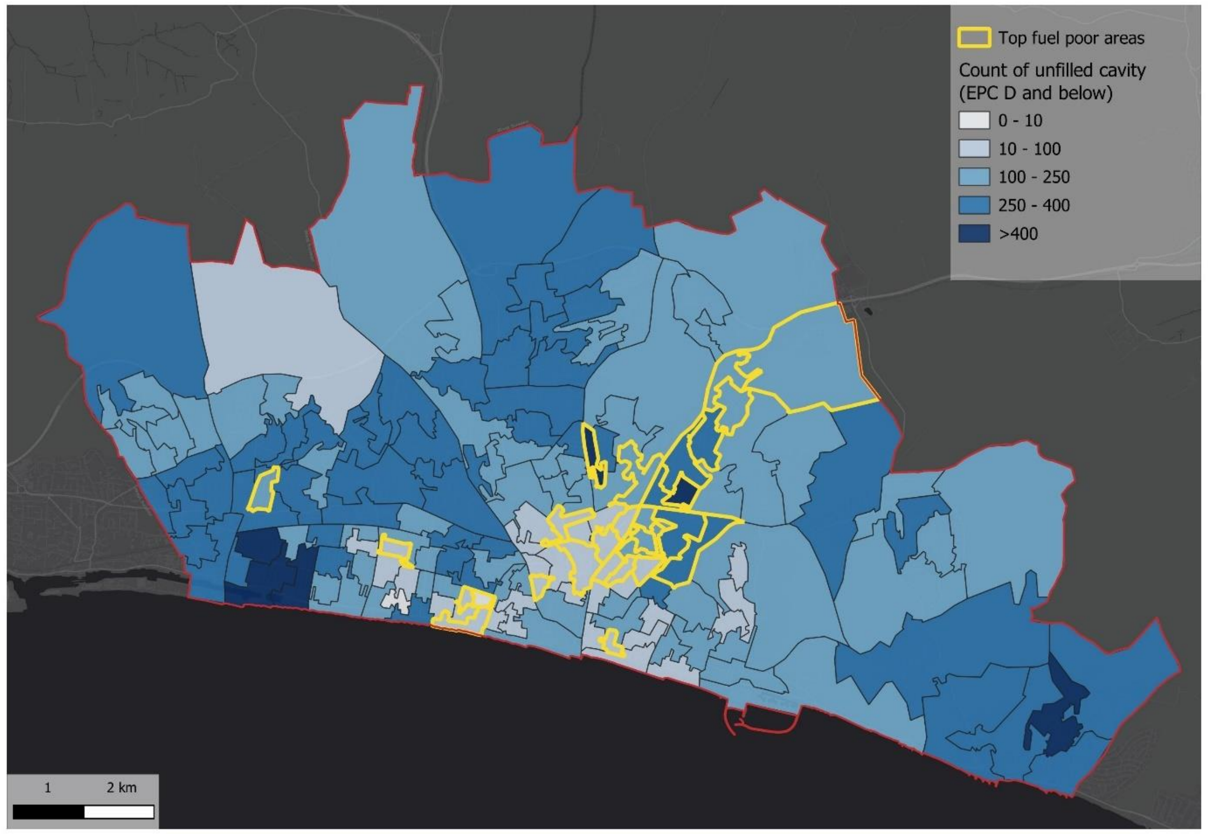
They describe this working as follows:

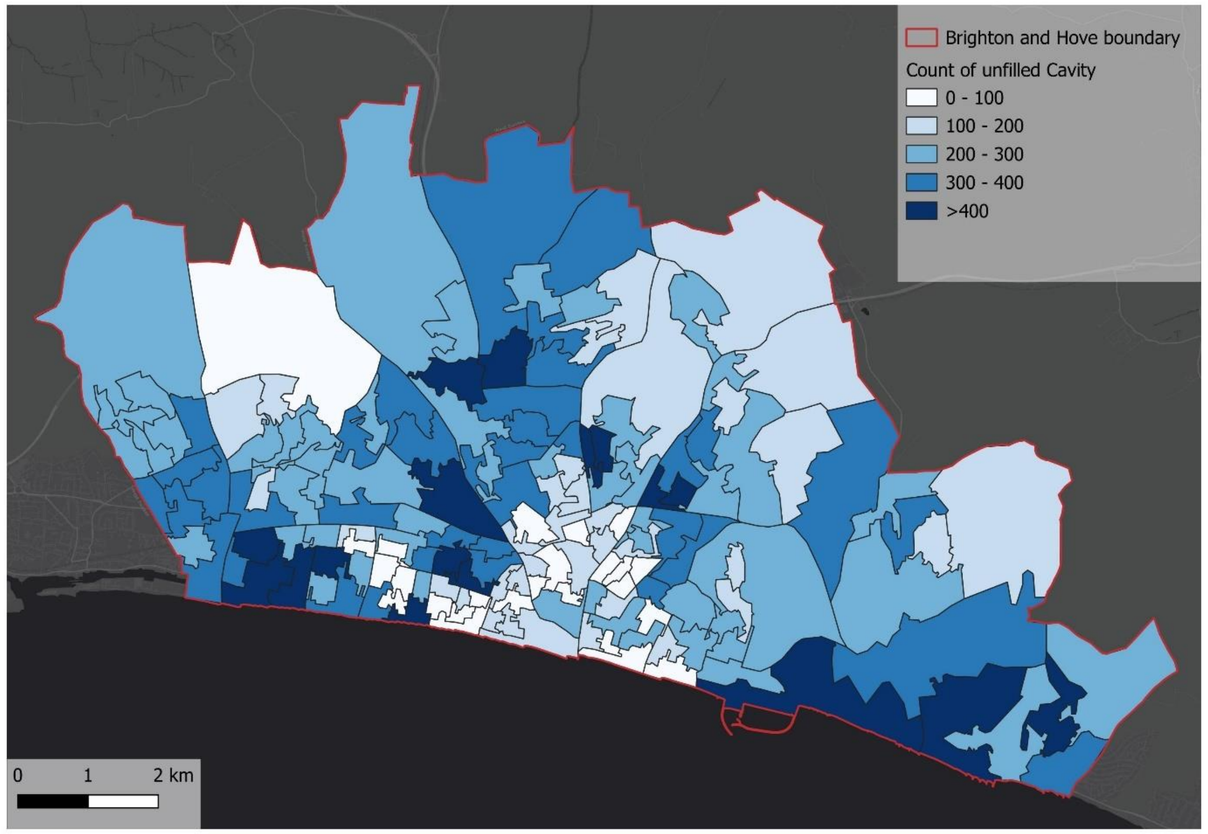
- Funding and supporting vehicles (FinCo and OpCo) are set up alongside local authority implementation and capitalised from a mix of funding sources.
- The funding vehicle then pays the upfront costs of deep decarbonisation and other broader interventions for a neighbourhood at no cost to the residents and/or property owners.
- The resident retains part of the energy and maintenance saving, leaving them in a better economic position with a more comfortable house and enhanced neighbourhood.
- The remainder of the savings are captured through on-utility-billed, property-linked, long-term service contracts, creating an annuity income stream for the funding vehicle to support the capital structure.

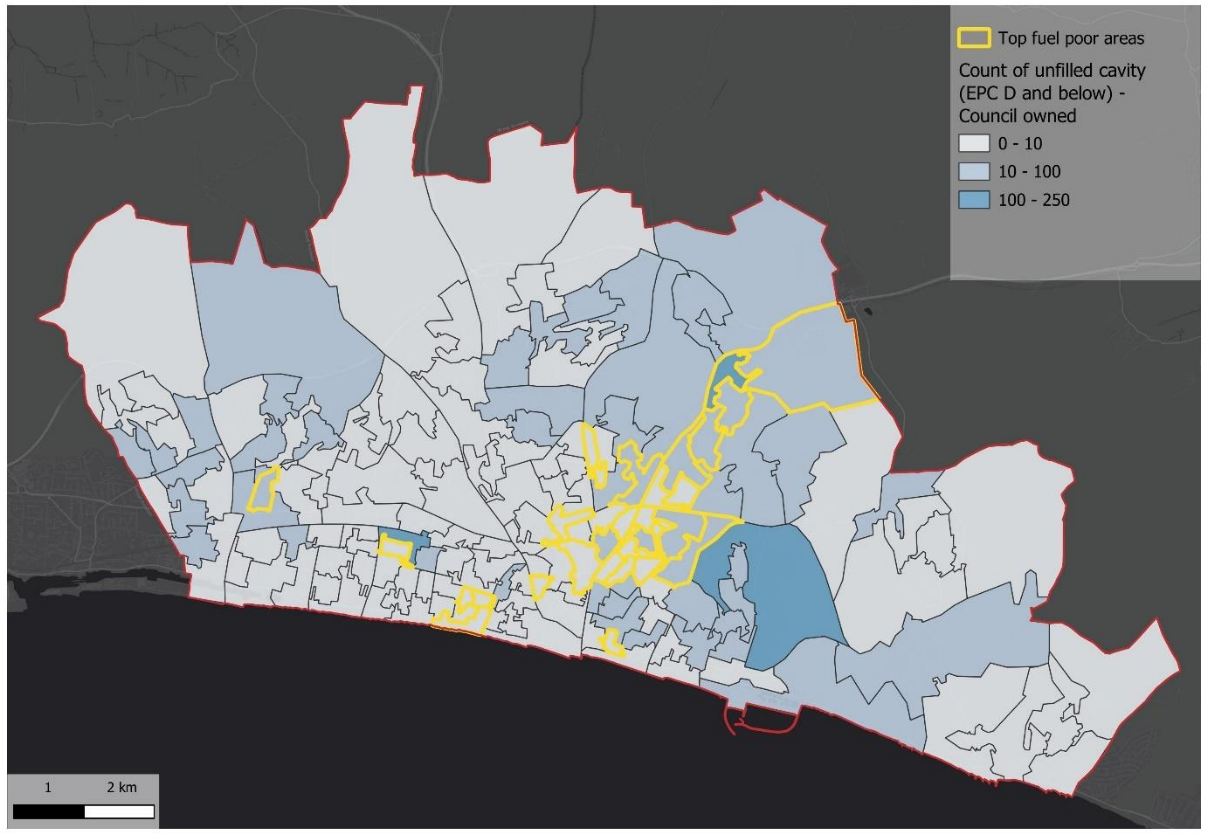
[137] Net Zero project development and delivery case study: Bristol City Leap - 3ci
[138] 3Ci-NZN-Outline-Business-Case-June-2023-2-1.pdf
[139] Net zero neighbourhoods: proposals welcomed - 3ci

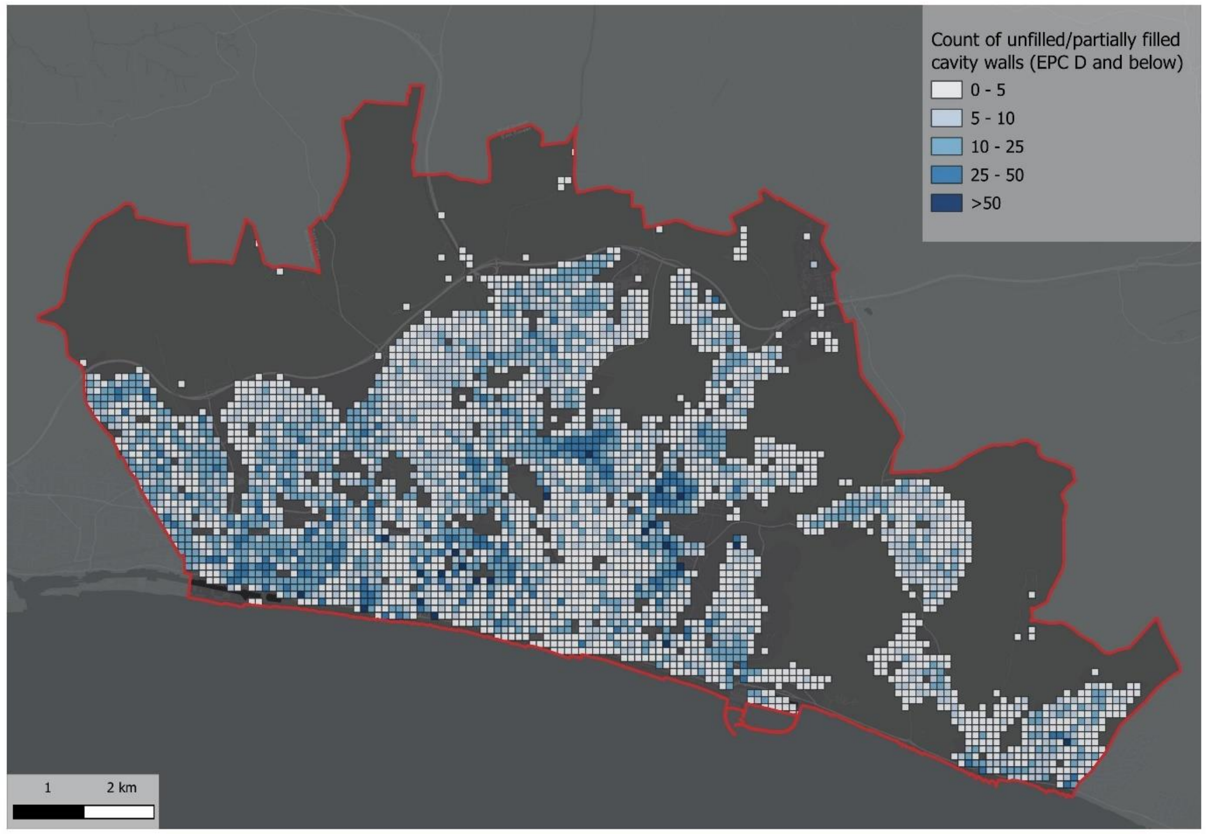
– domestic maps

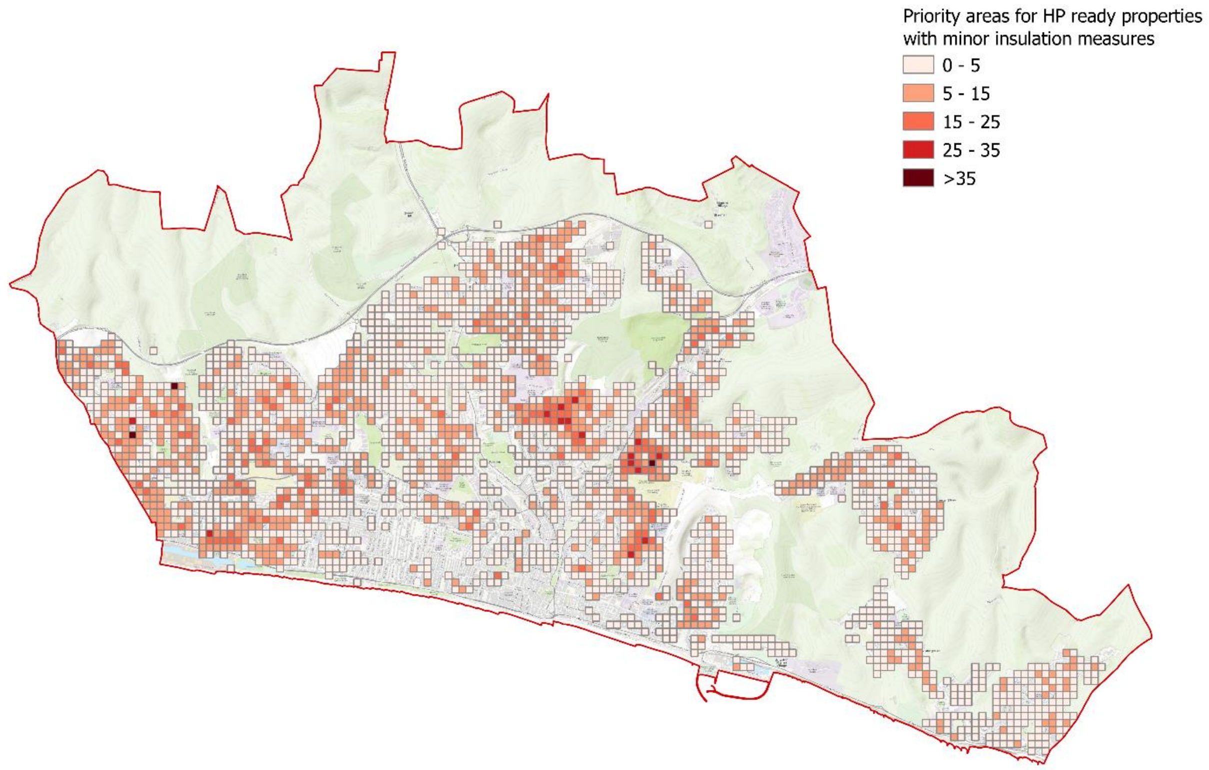

Count of domestic properties with EPC D and below
0 - 200
200 - 400
400 - 600
600 - 800
>800
0
1
2 km

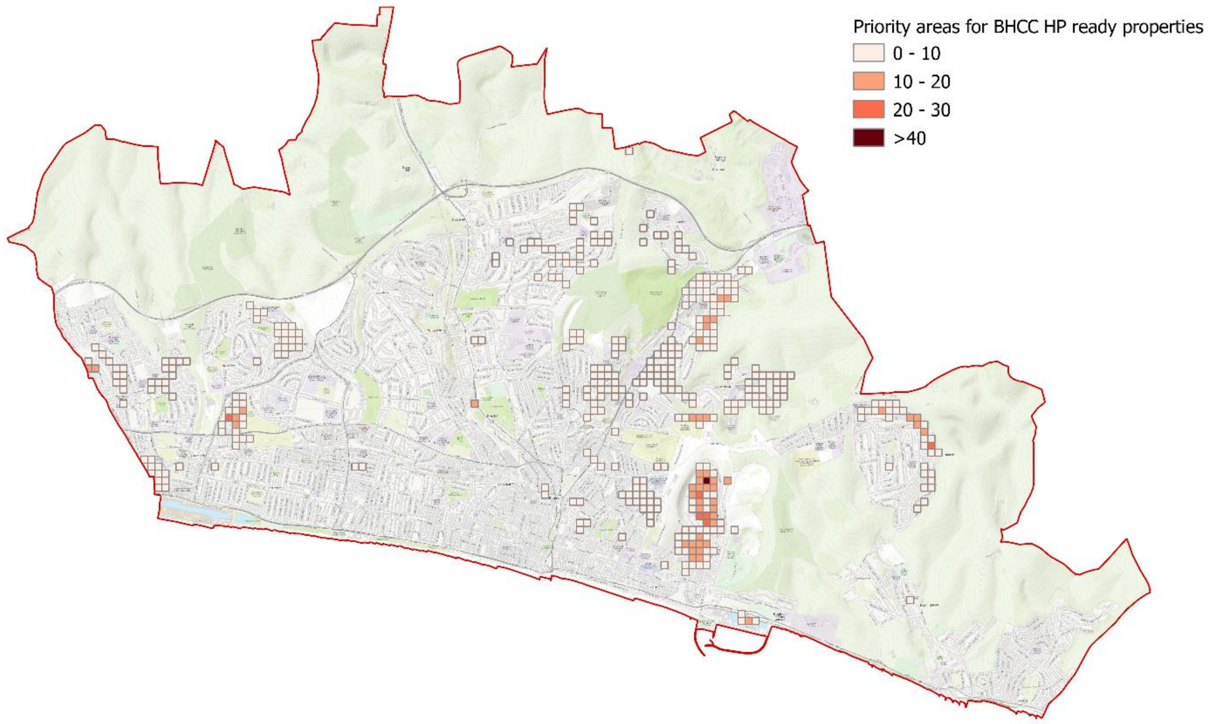

Top fuel poor areas
Count of unfilled cavity (EPC D and below)
0 - 10
10 - 100
100 - 250
250 - 400
>400
1
2 km

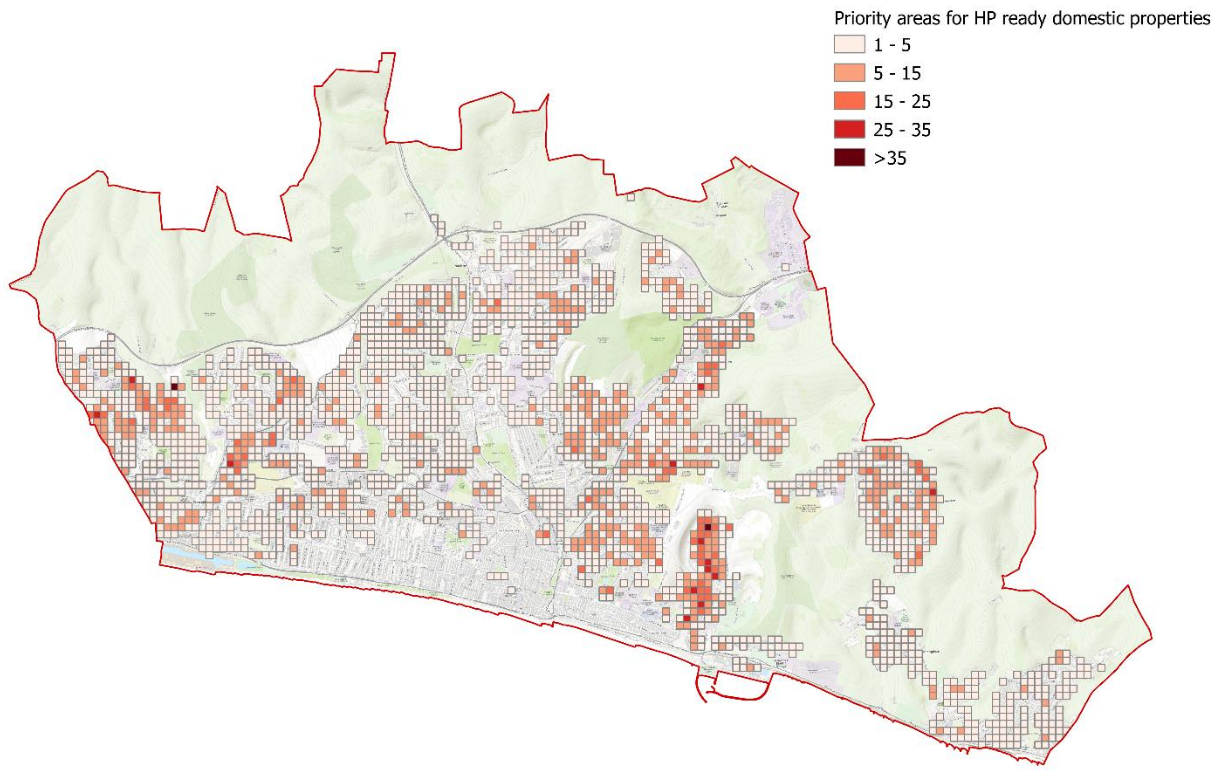

Brighton and Hove boundary
Count of unfilled Cavity
0 - 100
100 - 200
200 - 300
300 - 400
>400
0
1
2 km

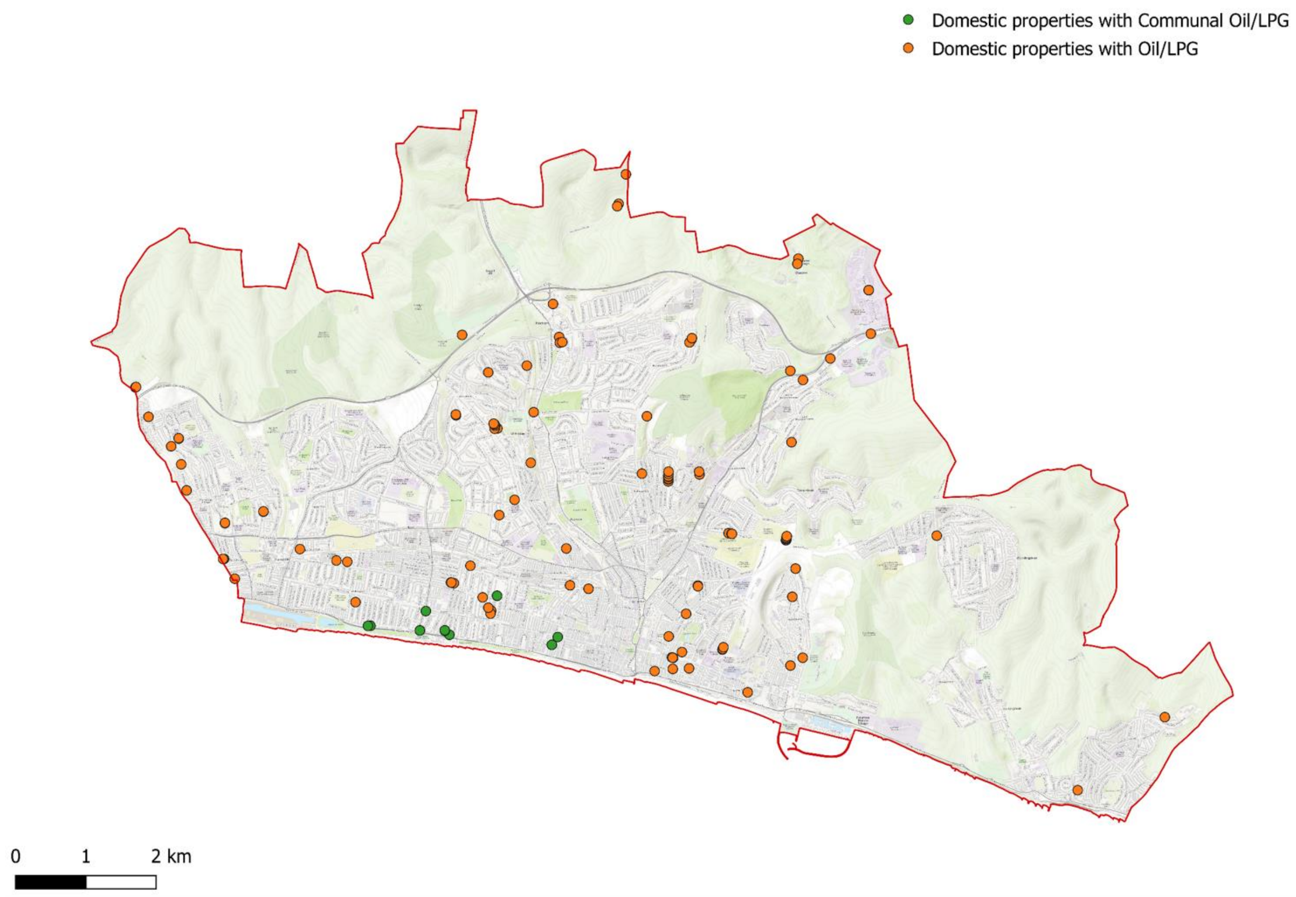

Top fuel poor areas
Count of unfilled cavity (EPC D and below) - Council owned
0 - 10
10 - 100
100 - 250
1
2 km

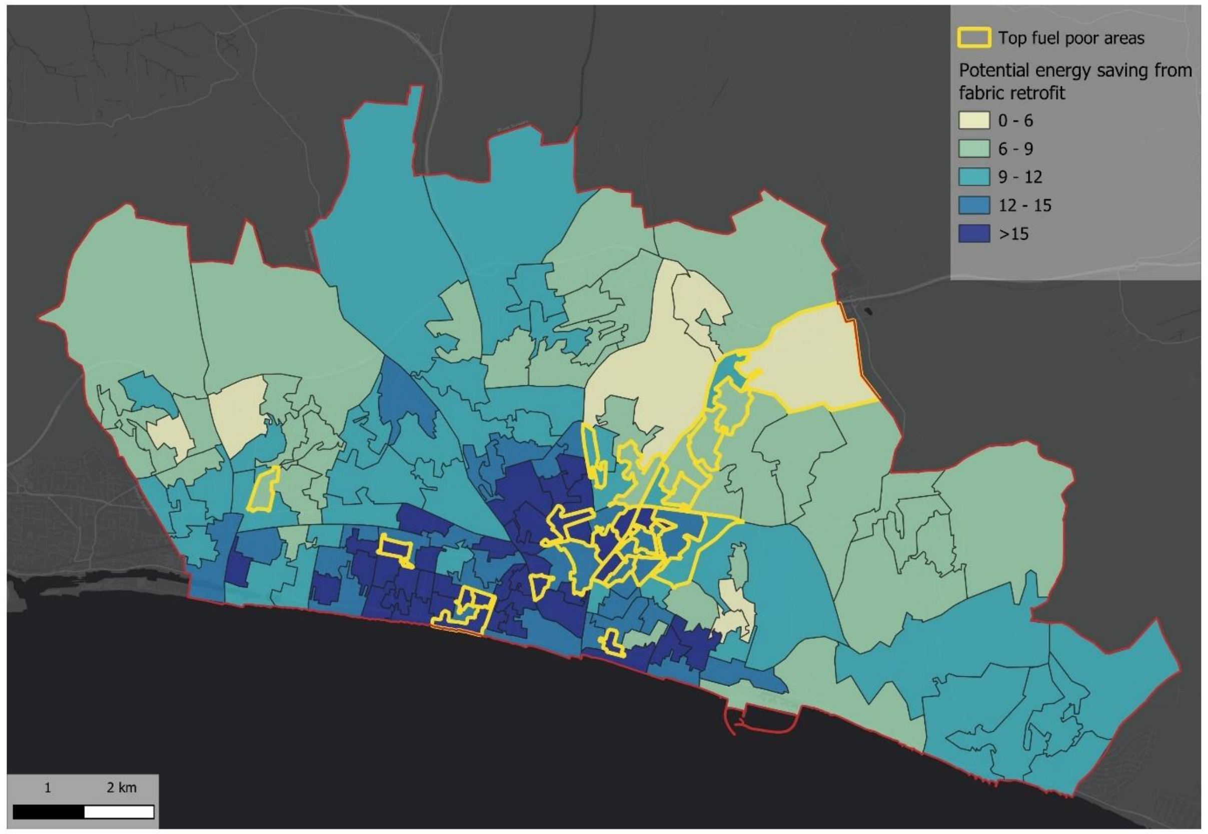

Count of unfilled/partially filled cavity walls (EPC D and below)
0 - 5
5 - 10
10 - 25
25 - 50
>50
1
2 km

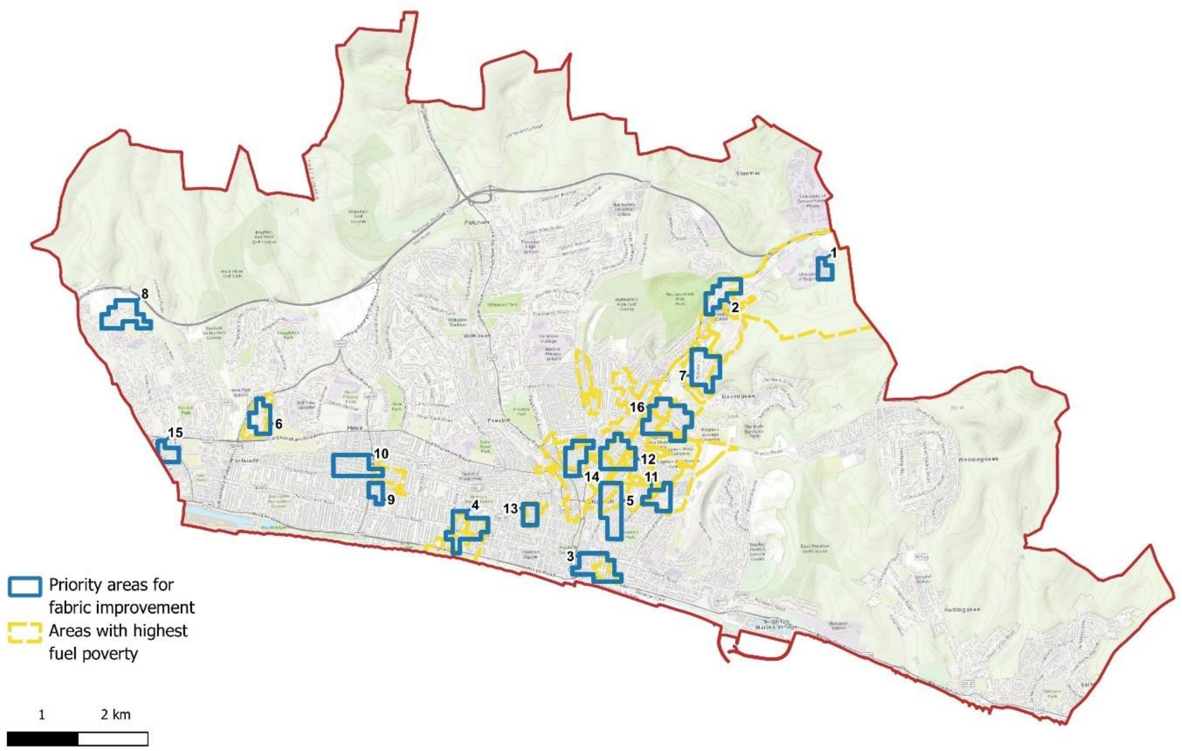

Priority areas for HP ready properties with minor insulation measures
0 - 5
5 - 15
15 - 25
25 - 35
>35

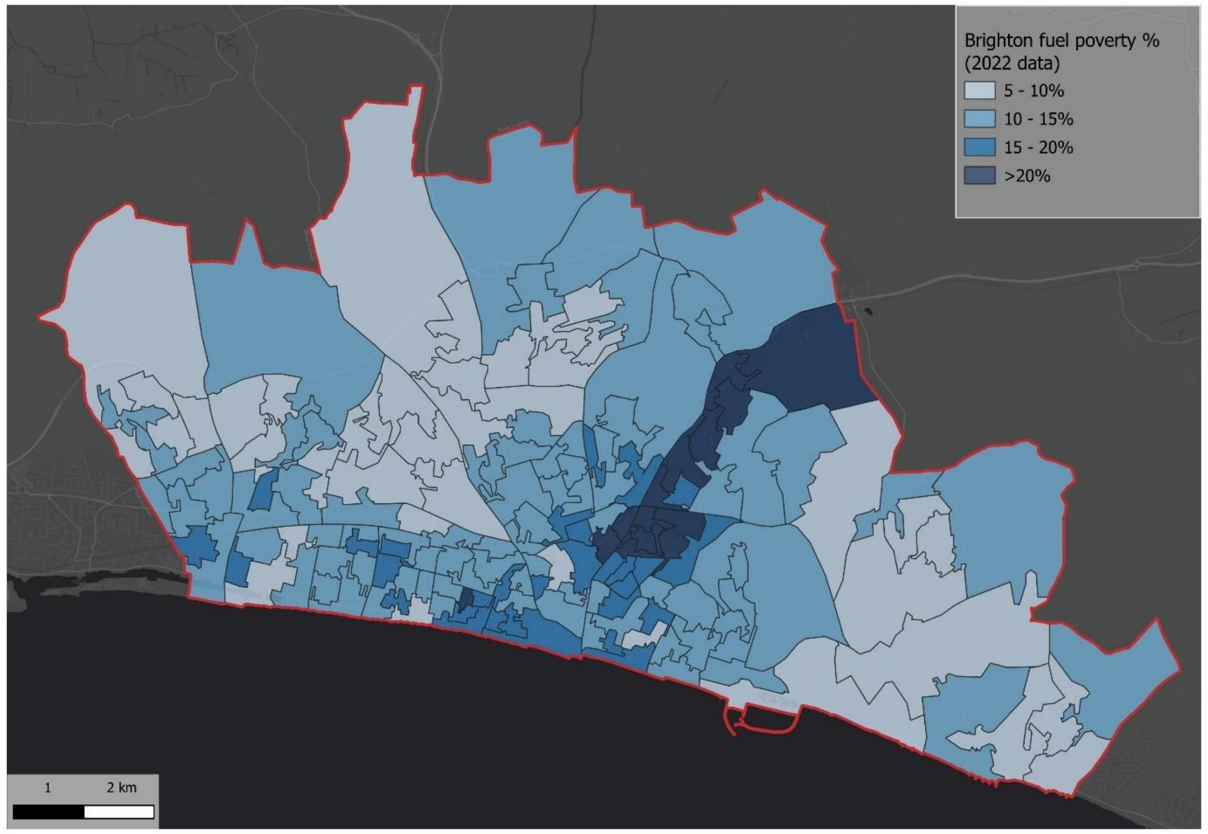

Priority areas for BHCC HP ready properties
0 - 10
10 - 20
20 - 30
>40

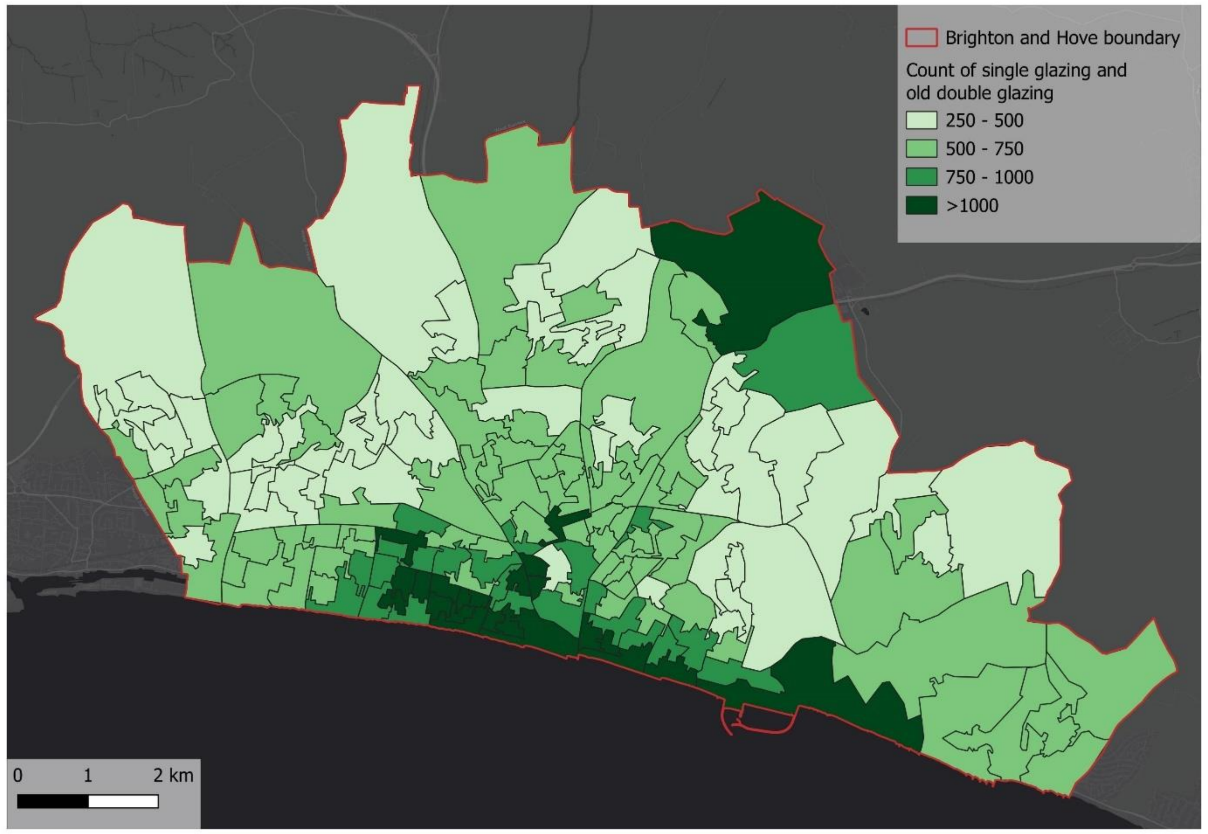

Priority areas for HP ready domestic properties
1 - 5
5 - 15
15 - 25
25 - 35
>35

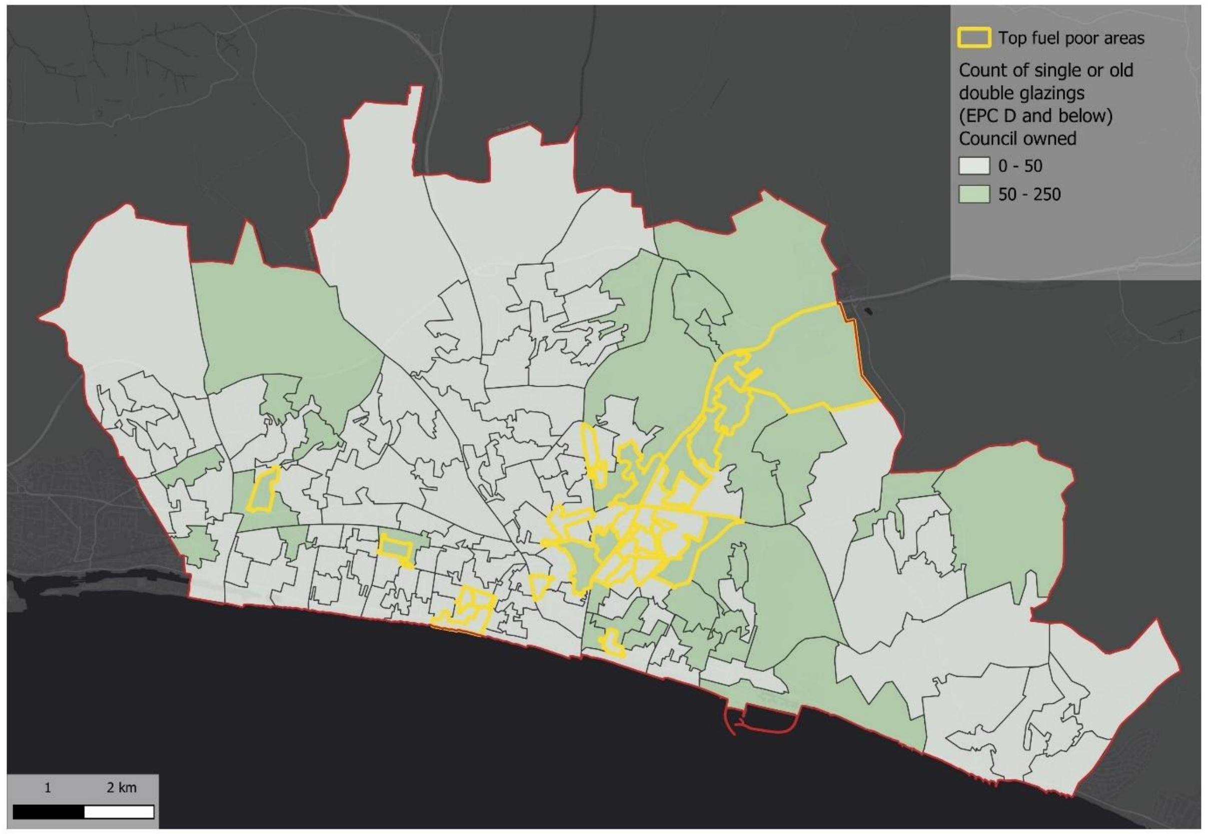

Domestic properties with Communal Oil/LPG
Domestic properties with Oil/LPG
0 1 2 km

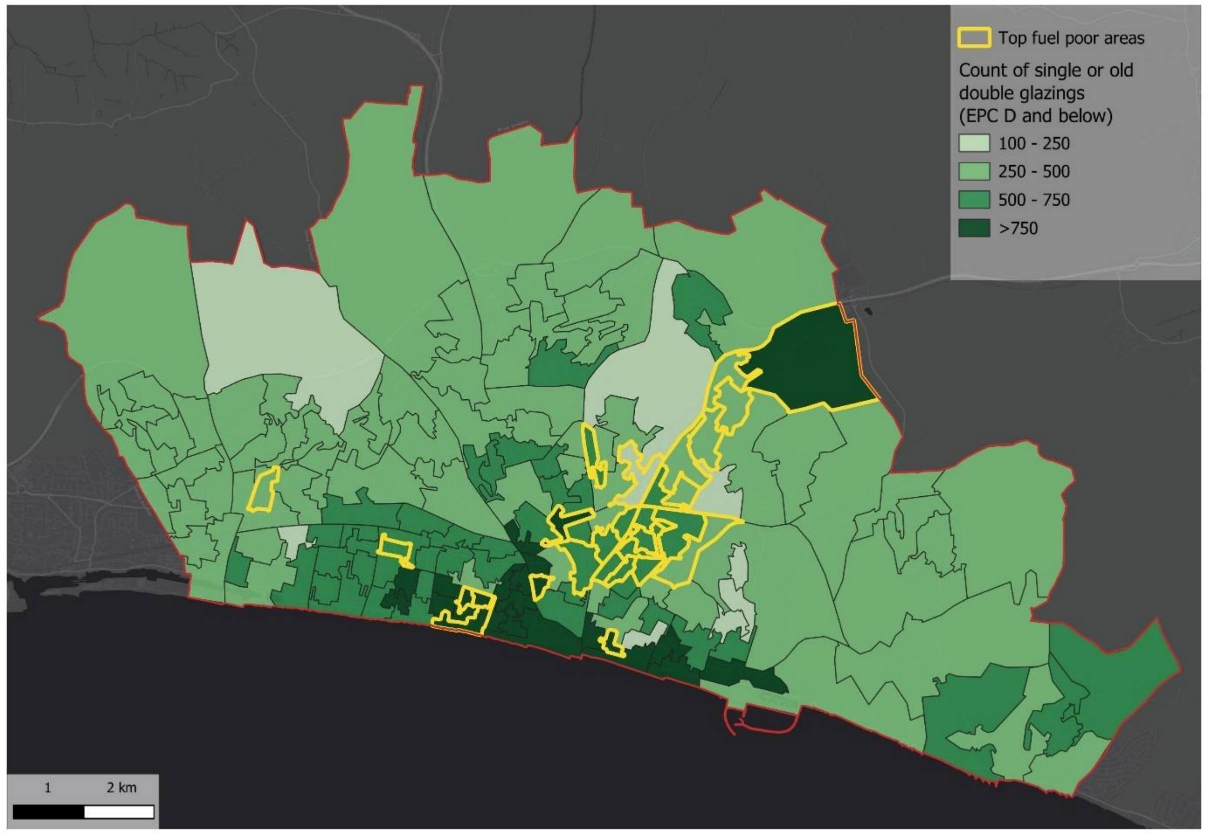

Top fuel poor areas
Potential energy saving from fabric retrofit
0 - 6
6 - 9
9 - 12
12 - 15
>15
1 2 km

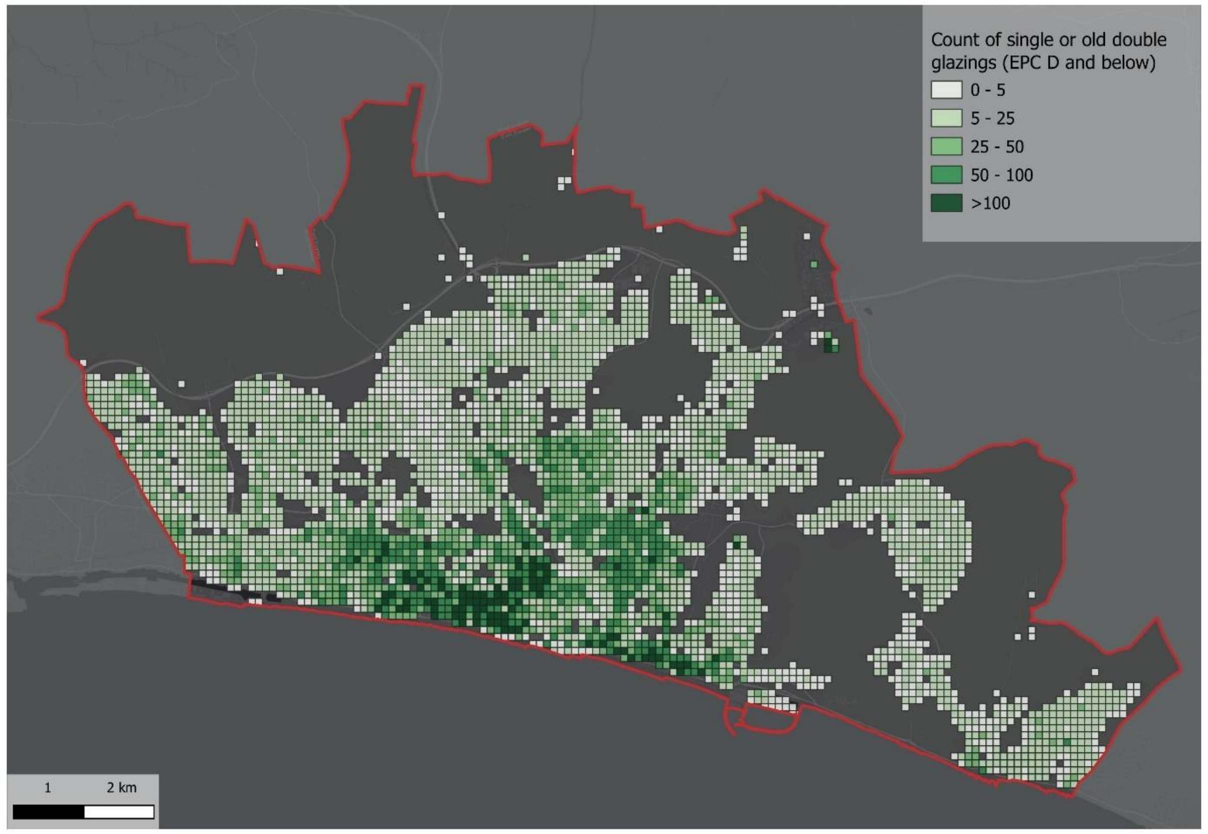

Priority areas for fabric improvement
Areas with highest fuel poverty
1 2 km

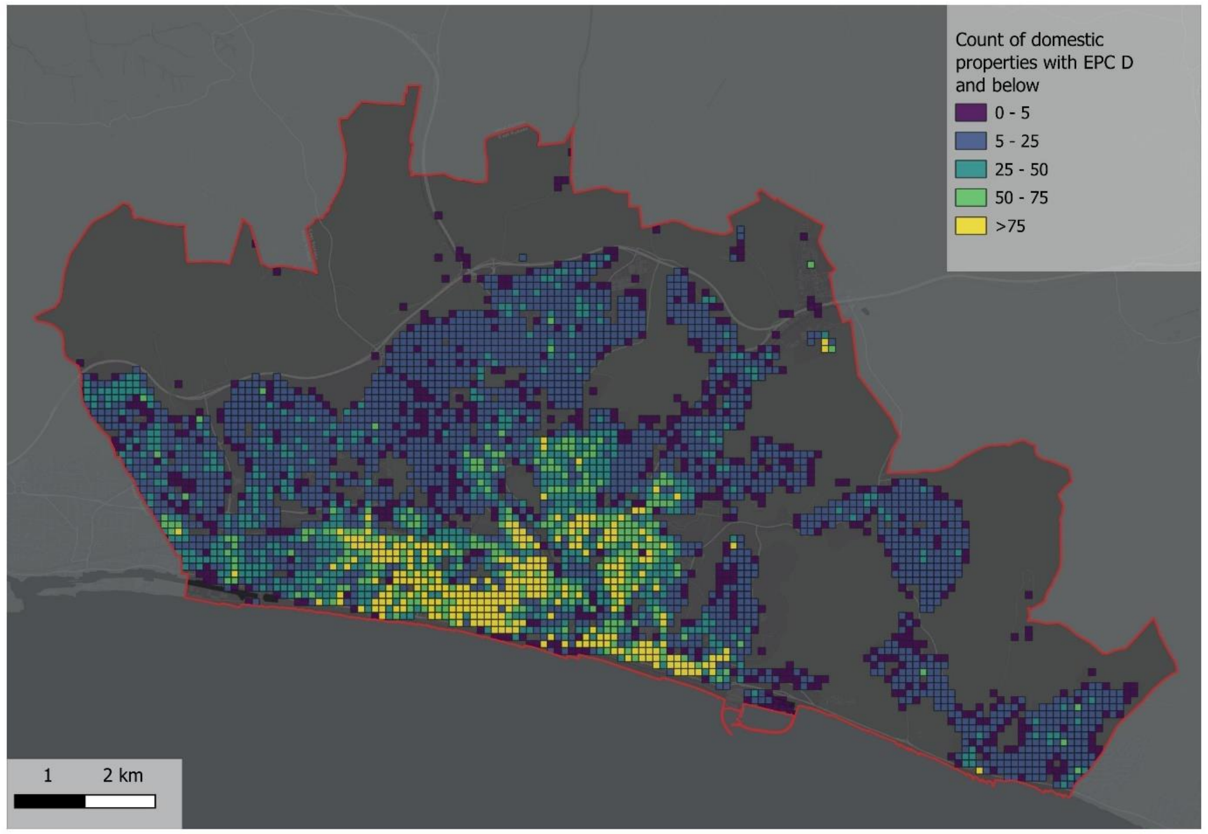

Brighton fuel poverty % (2022 data)
5 - 10%
10 - 15%
15 - 20%
>20%
1 2 km

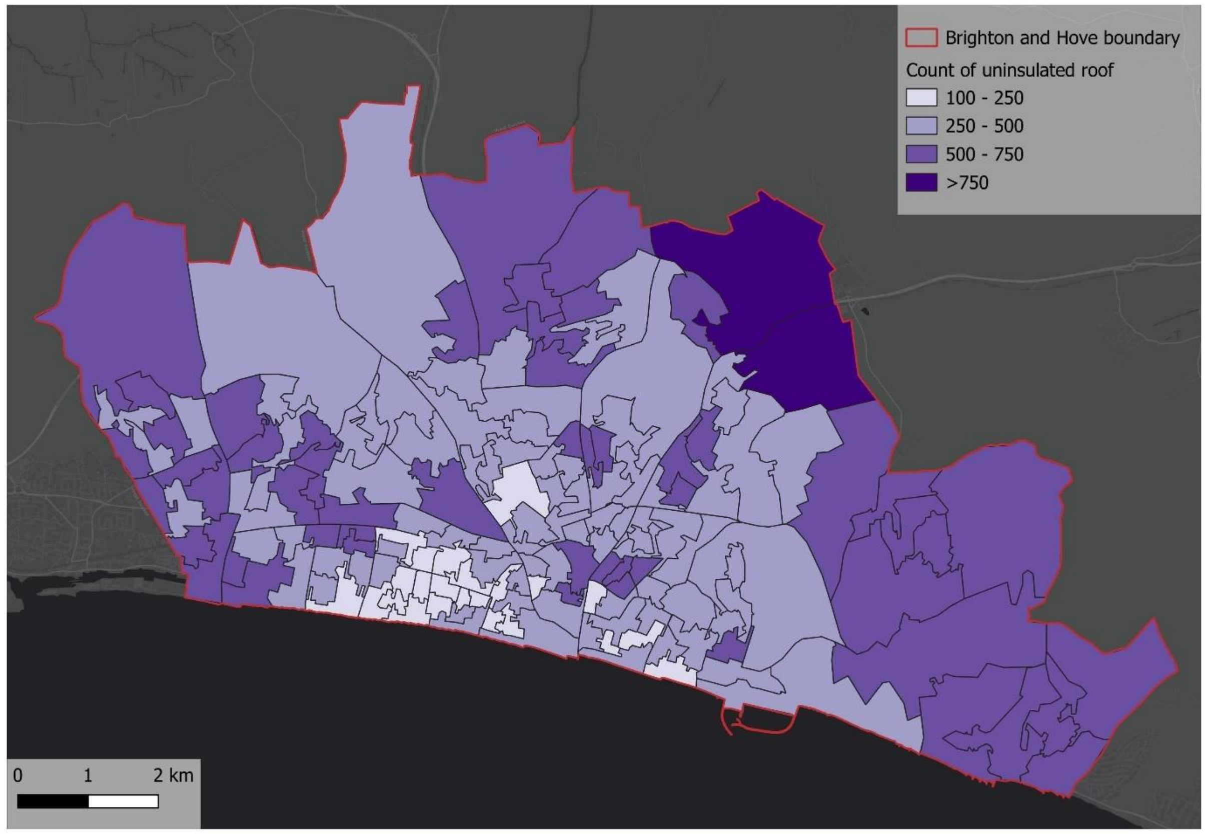

Brighton and Hove boundary
Count of single glazing and old double glazing
250 - 500
500 - 750
750 - 1000
>1000
0 1 2 km

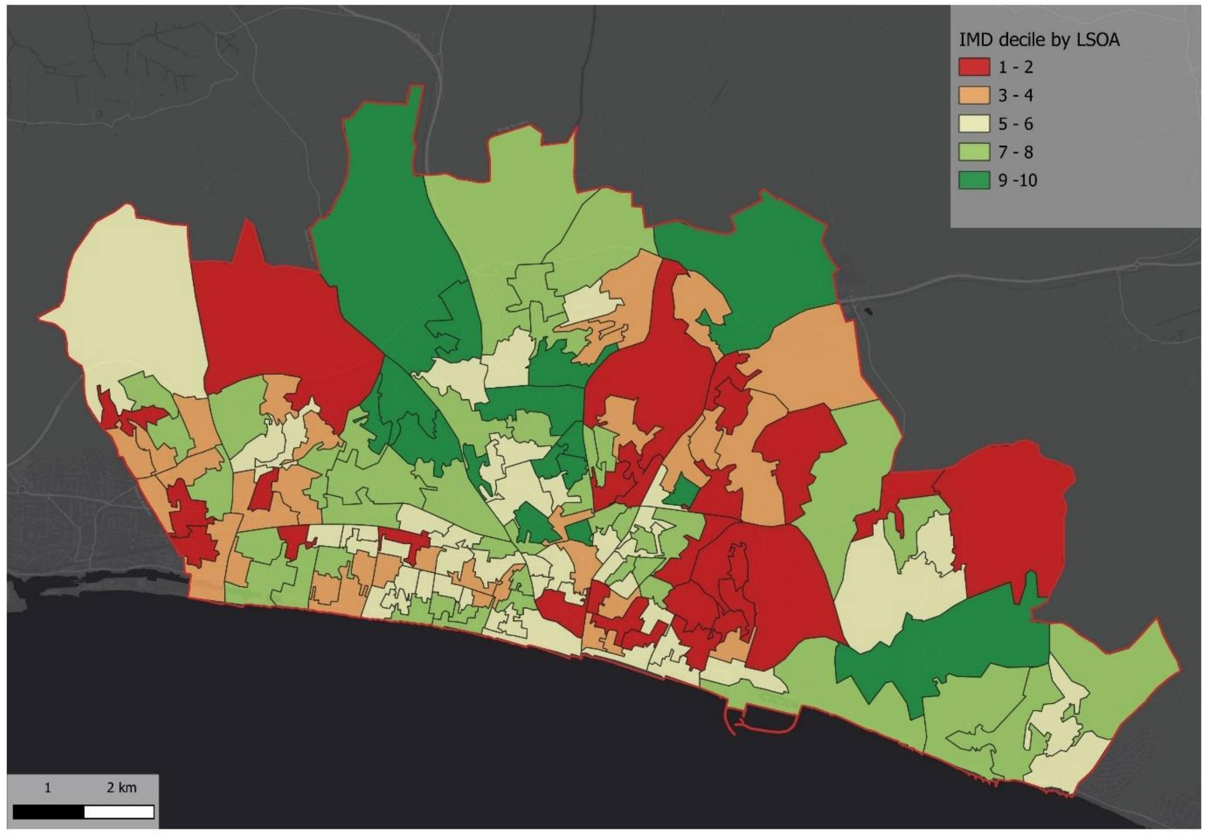

Top fuel poor areas
Count of single or old double glazings (EPC D and below) Council owned
0 - 50
50 - 250
1 2 km

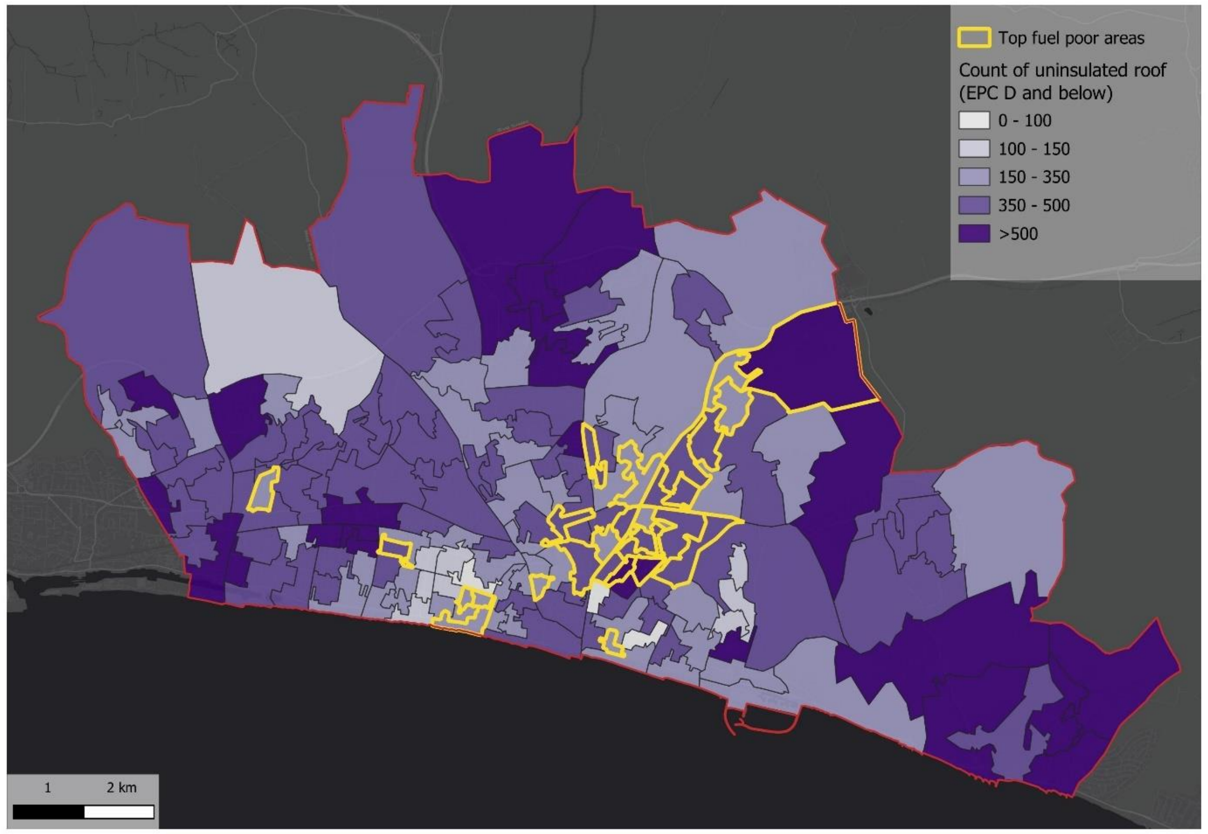

Top fuel poor areas
Count of single or old double glazings (EPC D and below)
100 - 250
250 - 500
500 - 750
>750
1 2 km

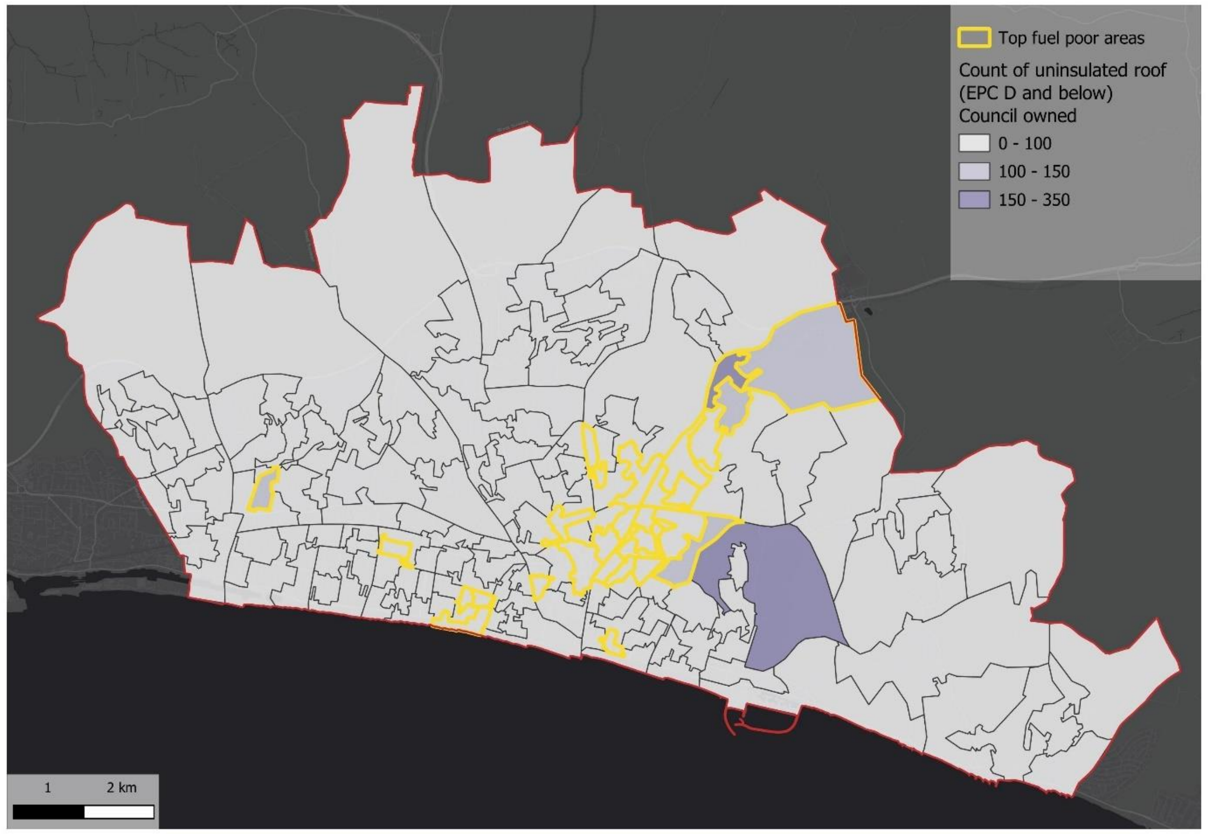

Count of single or old double glazings (EPC D and below)
0 - 5
5 - 25
25 - 50
50 - 100
>100
1 2 km

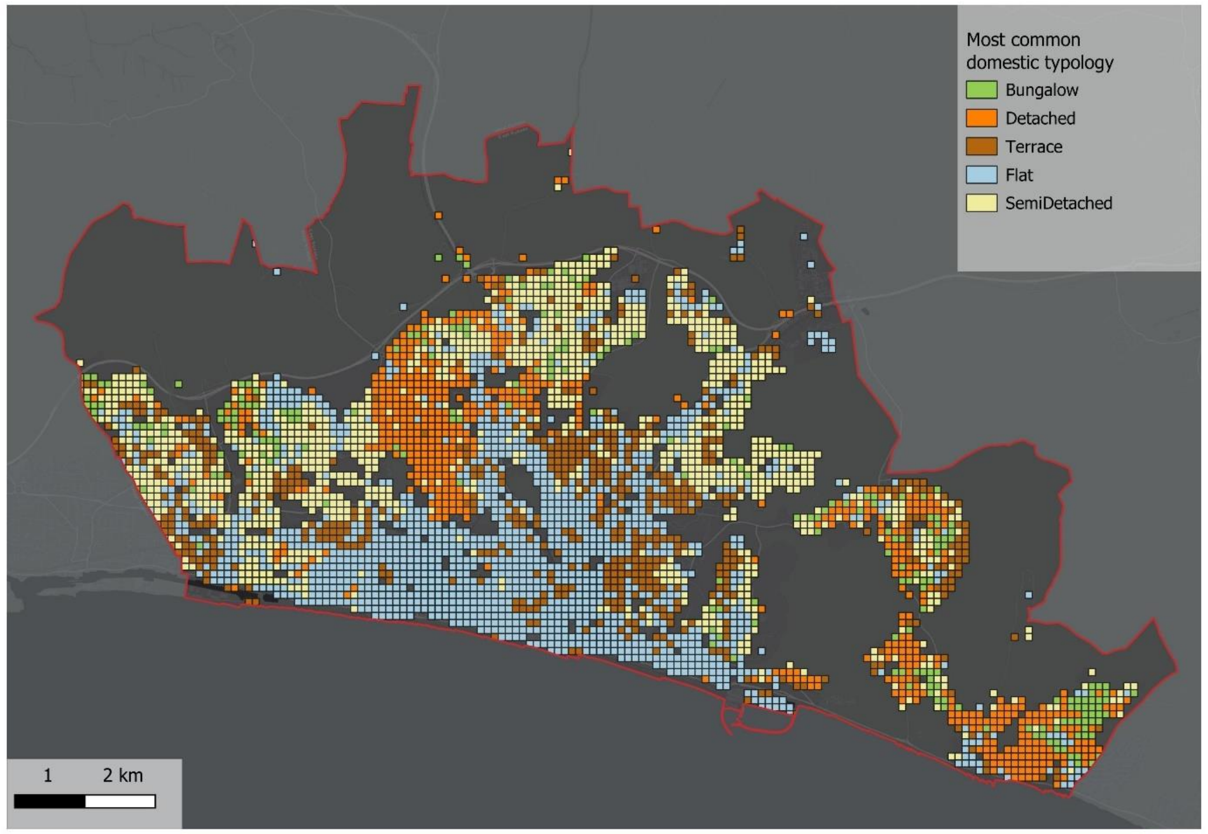

Count of domestic properties with EPC D and below
0 - 5
5 - 25
25 - 50
50 - 75
>75
1 2 km

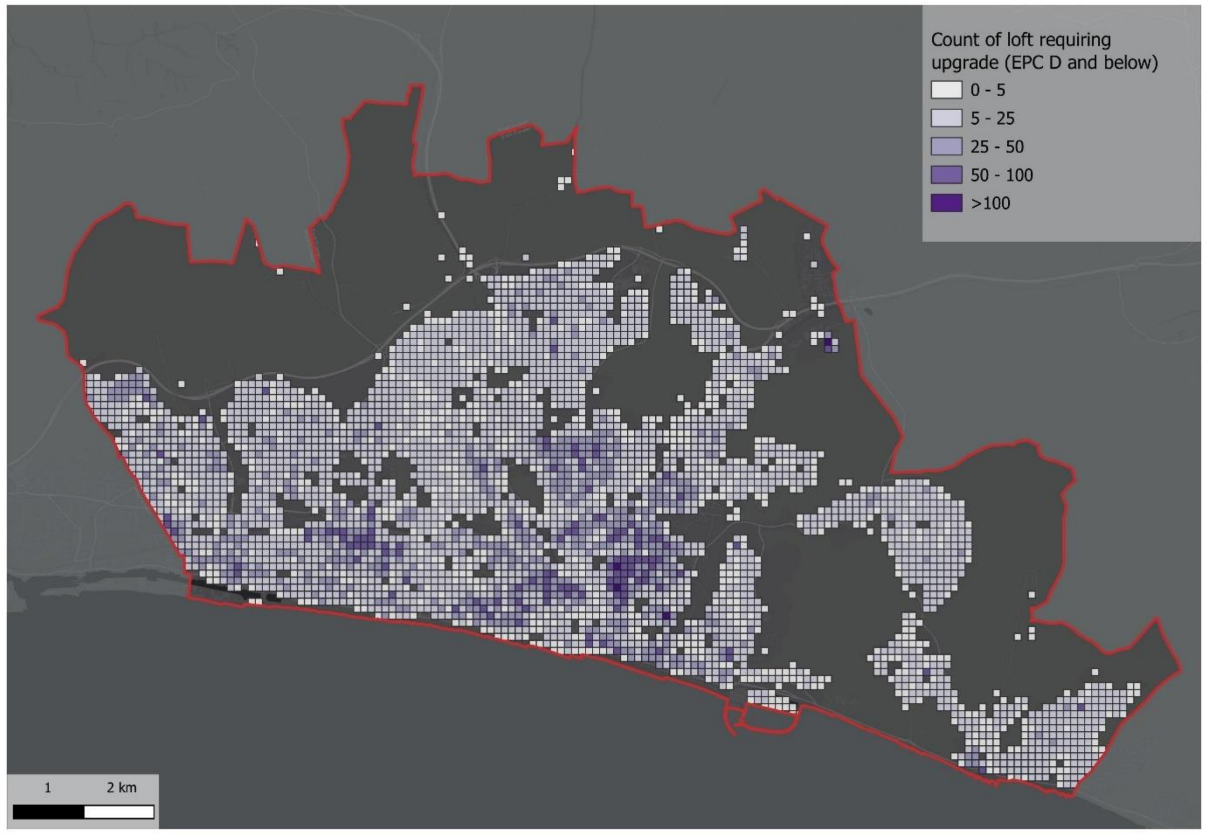

Brighton and Hove boundary
Count of uninsulated roof
100 - 250
250 - 500
500 - 750
>750
0 1 2 km

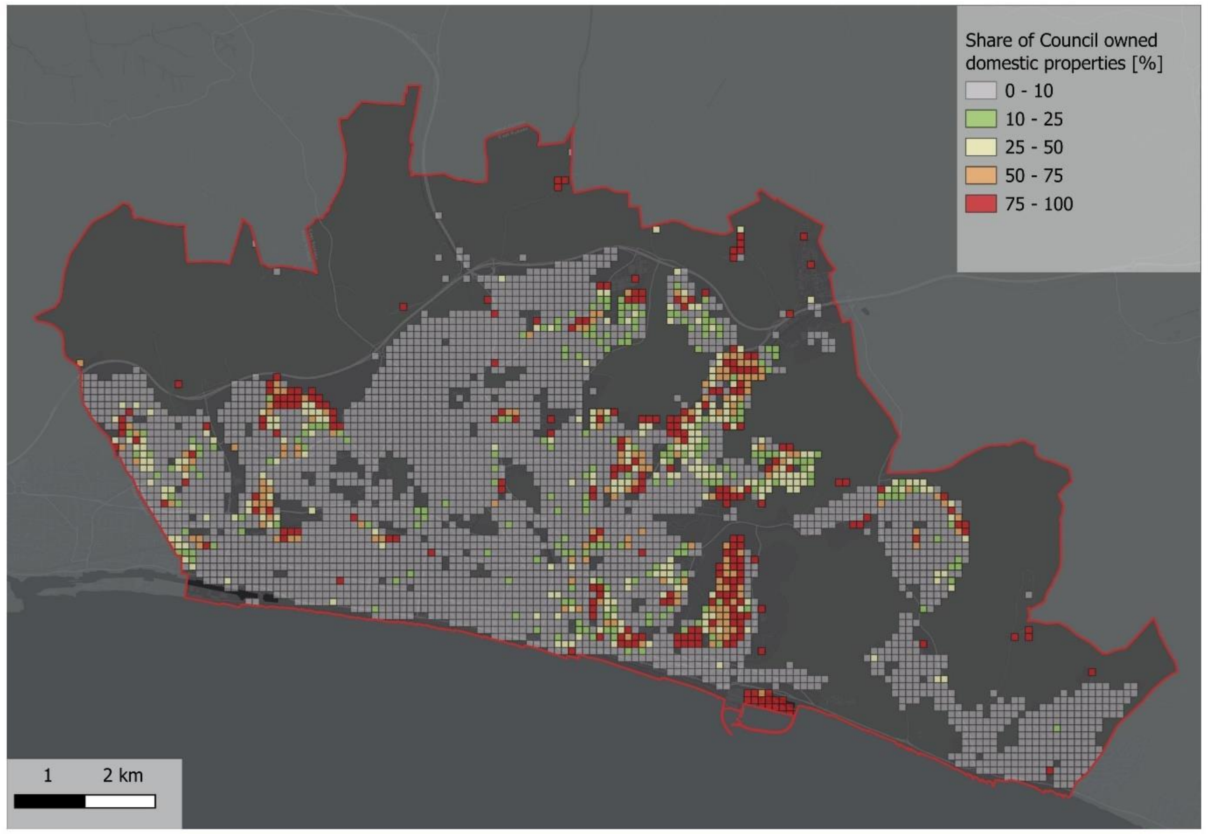

IMD decile by LSOA
1 - 2
3 - 4
5 - 6
7 - 8
9 -10
1 2 km

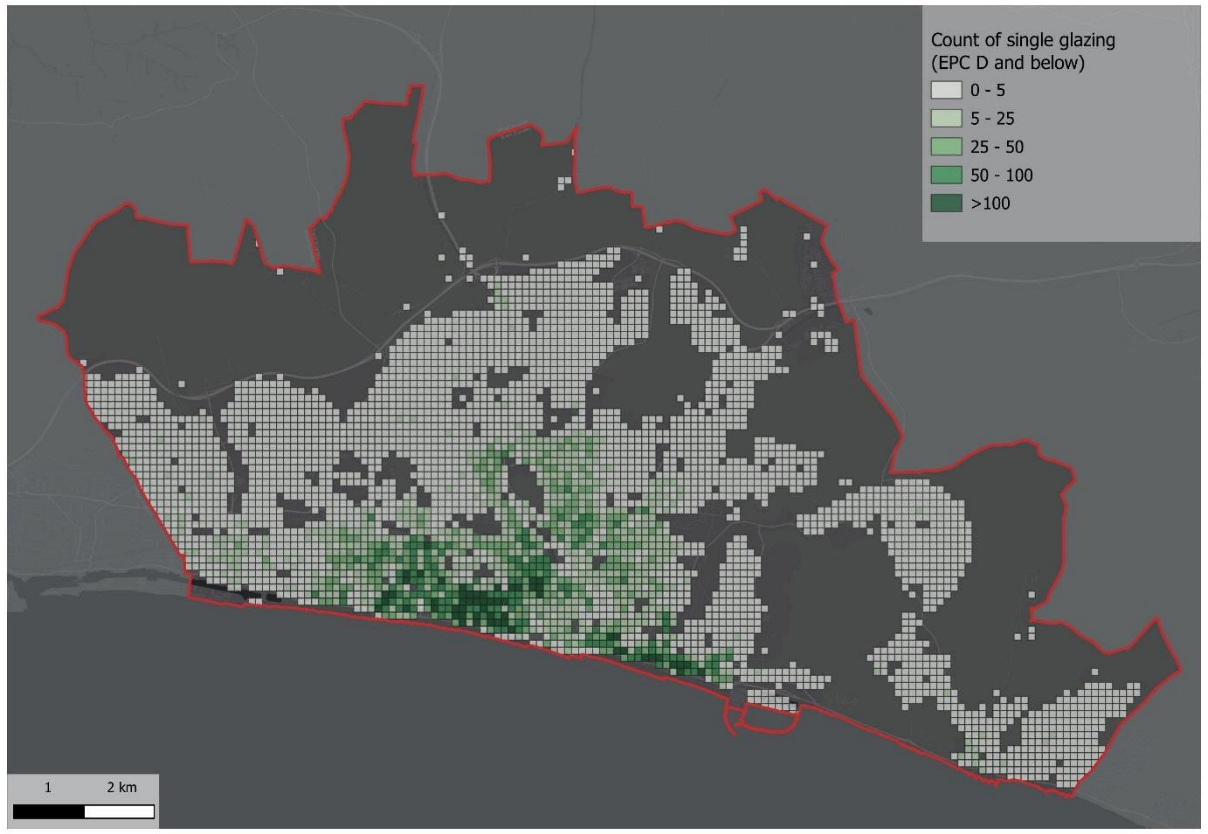

Top fuel poor areas
Count of uninsulated roof (EPC D and below)
0 - 100
100 - 150
150 - 350
350 - 500
>500
1 2 km

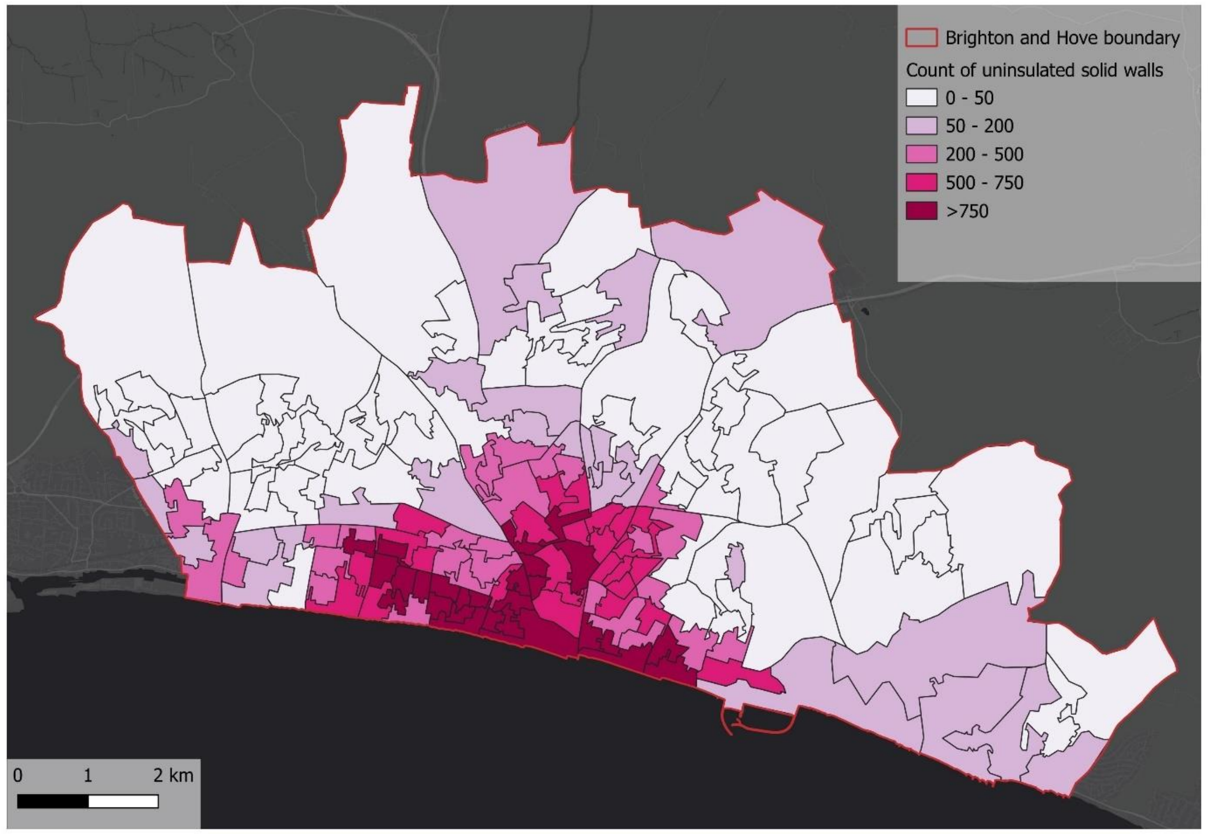

Top fuel poor areas
Count of uninsulated roof (EPC D and below) Council owned
0 - 100
100 - 150
150 - 350
1
2 km

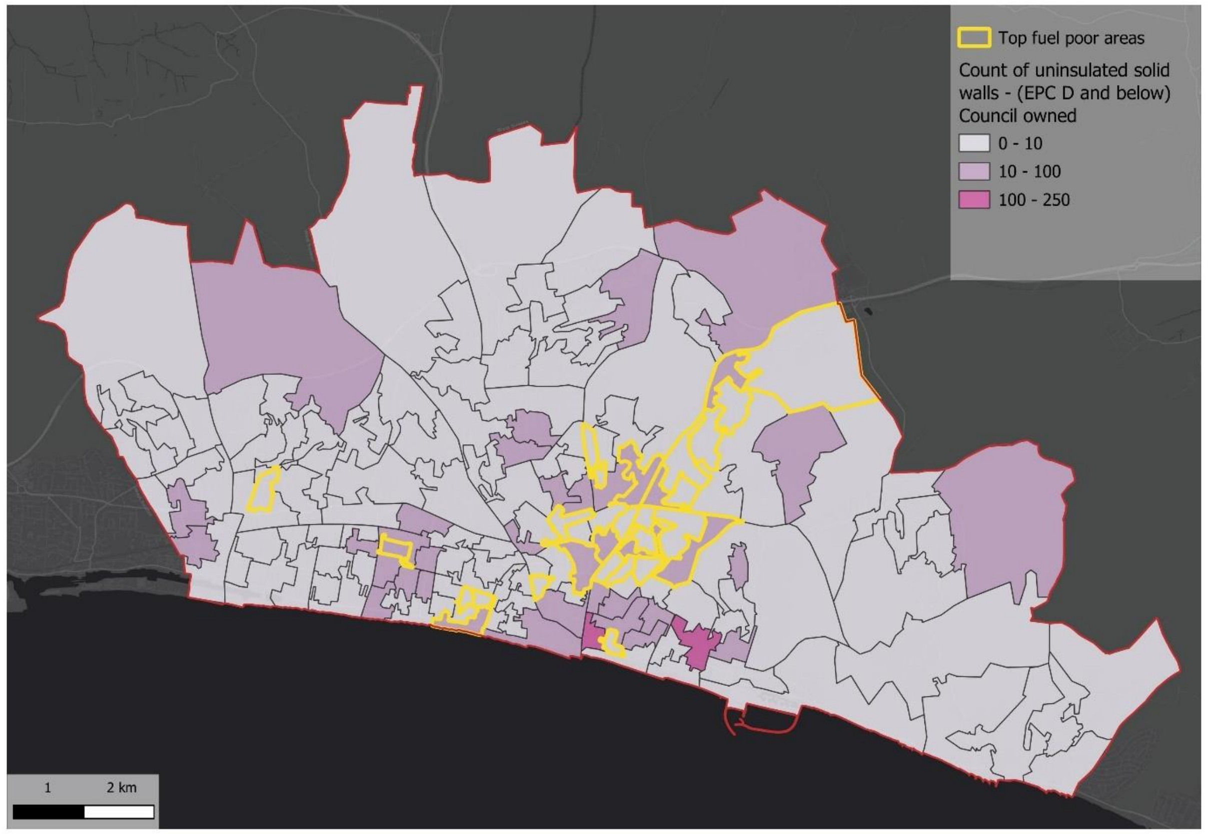

Most common domestic typology
Bungalow
Detached
Terrace
Flat
SemiDetached
1
2 km

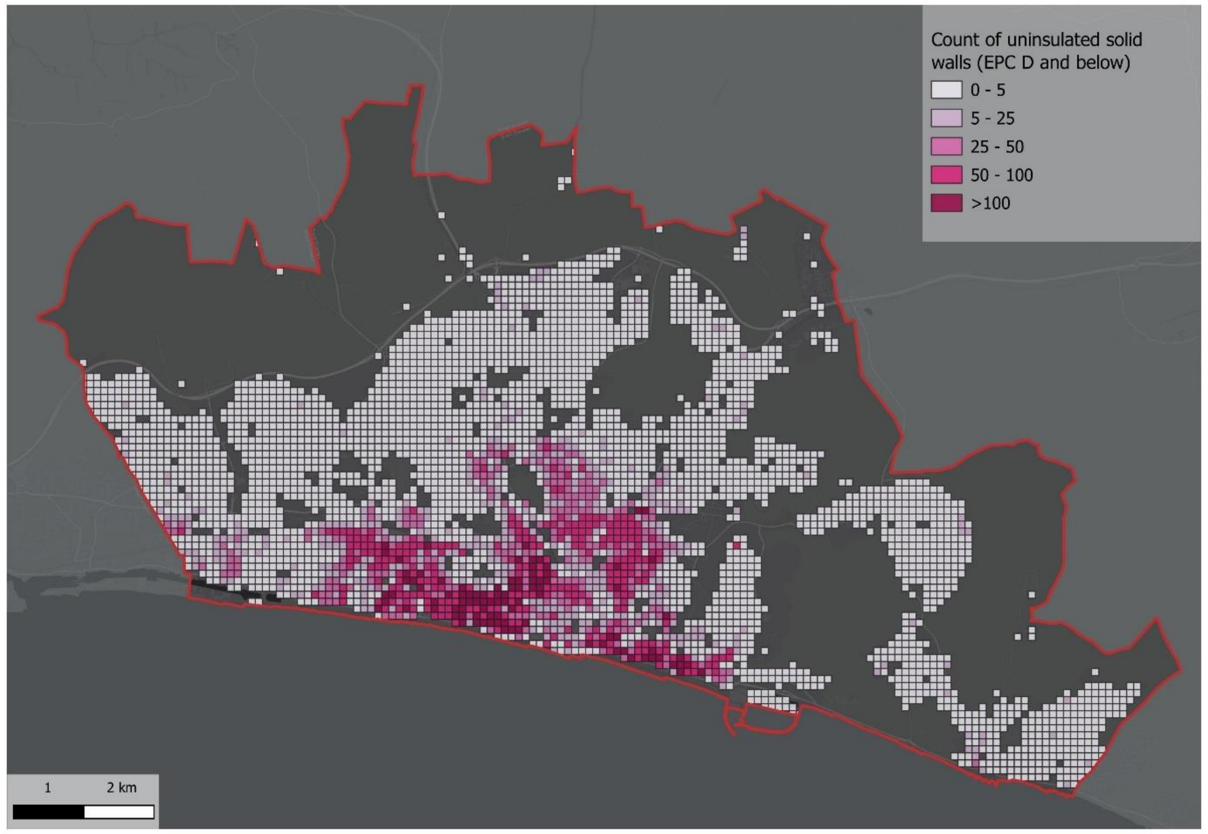

Count of loft requiring upgrade (EPC D and below)
0 - 5
5 - 25
25 - 50
50 - 100
>100
1
2 km

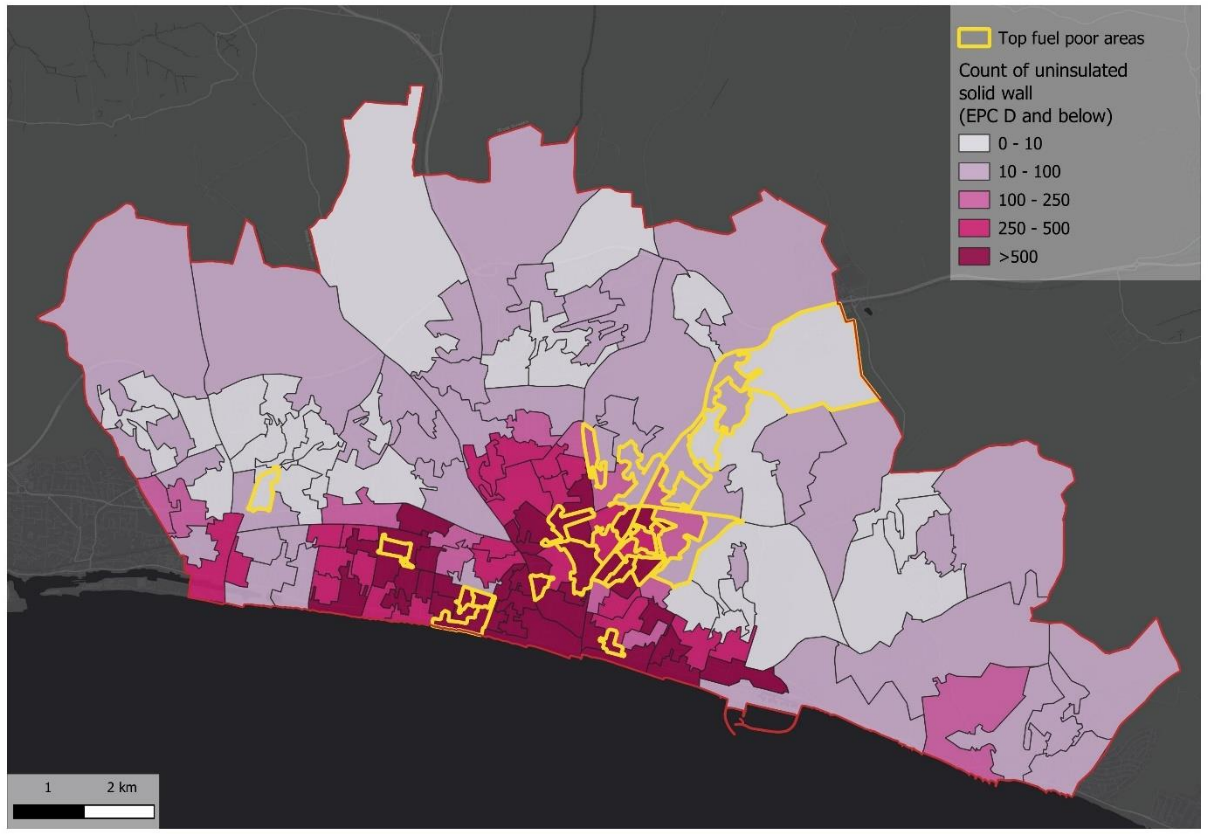

Share of Council owned domestic properties [%]
0 - 10
10 - 25
25 - 50
50 - 75
75 - 100
1
2 km


Count of single glazing
(EPC D and below)
0 - 5
5 - 25
25 - 50
50 - 100
>100
1 2 km

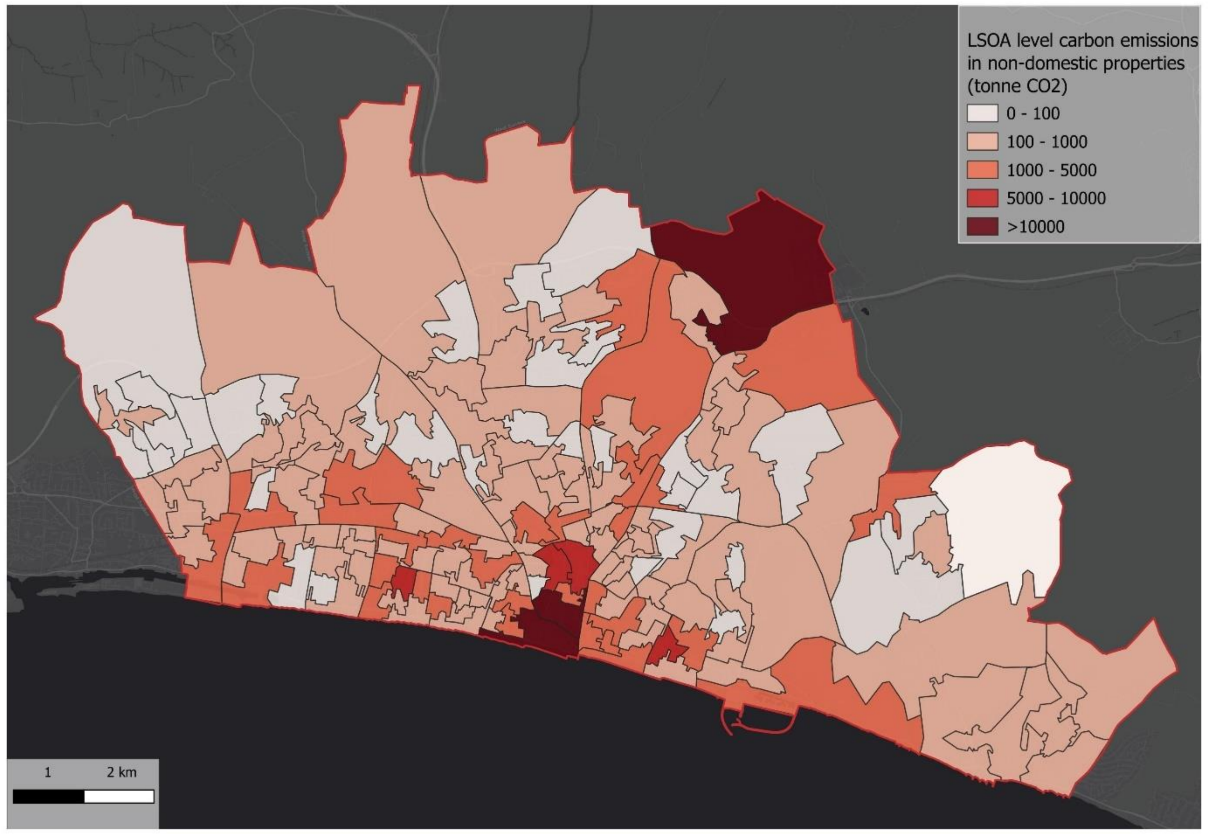

Brighton and Hove boundary
Count of uninsulated solid walls
0 - 50
50 - 200
200 - 500
500 - 750
>750
0 1 2 km

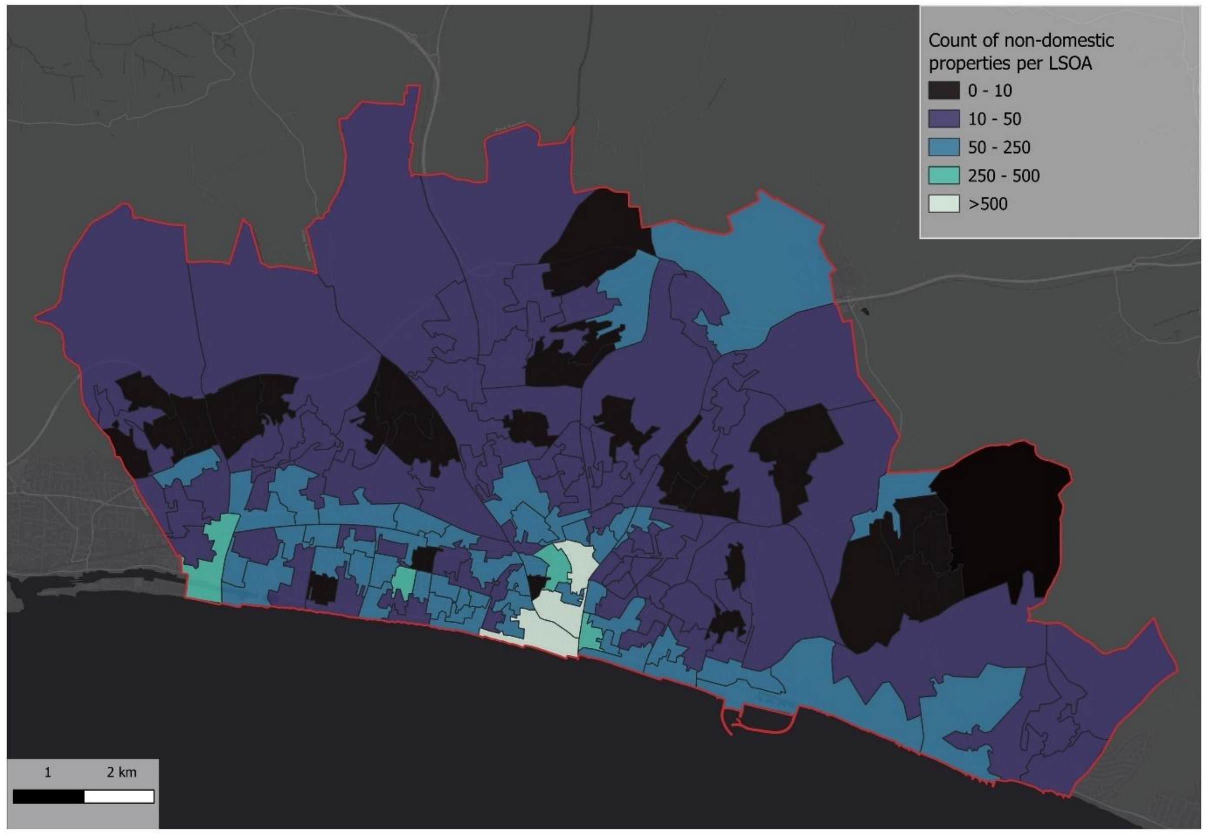

Top fuel poor areas
Count of uninsulated solid walls - (EPC D and below) Council owned
0 - 10
10 - 100
100 - 250
1 2 km

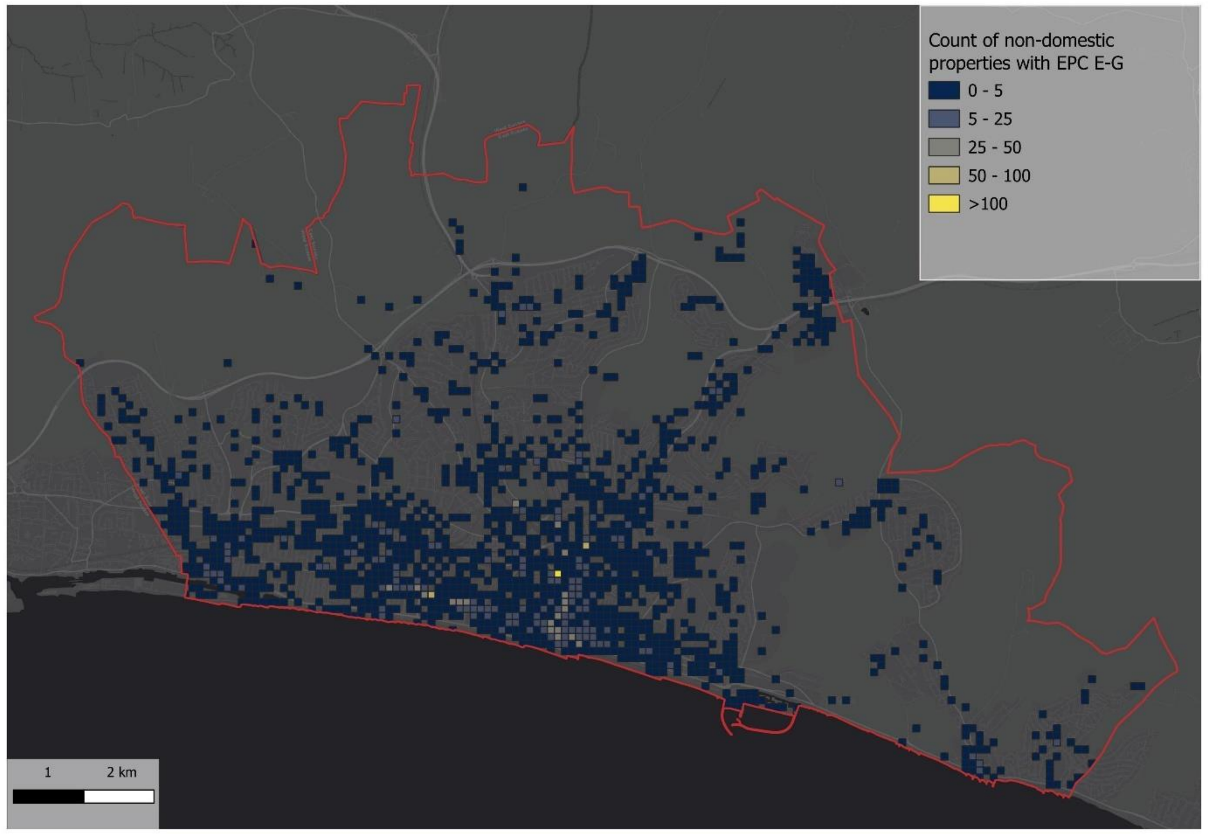

Count of uninsulated solid walls (EPC D and below)
0 - 5
5 - 25
25 - 50
50 - 100
>100
1 2 km

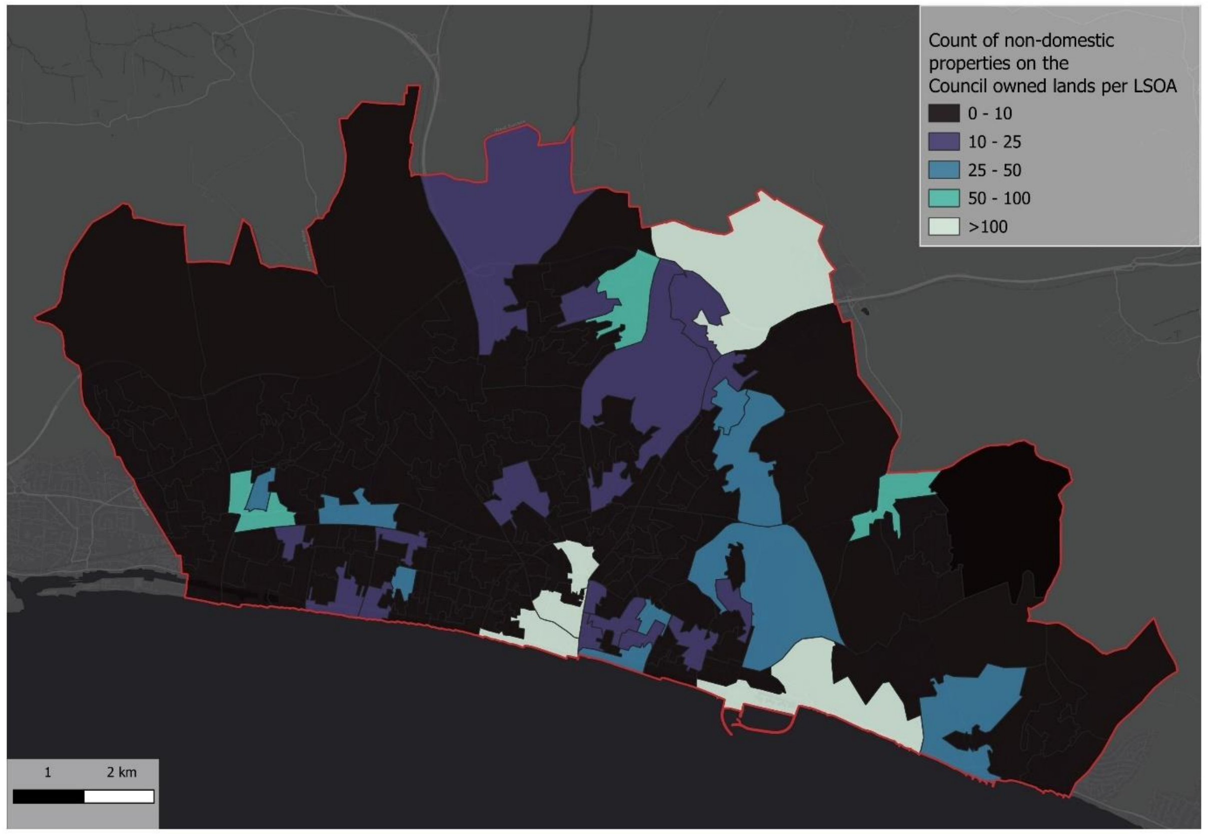

Top fuel poor areas
Count of uninsulated solid wall (EPC D and below)
0 - 10
10 - 100
100 - 250
250 - 500
>500
1
2 km

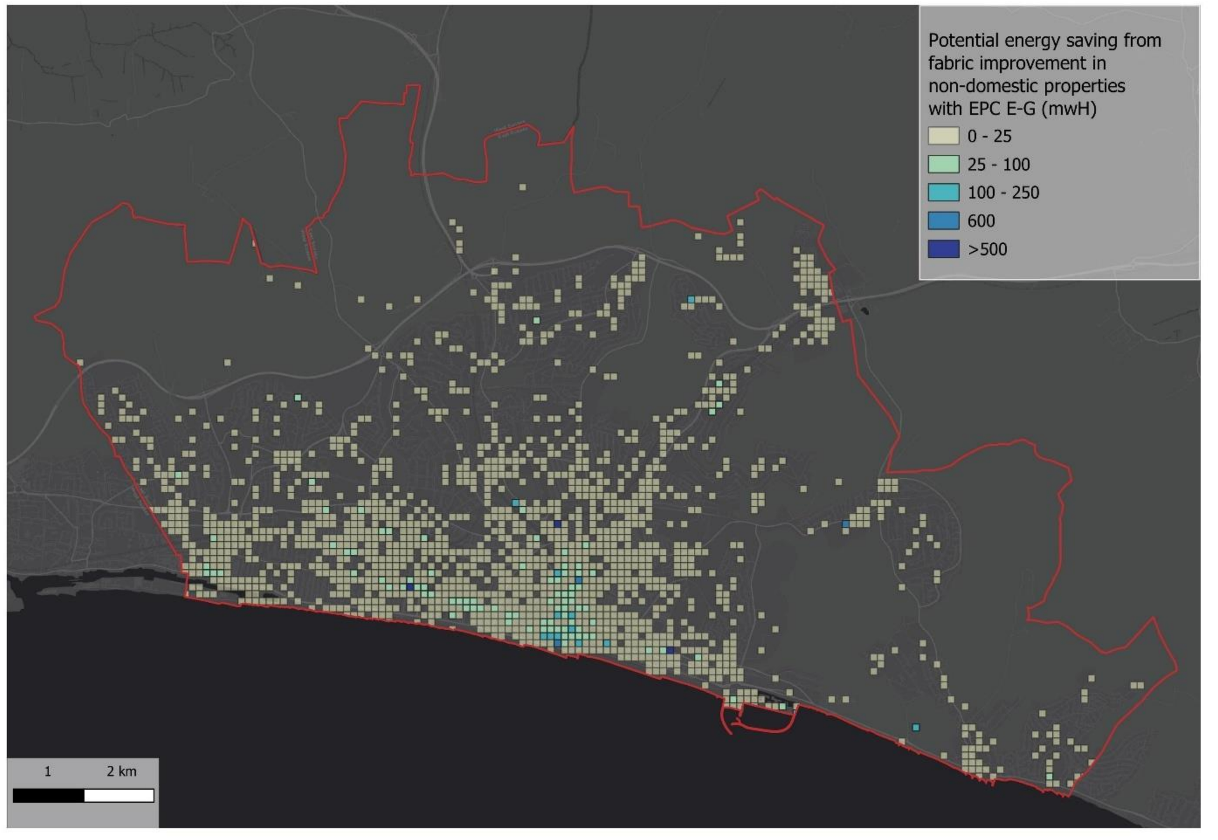
– non-domestic maps

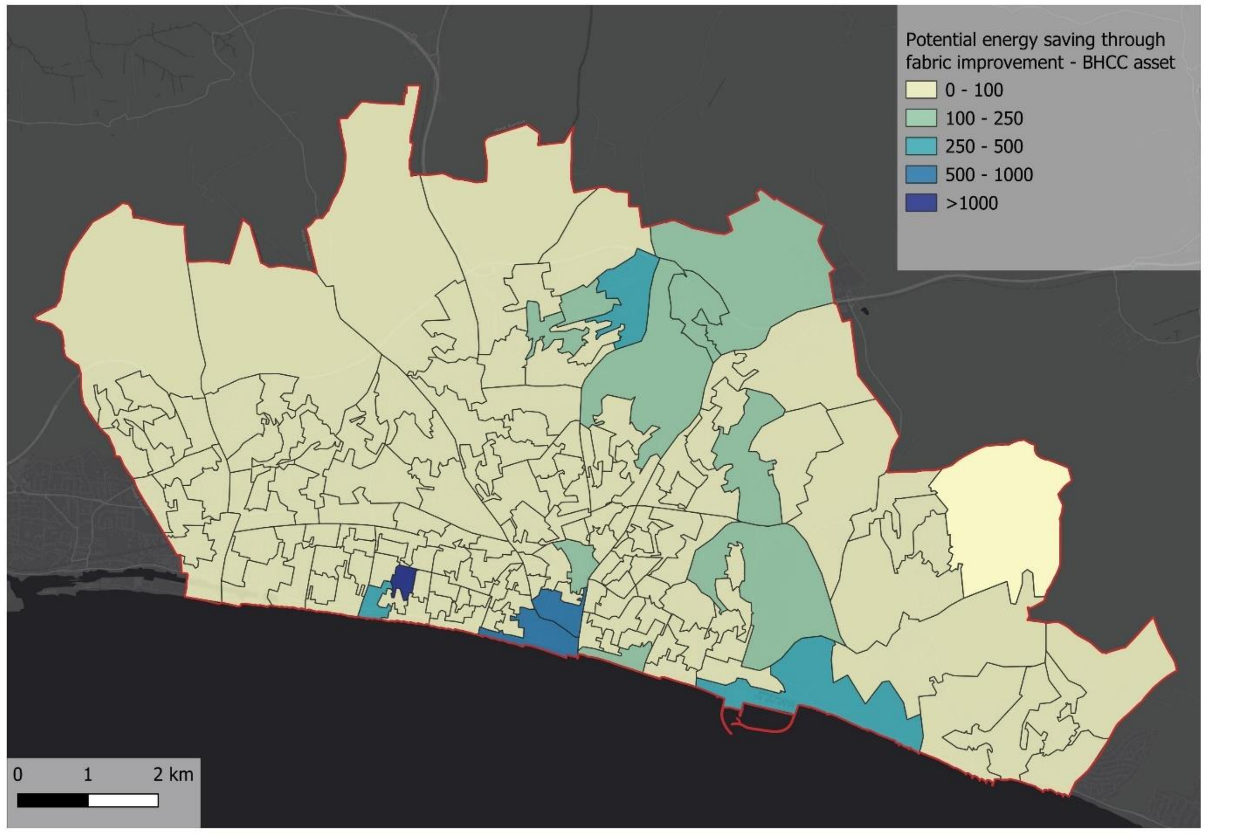

LSOA level carbon emissions in non-domestic properties (tonne CO2)
0 - 100
100 - 1000
1000 - 5000
5000 - 10000
>10000
1
2 km

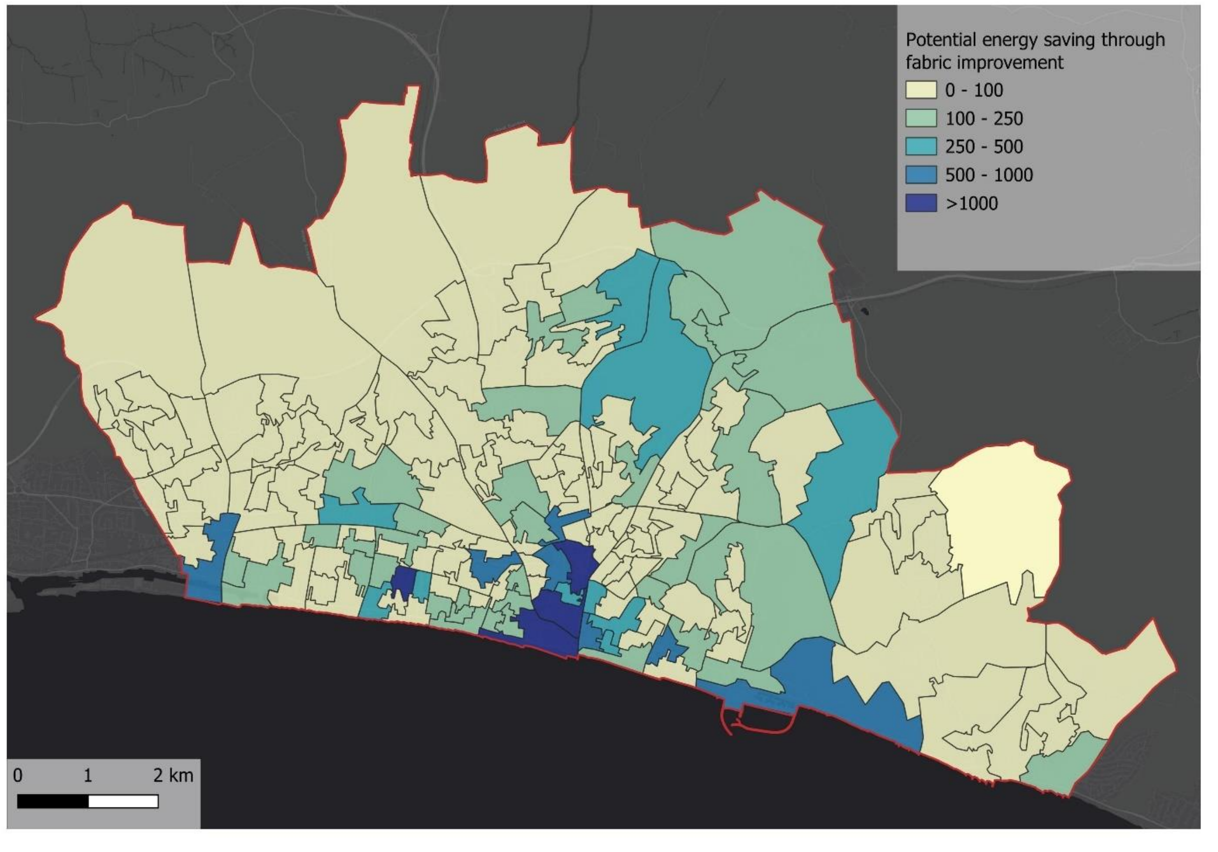

Count of non-domestic properties per LSOA
0 - 10
10 - 50
50 - 250
250 - 500
>500
1
2 km

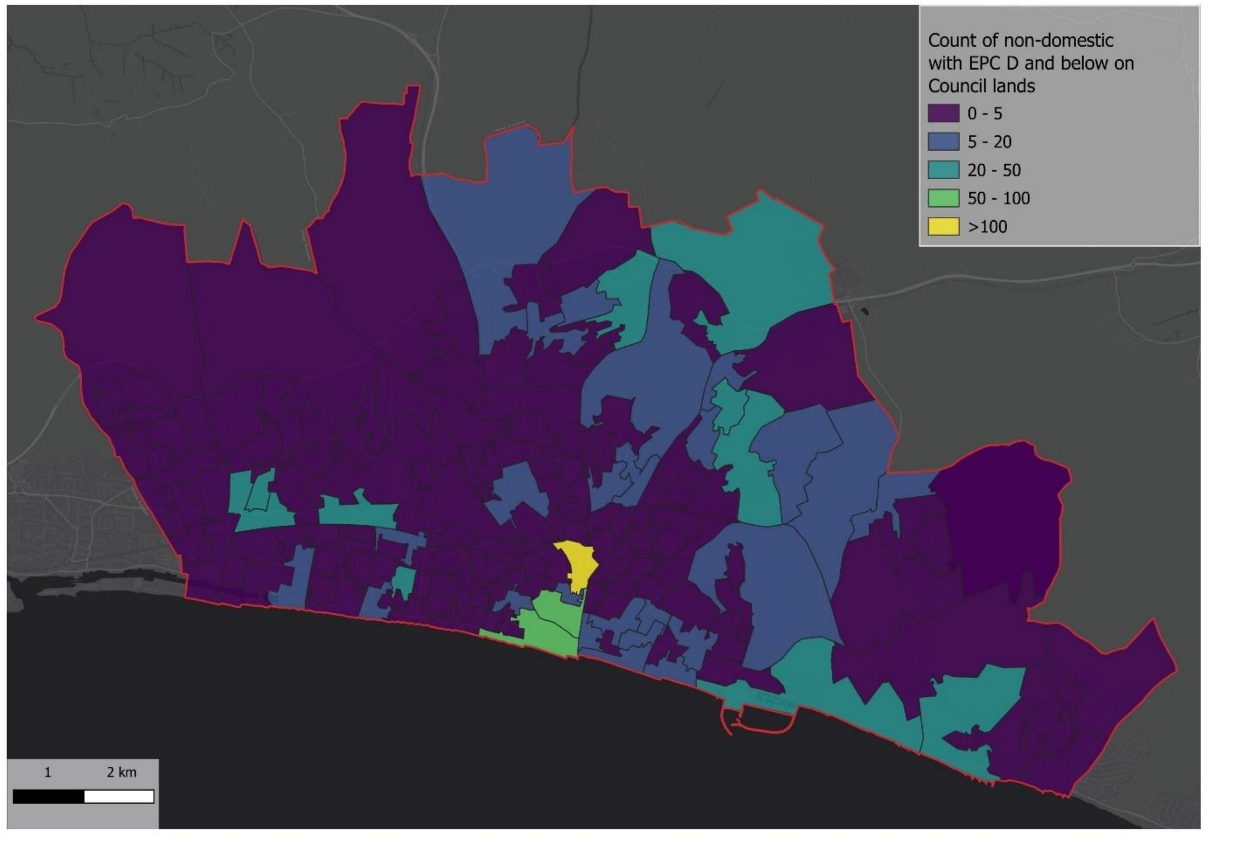

Count of non-domestic properties with EPC E-G
0 - 5
5 - 25
25 - 50
50 - 100
>100
1
2 km

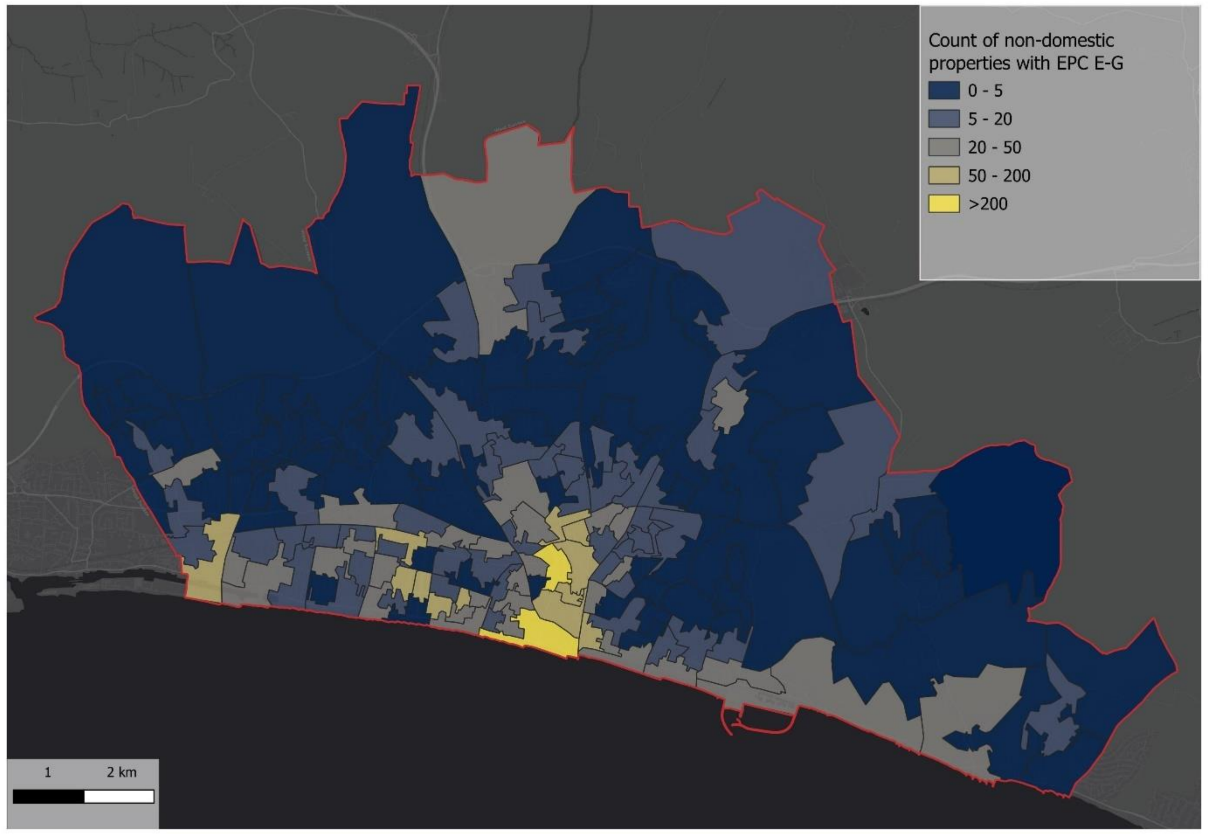

Count of non-domestic properties on the Council owned lands per LSOA
0 - 10
10 - 25
25 - 50
50 - 100
>100
1
2 km

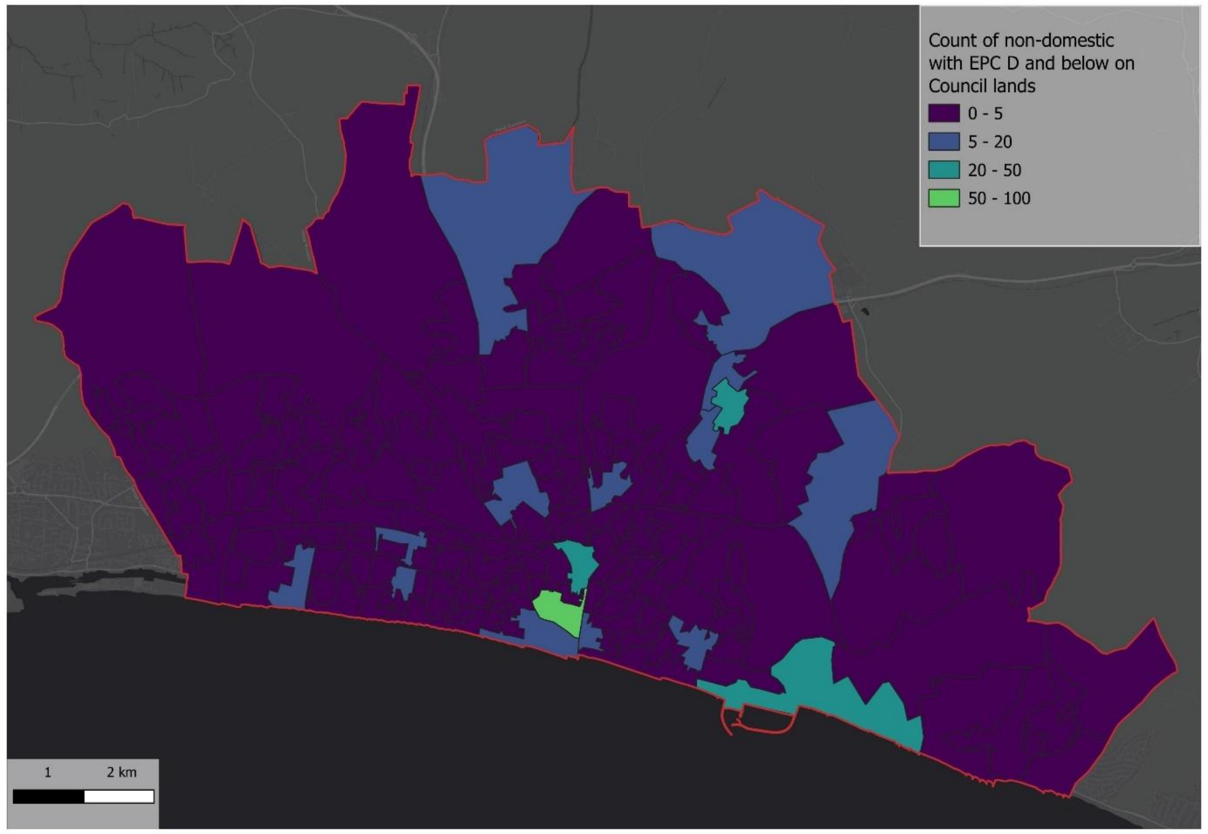

Potential energy saving from fabric improvement in non-domestic properties with EPC E-G (mwH)
0 - 25
25 - 100
100 - 250
600
>500
1
2 km

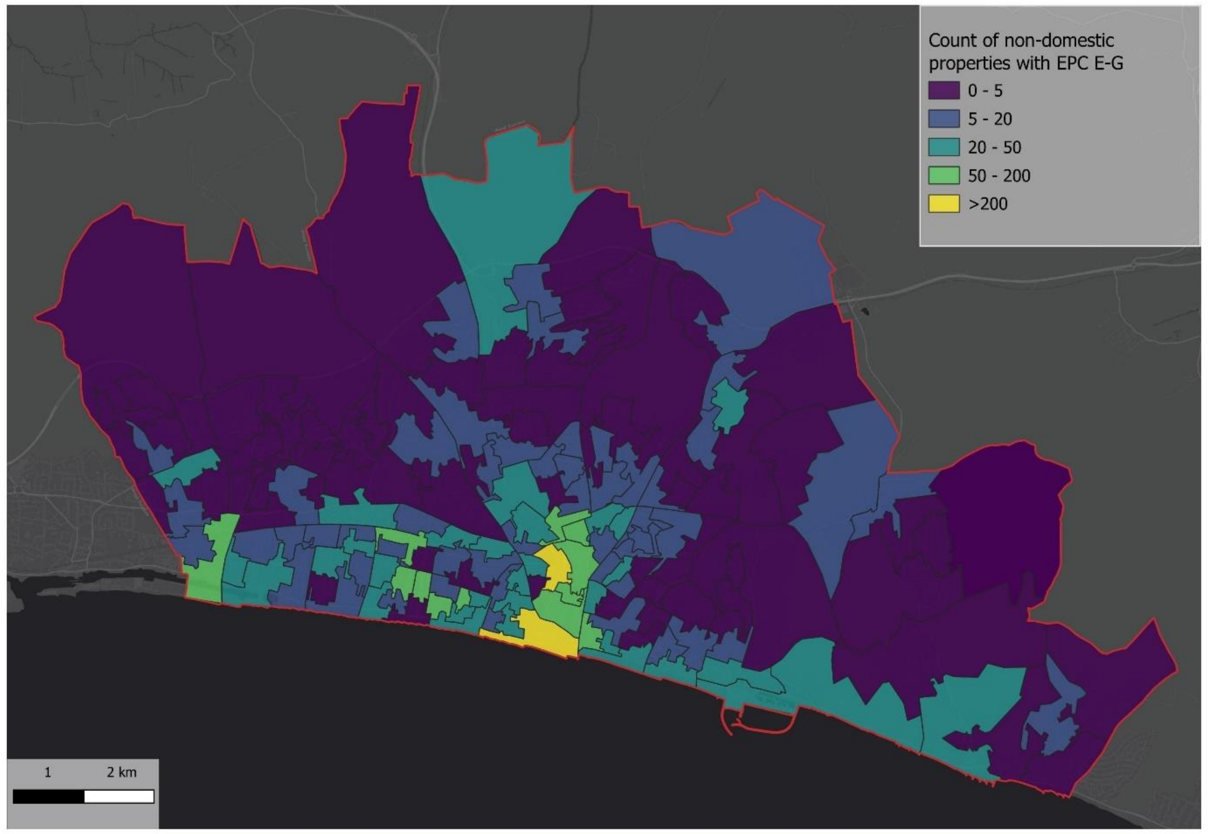

Potential energy saving through fabric improvement - BHCC asset
0 - 100
100 - 250
250 - 500
500 - 1000
>1000
0
1
2 km

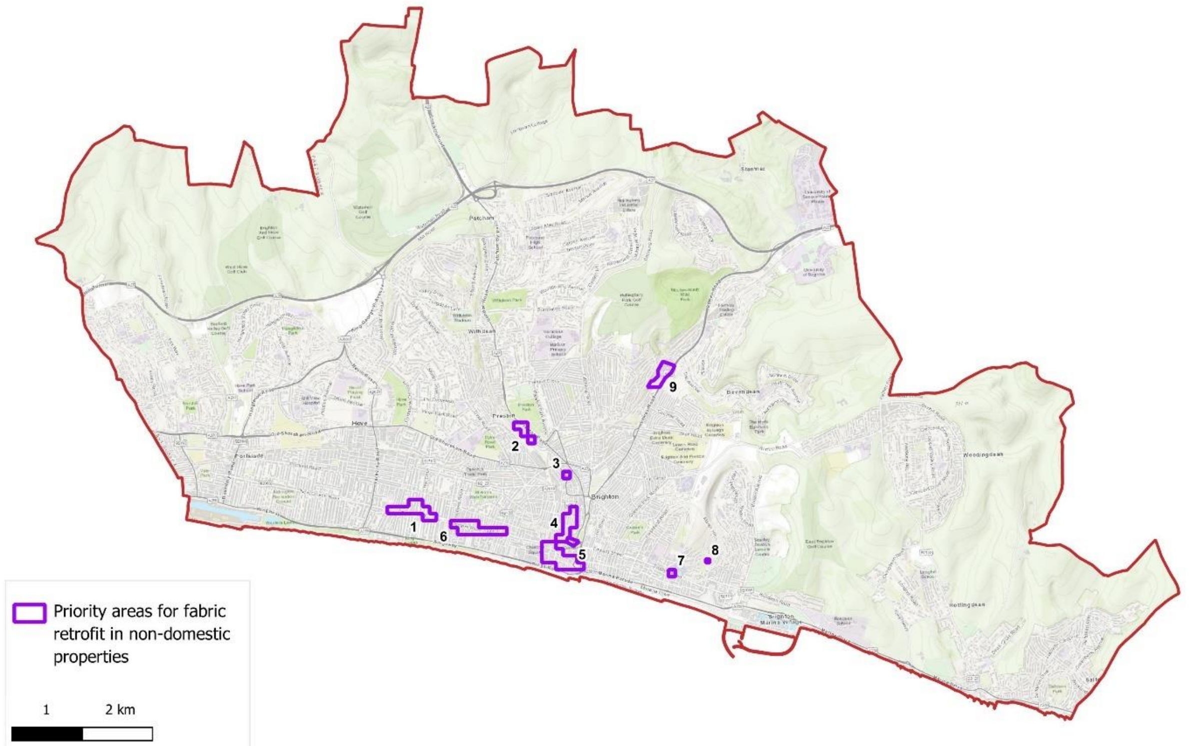

Potential energy saving through fabric improvement
0 - 100
100 - 250
250 - 500
500 - 1000
>1000
0
1
2 km

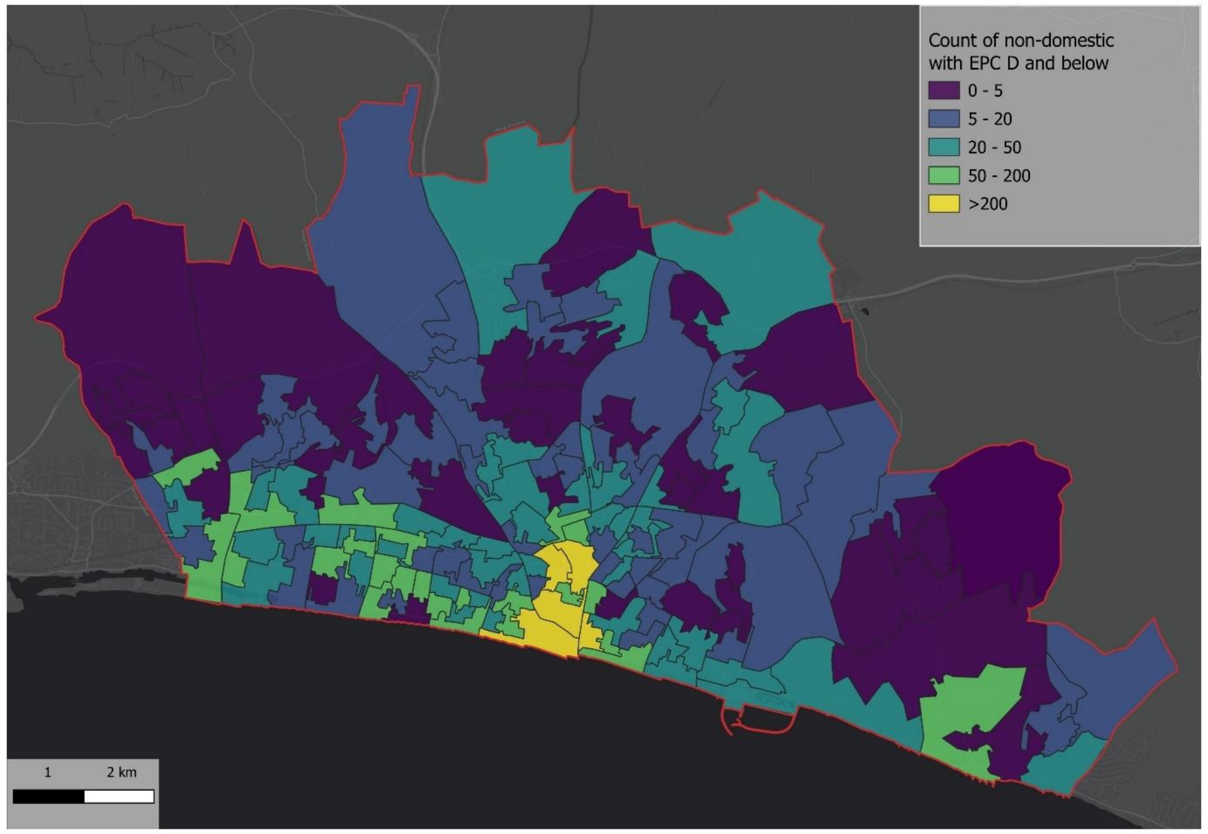

Count of non-domestic with EPC D and below on Council lands
0 - 5
5 - 20
20 - 50
50 - 100
>100
1
2 km


Count of non-domestic properties with EPC E-G
0 - 5
5 - 20
20 - 50
50 - 200
>200
1
2 km

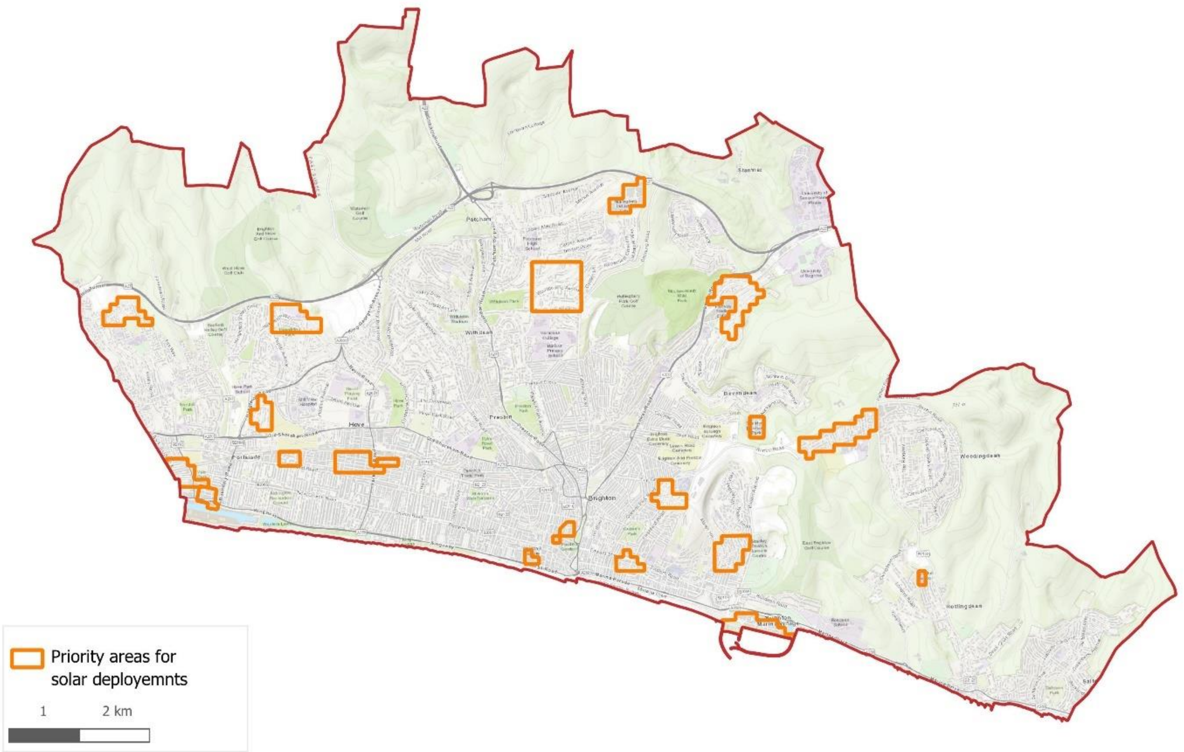

Count of non-domestic with EPC D and below on Council lands
0 - 5
5 - 20
20 - 50
50 - 100
1
2 km

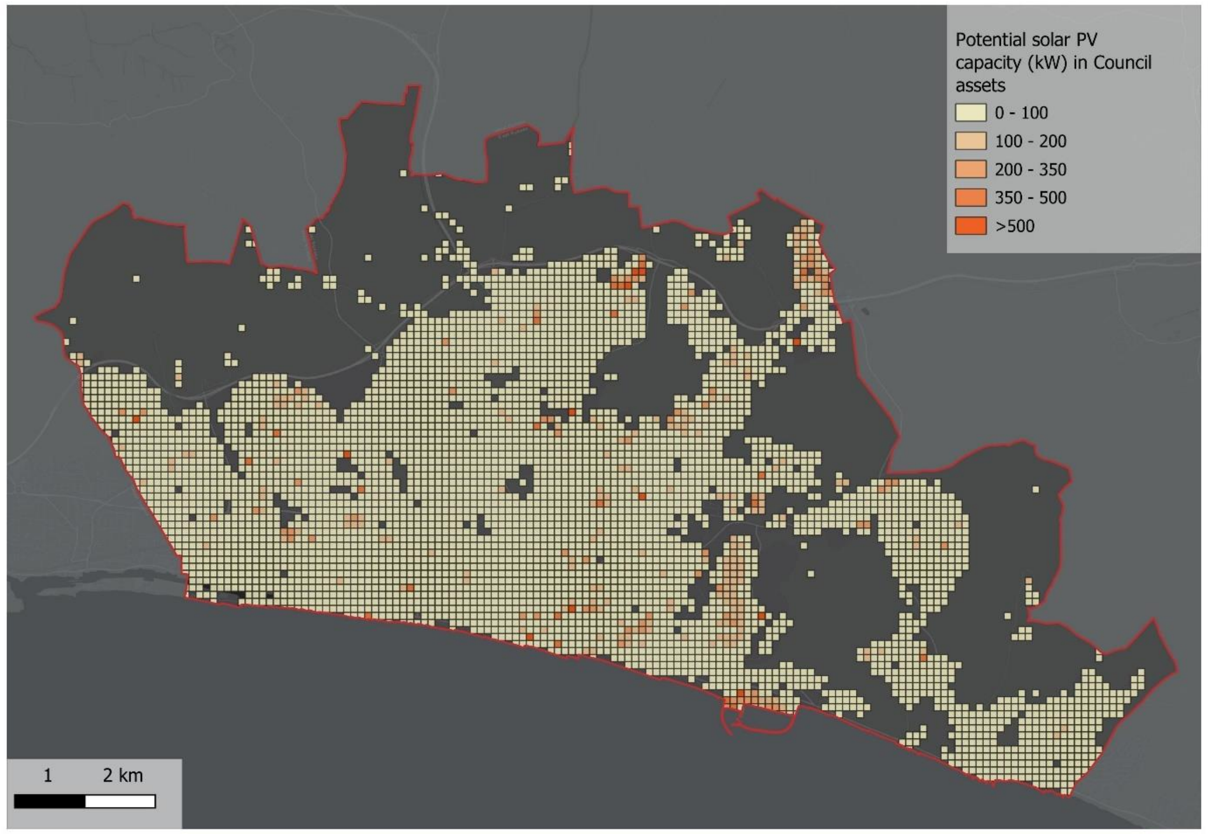

Count of non-domestic properties with EPC E-G
0 - 5
5 - 20
20 - 50
50 - 200
>200
1
2 km

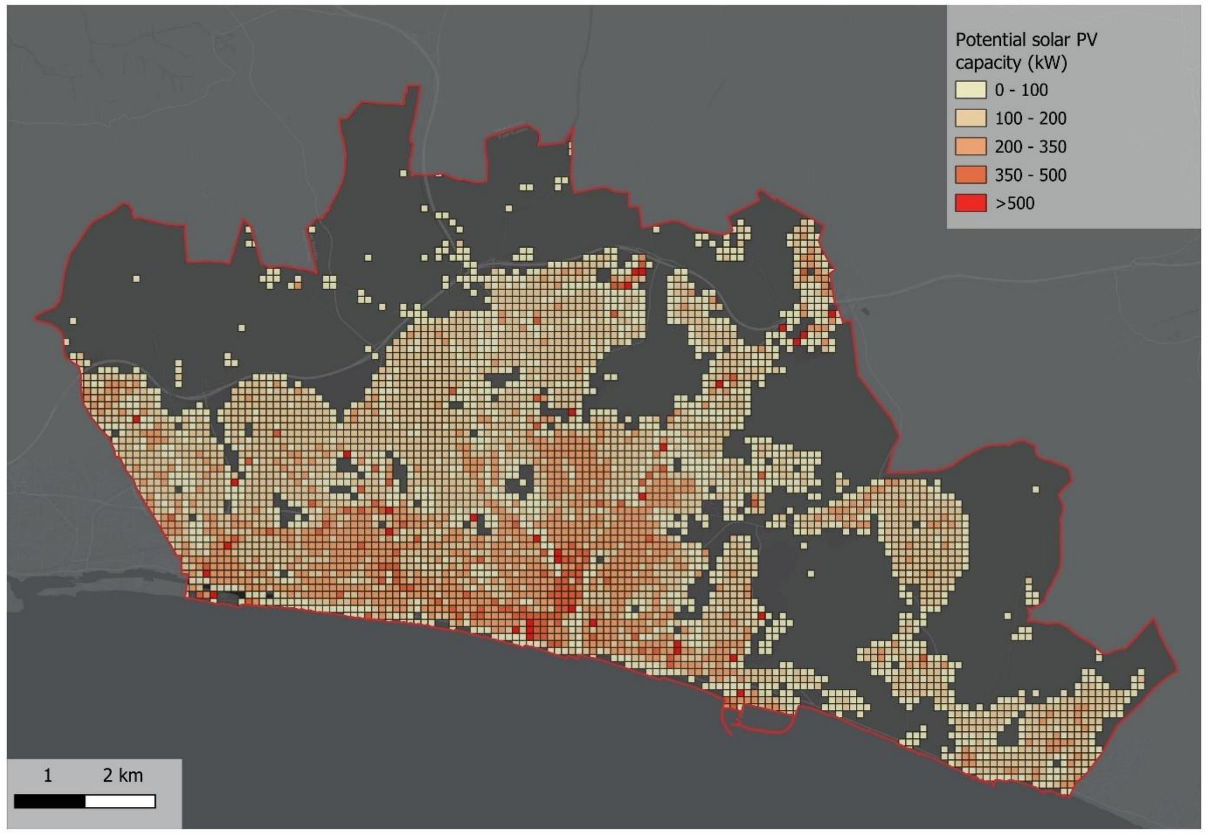

1
2
3
4
5
6
7
8
9
Priority areas for fabric retrofit in non-domestic properties
1
2 km

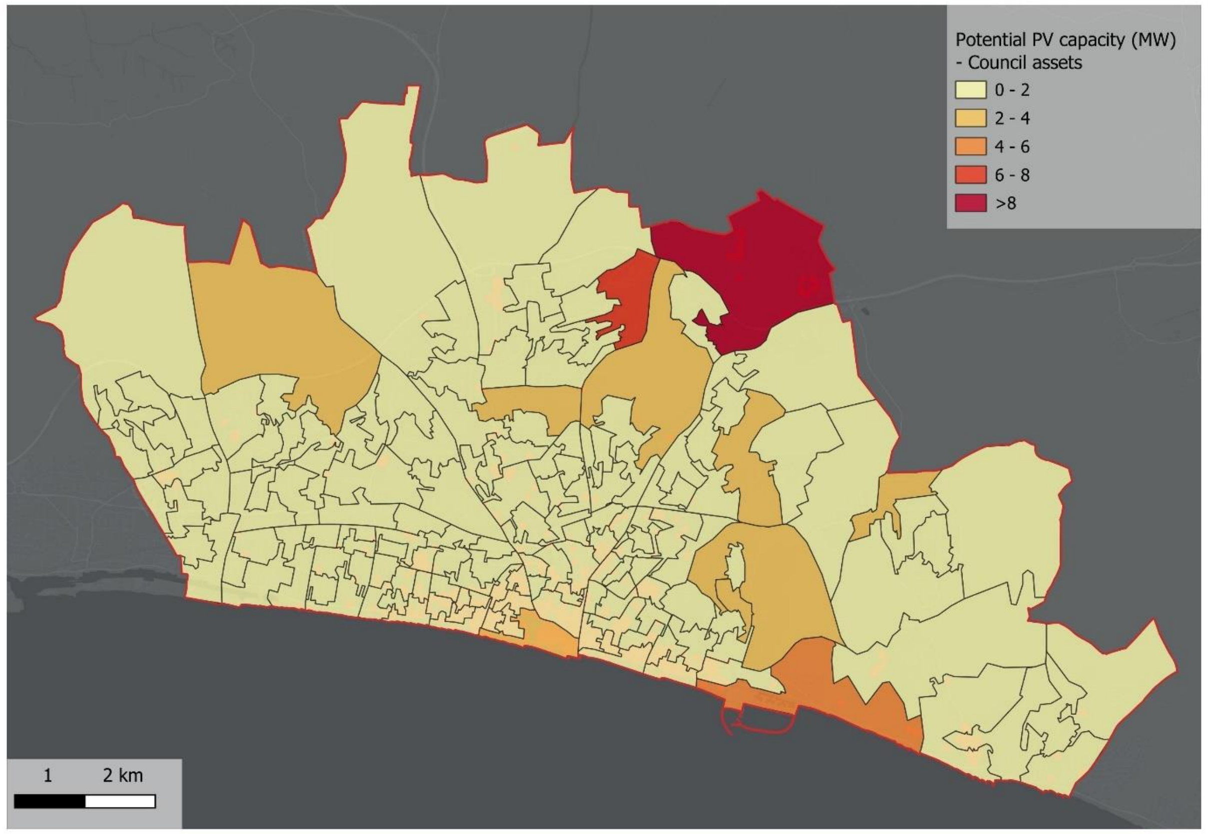

Count of non-domestic
with EPC D and below
0 - 5
5 - 20
20 - 50
50 - 200
>200
1
2 km

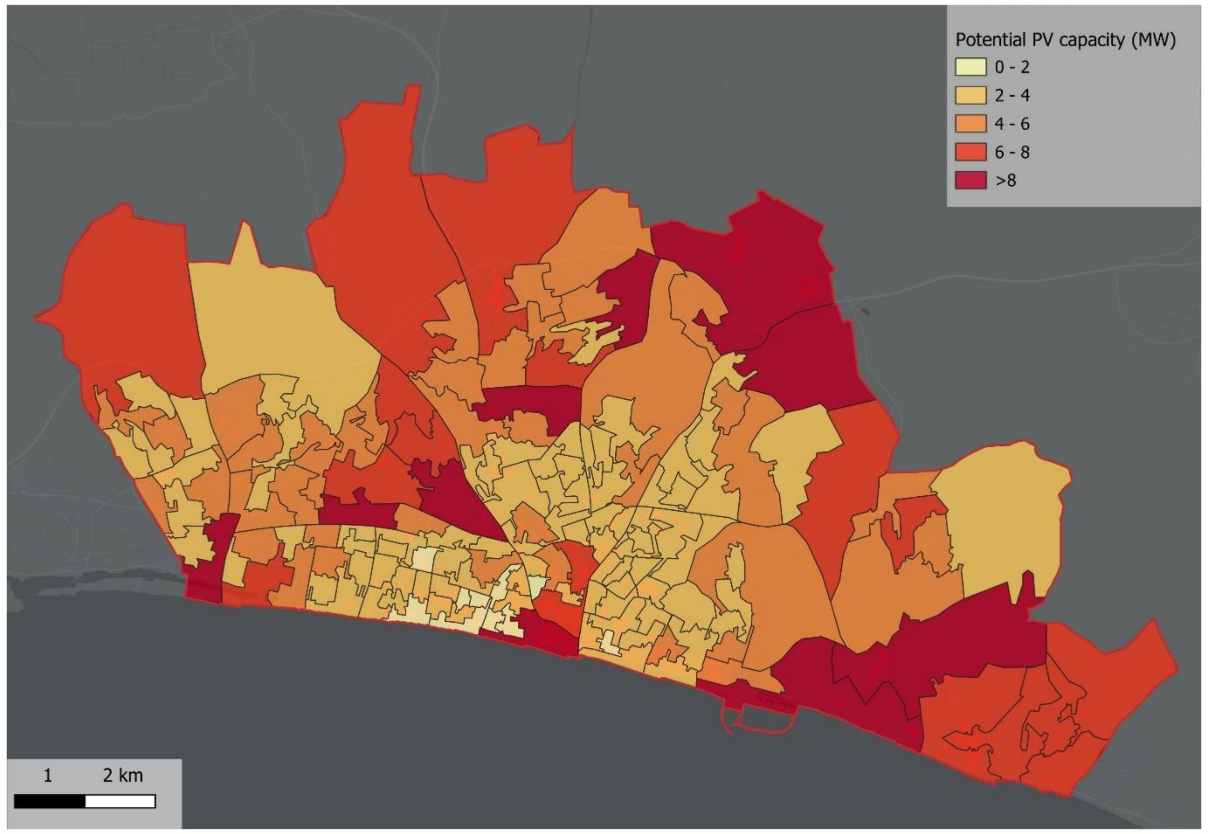
– solar maps

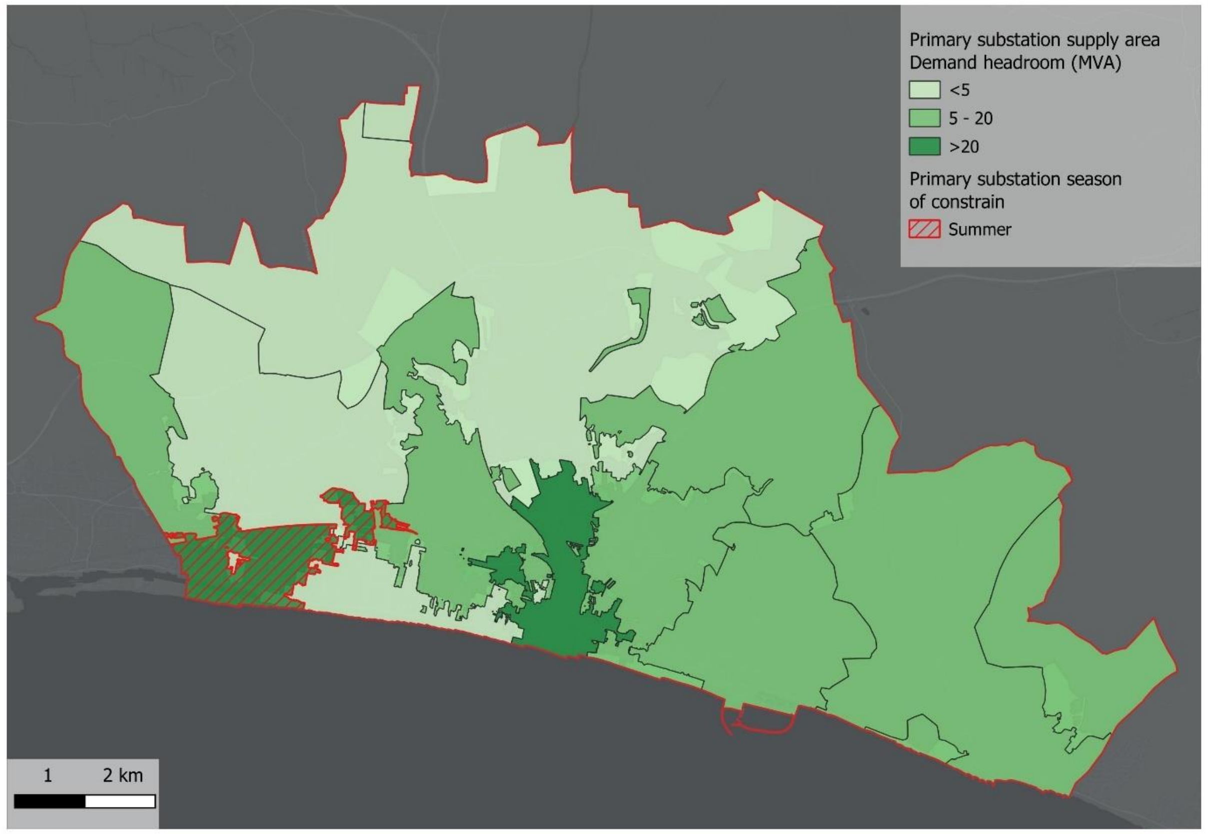

Priority areas for solar deployemnts
1
2 km


Potential solar PV capacity (kW) in Council assets
0 - 100
100 - 200
200 - 350
350 - 500
>500
1
2 km


Potential solar PV capacity (kW)
0 - 100
100 - 200
200 - 350
350 - 500
>500
1
2 km


Potential PV capacity (MW) - Council assets
0 - 2
2 - 4
4 - 6
6 - 8
>8
1
2 km


Potential PV capacity (MW)
0 - 2
2 - 4
4 - 6
6 - 8
>8
1
2 km


Primary substation supply area
Demand headroom (MVA)
<5
5 - 20
>20
Primary substation season
of constrain
Summer
1
2 km

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