Peterborough

Local Area Energy Plan

Catapult Energy Systems

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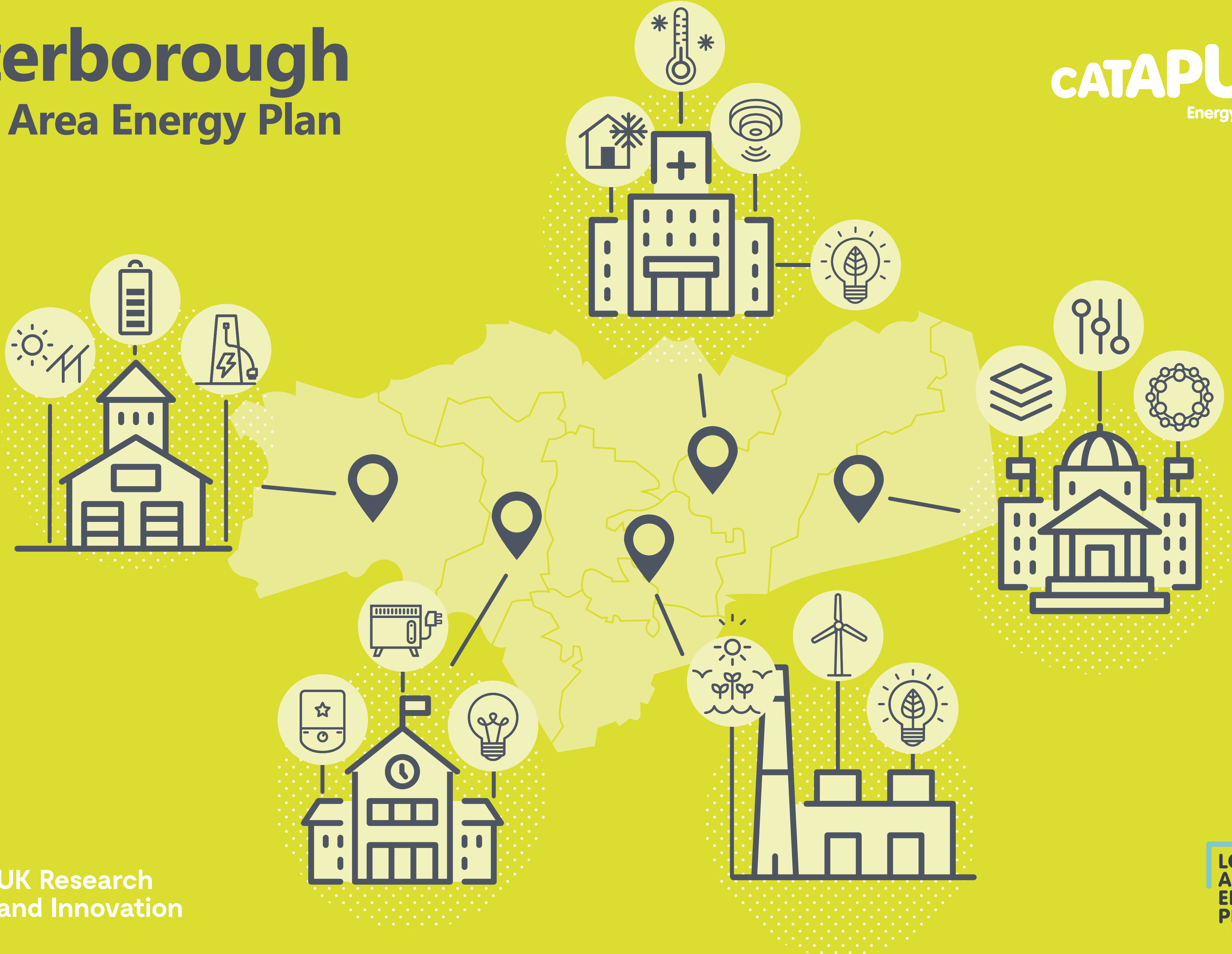

UK Research and Innovation

Local Area Energy Plan

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This plan was prepared by Energy Systems Catapult, on behalf of Peterborough City Council. Its development was funded by Innovate UK as part of the Prospering from the Energy Revolution (PfER) programme.

CATAPULT Energy Systems

We work with Innovate UK

PETERBOROUGH CITY COUNCIL

Executive Summary

To meet a net zero target of **2040**, this plan requires capital investment of:

£8.8 billion
total

Including:

£2.1 billion
in domestic properties

£1.6 billion
in energy networks

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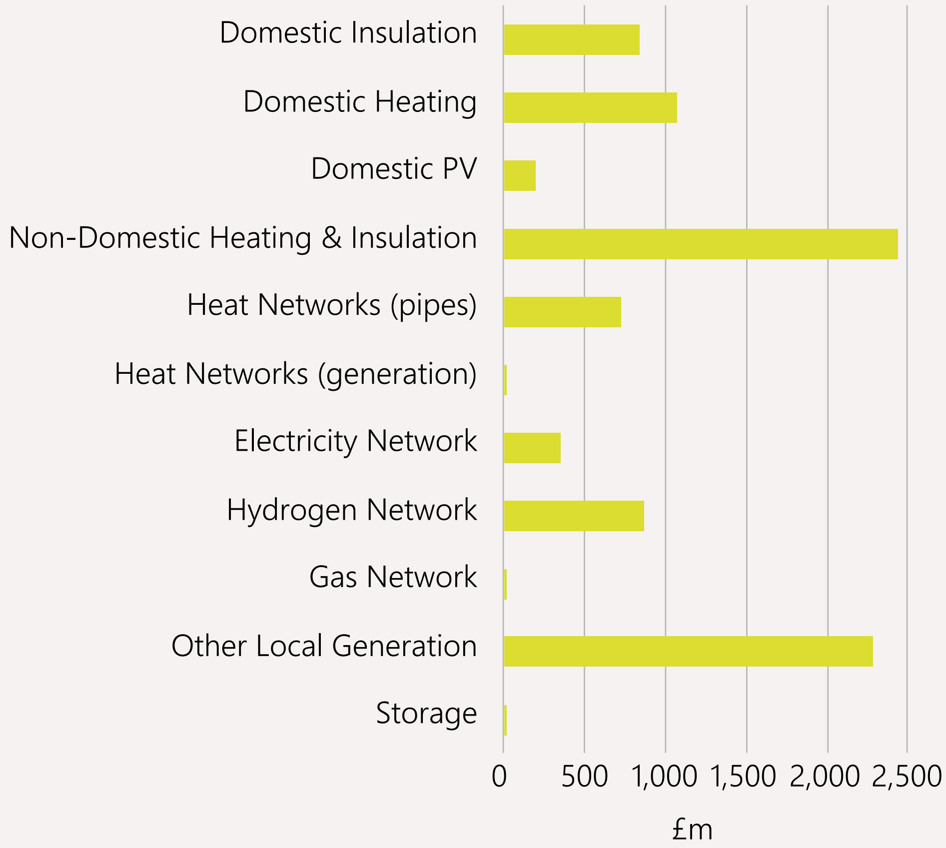
Saving:

4.3 million tonnes CO_2
cumulatively to 2050 against a business-as-usual pathway

Total Capital Investment



Peterborough's energy system will have transformed, with:

80,000
heat pumps installed in homes

At least 16,000 **new connections to a district heat network**

66,000
homes retrofitted with insulation, glazing and draughtproofing improvements

72%
of cars fully electric or plug-in hybrid

35%
homes generating their own electricity with rooftop solar

Up to 1,350 MW
of large scale renewable generation

Context & Current State

In July 2019, Peterborough City Council (PCC) declared a climate emergency and noted that local governments *"have a duty to act"* and *"should not wait for...national governments"*. To address this challenge, PCC committed to *"make the Council's activities net zero carbon by 2030, and to support the city to achieve the same."* The additional benefits of reaching net zero were also noted including *"reducing fuel poverty, improving physical and mental health, improving air quality, stimulating our economy and providing jobs to the local area"*.

Yet, few local authorities have a clear plan on how to reach net zero or realise the benefits. To meet this need and further decarbonisation of local areas, Energy Systems Catapult (ESC) pioneered the local area energy planning (LAEP) approach to deliver a comprehensive, data-driven and cost-effective plan for decarbonisation. Importantly, the approach requires working closely with stakeholders to build upon progress being made and incorporate existing plans. An example of this is the PIRI (Peterborough Integrated Renewables Infrastructure) programme which is looking to develop an integrated energy system design for electricity, heat and transport that will provide benefits to the community and business.

To contextualise the costs given in the LAEP, PCC have a gross annual budget of around £423m[*] (although this likely includes ringfenced funding) and their 'core spending power' is around £171m[**].

* https://www.peterborough.gov.uk/news/matt-gladstone-announced-as-new-chief-executive

** https://commonslibrary.parliament.uk/local-authority-data-finances/

Scenarios

To carry out the modelling and analysis required to produce a LAEP, Peterborough was split into ten geographical areas or 'zones' based on connections to the electricity network (these do not follow any typical political or geographical boundaries).

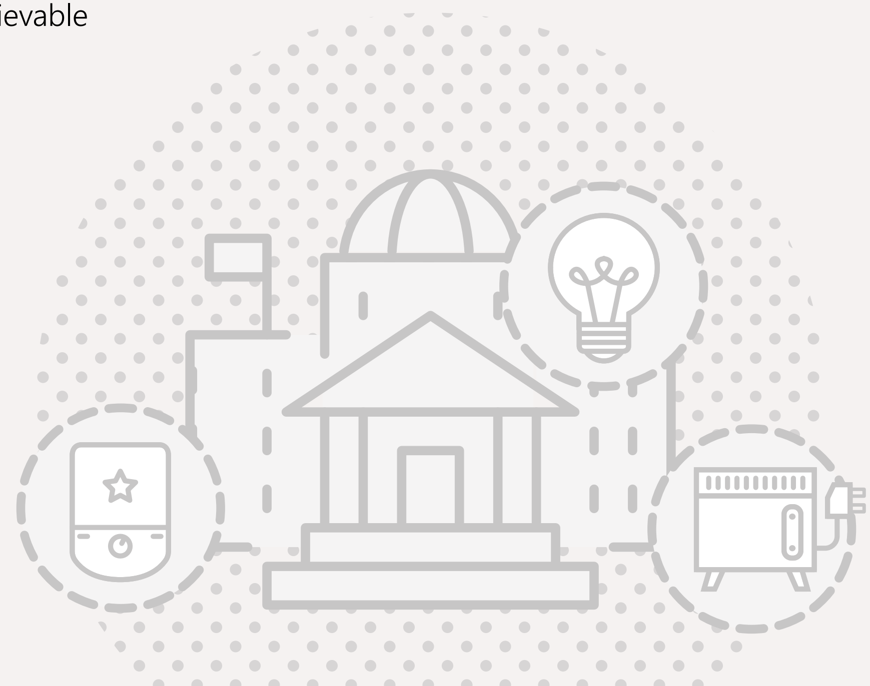
Following discussions with PCC and key stakeholders, the zoning was agreed and three main future scenarios were identified for consideration: a 2030 net zero target, a 2040 net zero target, and a 2050 net zero target in line with the UK as a whole. Further to this, some comparisons were modelled: a "business-as-usual" scenario where no carbon target was set, and a 2030 target where a greater number of flexibility options were available, such as cars charging and heat pumps running during off-peak hours to reduce network demand. This plan centres on the 2040 target as the earliest plausible date that net zero is likely achievable across Peterborough.

Pathway

From this a pathway has been developed which identifies the key projects and decision points on the transition to net zero. The key short-term aspects of this pathway are:

- Decide whether a small or large district heat network is desirable.
- Begin roll-out of energy efficiency measures and heat pumps to rural, off-gas grid dwellings.
- Develop a scheme to widely and rapidly deploy home EV chargers.

As part of the pathway to net zero, some near-term projects have been identified for further feasibility study or 'low regret' deployment.



Buildings

Peterborough currently has around 87,000 dwellings and plans to add another 15,000 dwellings between 2022 and 2036. In order to reach net zero, energy efficiency upgrades will need to be carried out on up to 66,000 dwellings, as well as public, commercial and industrial buildings, by retrofitting insulation, upgrading glazing and various other measures.

Retrofitting was found to be 'low regret' almost universally under all scenarios. The exceptions are in the City Central and City East zones where a concerted effort to create a larger heat network scheme would affect the number of dwellings requiring retrofit. In these more urban areas, there is a higher proportion of flats where individual flat retrofit is unlikely to make a large impact due to the limited number of applicable measures. Rural areas, however, were found to have a proportionately higher number of dwellings requiring a 'deep' retrofit i.e. more expensive and intrusive measures such as solid wall insulation, floor insulation, and triple glazing. These areas currently have poor energy performance certificate (EPC) ratings and higher fuel poverty meaning that the improvements would have a positive social impact in addition to the carbon/energy impact.

New build dwellings are expected to be designed and constructed to a standard where they are not going to require insulation upgrades before the chosen net zero target; however, there is an opportunity to bring forward the use of low-carbon heating systems for new builds from the current 2025 date, to avoid more expensive retrofit at a later time.

In total, domestic retrofits are expected to cost over £800m to reach net zero (an average of around £12,750 per dwelling, although the cost for a specific dwelling will vary significantly depending on its individual requirements).

Heating

The decarbonisation of heat is one of the greatest challenges in the transition to net zero, the predominant heating system in Peterborough being fossil gas (88% of homes) or oil (4%). Around 80,000 of these will need to be replaced by heat pumps (mostly air source) and over 16,000 homes connected to a heat network. Although lower in population, the rural off-gas areas are those that are 'low regrets' i.e. those that will need to transition to heat pumps regardless of when net zero will be achieved. Specifically, the zones of Barnack & Wittering, Glinton & Newborough, Castor & Marholm, and East Rural are key deployment areas for heat pumps.

The PIRI (Peterborough Integrated Renewables Infrastructure) heat network was shown to be viable in all net zero scenarios modelled. In scenarios with more ambitious net zero target dates, the heat network becomes increasingly important – and cost-effective – as a solution for domestic dwellings in urban areas. From a delivery perspective, this means the longer it takes to connect buildings to the heat network, the less cost-effective the scheme overall.

For non-domestic buildings, again, much of the space heating can be decarbonised using heat pumps, however there is a sizeable proportion of high-temperature and/or process heat required where heat pumps are not going to be suitable. Before the mid-2030s, this is an issue as hydrogen will not be available at scale meaning that this part of the economy will continue to rely on fossil gas and produce carbon emissions. If decarbonisation is required before hydrogen is available at scale, on-site generation of hydrogen via electrolysis could be considered although it is likely to be at a higher cost than fossil gas.

After the mid-2030s, hydrogen is expected to become a viable option to decarbonise the remaining non-domestic buildings. At this stage, it may also be worth considering extending the hydrogen offering to nearby dwellings.

Transport

HM Government have legislated to ban the sale of new fossil fuelled cars from 2030. By this date, it is expected that almost 40% of private vehicles in Peterborough will be EV or plug-in hybrid, and by 2040, there will be around 80,000 plug-in vehicles registered in Peterborough. This will require over 50,000 domestic EV charging points (at a capital cost of around £32m) and consume 78GWh of electricity per year.

In urban areas, housing is more densely concentrated and often does not have off-street parking, meaning a network of public charging points will be required.

A survey carried out as part of this work found that a majority of residents of Peterborough are considering EVs as their next vehicle, but this was dominated by those with off-street parking available to them.

Local Generation

The electricity demand in 2040 is likely to have increased by almost 50% compared to current levels due to the decarbonisation of transport and heating. Therefore, for Peterborough to decarbonise at a rate faster than the UK as a whole, a significant amount of locally generated low-carbon electricity will be required. Rooftop and ground-mounted solar have been studied to demonstrate the scale of local renewable capacity which would decarbonise Peterborough, however generation should be diversified alongside the deployment of storage to give a better security of supply.

A high-level assessment was conducted to give a high-level indication of the maximum contribution of ground-mounted solar to the future energy system. From this land area, it was found that deploying 1.35GW_p of ground-mounted solar could be cost-optimal (subject to full feasibility analyses and site visits), which would generate approximately 1,975 GWh of energy per year. Again, in practice, this should be varied generation by a mixture of low carbon sources, including onshore wind.

Domestic rooftop solar could also provide a large contribution. It is estimated that deploying around 157 MW_p of rooftop solar capacity could be cost-optimal (subject to full feasibility and site visits). This would require a capital investment in the region of £166m, however there would be significant social benefits to residents, especially those in fuel poverty. By adding in-home battery storage, more of the generated electricity could be consumed by the household, reducing the reliance on the network during peak times and reducing the amount of electricity purchased. The economic case for batteries can be marginal in today's market, but is likely to change with the emergence of novel incentives such as time-of-use tariffs, falling battery costs, and with an increase in electricity prices.

Electricity Network & Flexibility

To meet the new demand from electric heating and transport, there will be a need to upgrade the electrical network, since some areas could see capacity increases to as much as 4x current levels. The current capacity on the high-voltage network should be suitable to accommodate electrification without the need for capacity upgrade in most zones, with only City North likely requiring an upgrade of the high-voltage feeders.

However, there is a significant constraint on the low-voltage network with capacity upgrades being required for both substations and feeders across the whole of Peterborough (especially in rural zones).

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The core approach used assumes that additional demand is met through increased capacity however, in reality, further work would be required with DNOs to identify the most cost-effective means of providing the capacity. This may be via flexibility services which could be considered and deployed to reduce the investment required and make the network suitable for the future. Smart appliances which can shift the times they use electricity without any loss in performance can provide this flexibility. By shifting demand such that EVs were charged overnight and large thermal stores were used in dwellings, ESC's modelling showed the overall peak electrical demand for Peterborough could be reduced by around 20%.

Without flexibility, the total capital investment required would be between £300m and £400m.

Gas Network & Hydrogen

Although much of the current fossil gas demand for heating is expected to become electrified within Peterborough, the gas network still has an important part to play in the future energy system. As highlighted earlier, there are some areas of the non-domestic sector that cannot be electrified and therefore will remain on fossil gas before considering the transition to hydrogen in the mid-2030s. This provides an opportunity for nearby properties to also connect to a hydrogen network.

Many of the proposals for hydrogen however will depend on the Government's policy position which they are expected to lay out in 2026.

Socio-Economic Costs & Benefits

Net zero offers the opportunity to achieve localised and immediate benefits. For example, warmer retrofitted dwellings means less damp and mould and therefore a reduction in asthma and other respiratory diseases. Reduced energy usage would also assist those in fuel poverty. Economic benefits through net increases in jobs to design, install, upgrade, and maintain the low carbon measures would likely also be seen.

More generally, the transition away from fossil fuel burning would likely increase the health of residents through improved air quality.

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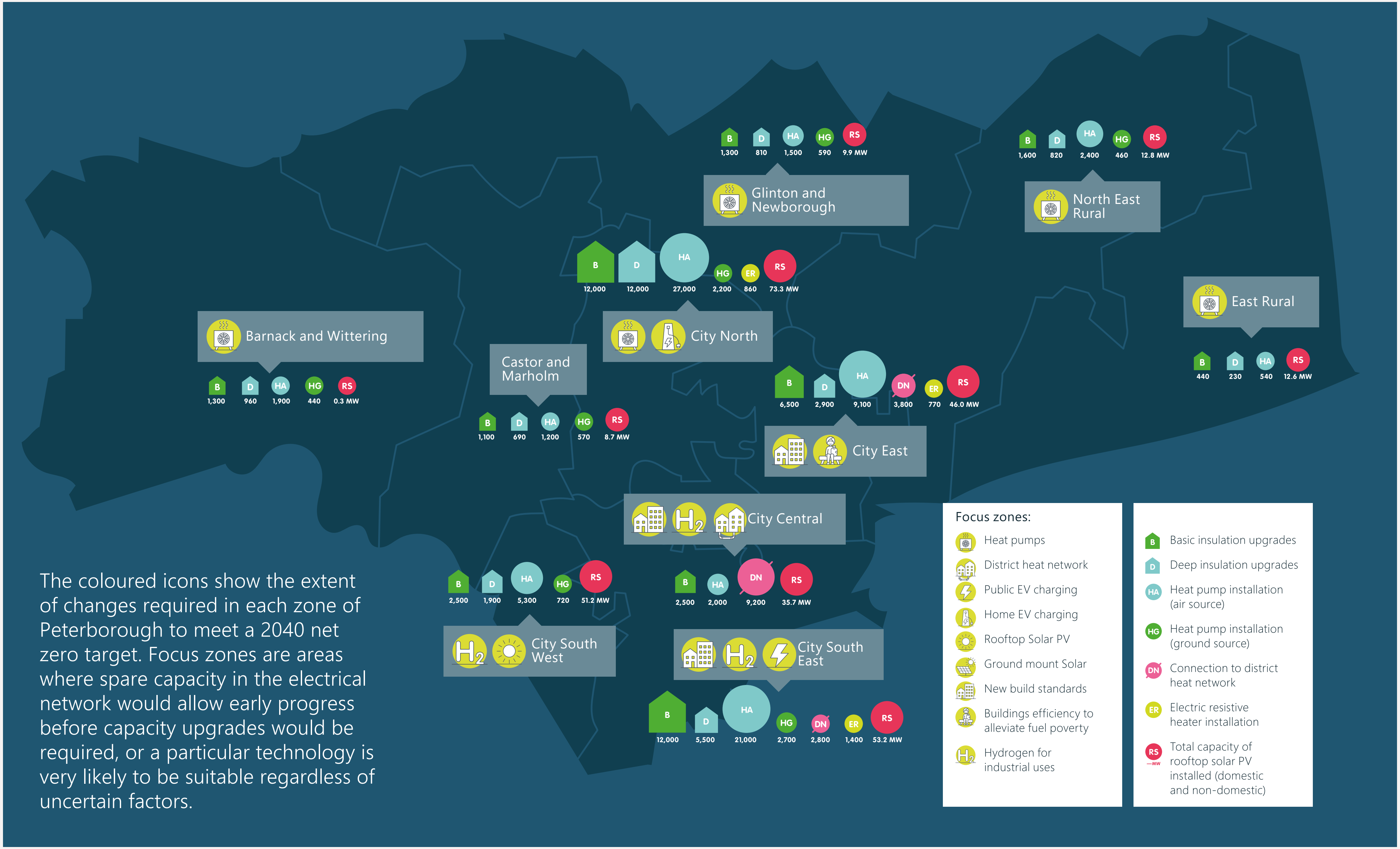
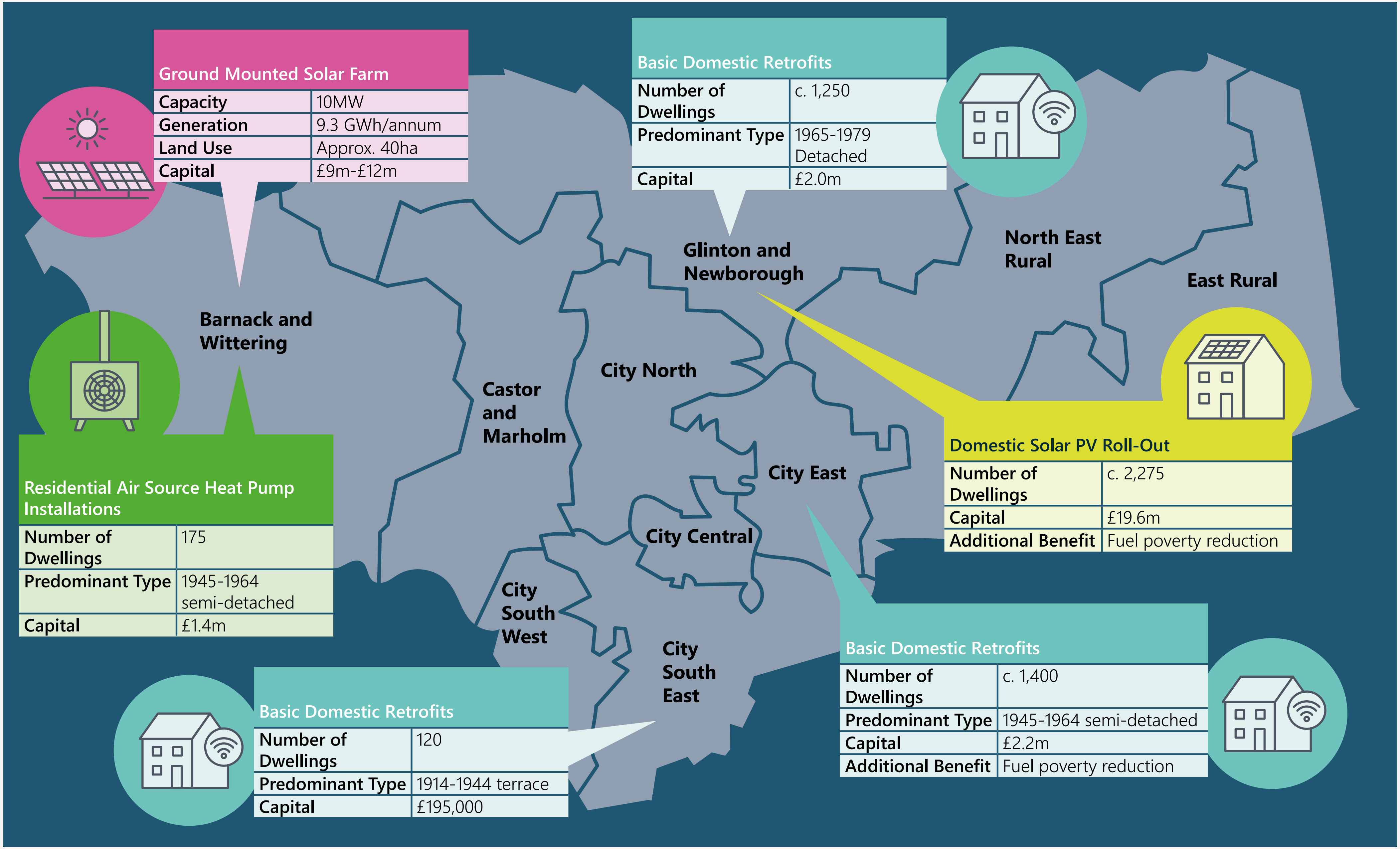
Plan on a Page



The coloured icons show the extent of changes required in each zone of Peterborough to meet a 2040 net zero target. Focus zones are areas where spare capacity in the electrical network would allow early progress before capacity upgrades would be required, or a particular technology is very likely to be suitable regardless of uncertain factors.

Project Summary



Ground Mounted Solar Farm

Capacity	10MW
Generation	9.3 GWh/annum
Land Use	Approx. 40ha
Capital	£9m-£12m

Basic Domestic Retrofits

Number of Dwellings	c. 1,250
Predominant Type	1965-1979 Detached
Capital	£2.0m

Residential Air Source Heat Pump Installations

Number of Dwellings	175
Predominant Type	1945-1964 semi-detached
Capital	£1.4m

Domestic Solar PV Roll-Out

Number of Dwellings	c. 2,275
Capital	£19.6m
Additional Benefit	Fuel poverty reduction

Basic Domestic Retrofits

Number of Dwellings	120
Predominant Type	1914-1944 terrace
Capital	£195,000

Basic Domestic Retrofits

Number of Dwellings	c. 1,400
Predominant Type	1945-1964 semi-detached
Capital	£2.2m
Additional Benefit	Fuel poverty reduction

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Introduction

Introduction to LAEP

What is a Local Area Energy Plan?

A Local Area Energy Plan (LAEP) aims to define the extent of the transformation required to transition an area's energy system to net zero in a given timeframe. This is achieved by an exploration of potential pathways that considers a range of technologies and scenarios, and when combined with stakeholder engagement leads to the identification of the most cost-effective preferred pathway and a sequenced plan of proposed actions to achieving an area's net zero goal.

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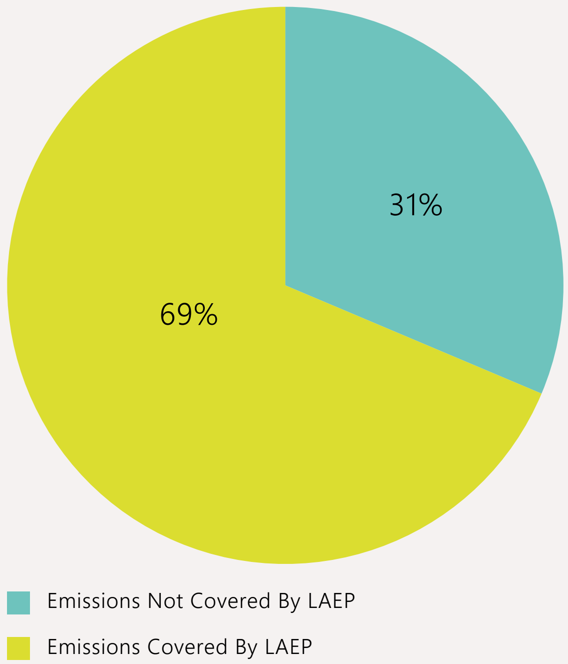
The scope of the LAEP covers the current energy consumption as well as the projected consumption in a defined area, primarily focussing on the area's built-environment (all categories of domestic, non-domestic, commercial and industrial buildings) and some aspects of energy used for transportation. Excluded are: land-use, land-use change and forestry (LULUCF), and transport from non-private vehicles (taken here as non-cars). This LAEP therefore considers almost 70% of emissions (see 'Context and Historical Emissions').

A LAEP identifies both early actions and long-term scale-up activities needed to reach the target in a cost-effective way, along with key enabling actions and decision points to stay on track and navigate future uncertainty.

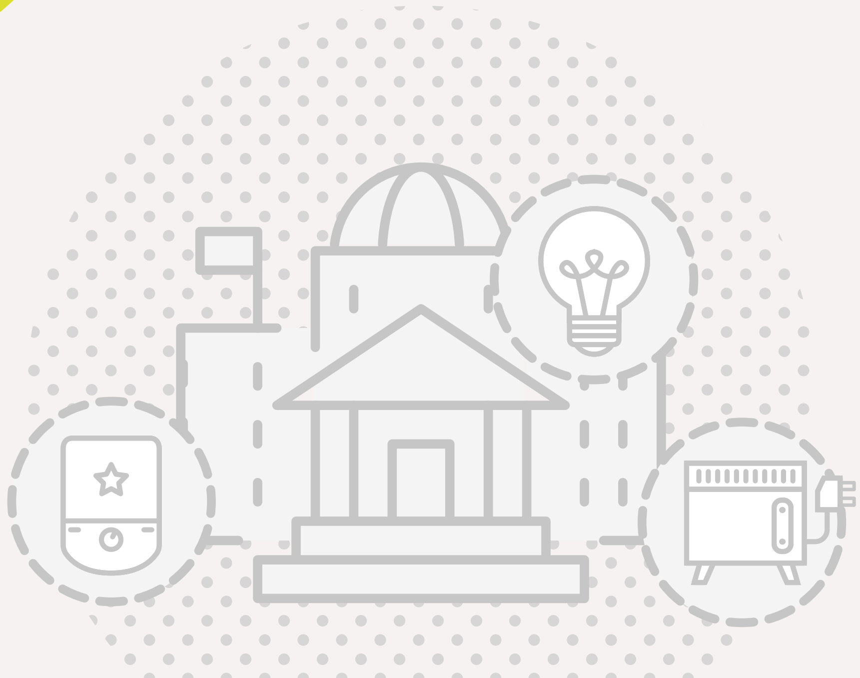
Approximate Proportion of Peterborough 2019 CO_2 Emissions Covered By LAEP



What to expect in this LAEP

The LAEP will set the scene by considering the current position of emissions and technology deployment in Peterborough. Each subsequent section will investigate a different part of the energy system and aims to identify low regret zones and focus zones for deployment.

Finally, projects will be outlined for PCC and stakeholders to prioritise for feasibility assessment and further consideration.



Zones

In order to carry out this work, it was necessary to separate Peterborough into smaller ‘zones’ to allow for a better understanding and assessment of options for decarbonisation.

Zones for analysis were identified based on areas served by primary substations, using data provided by the electrical networks (WPD and UKPN) that identifies buildings connected to secondary substations that are in-turn connected to each primary substation.

In total, ten zones were created using this method:

- Barnack and Wittering
- Castor and Marholm
- City Central
- City East
- City North
- City South East
- City South West
- East Rural
- Glinton and Newborough
- North East Rural

The zones therefore do not follow other standard geographical boundaries such as LSOAs, MSOAs, constituencies, or electoral wards.

Current State

Context & Historical Emissions

Peterborough City Council (PCC) has committed to **make the council's activities net zero carbon by 2030, and to support the city to achieve the same**.

PCC further committed to:

- ensure that net zero is embedded into all work and **decisions made are in line with reaching net zero by 2030**.
- **use planning powers to help deliver net zero** and increase tree planting.
- achieve **100% clean energy across the council's full range of functions by 2030** and explore renewable generation and storage.
- **replace all council vehicles with low carbon vehicles, provide electric vehicle infrastructure** and encourage alternatives to private car use across the city.
- **increase the efficiency of buildings**, which will **help to address fuel poverty.**
- **engage with residents, businesses and communities** to raise awareness, share best practice and keep everyone updated.
- **call on the UK Government** to provide the powers, resources and help with funding to make this possible.

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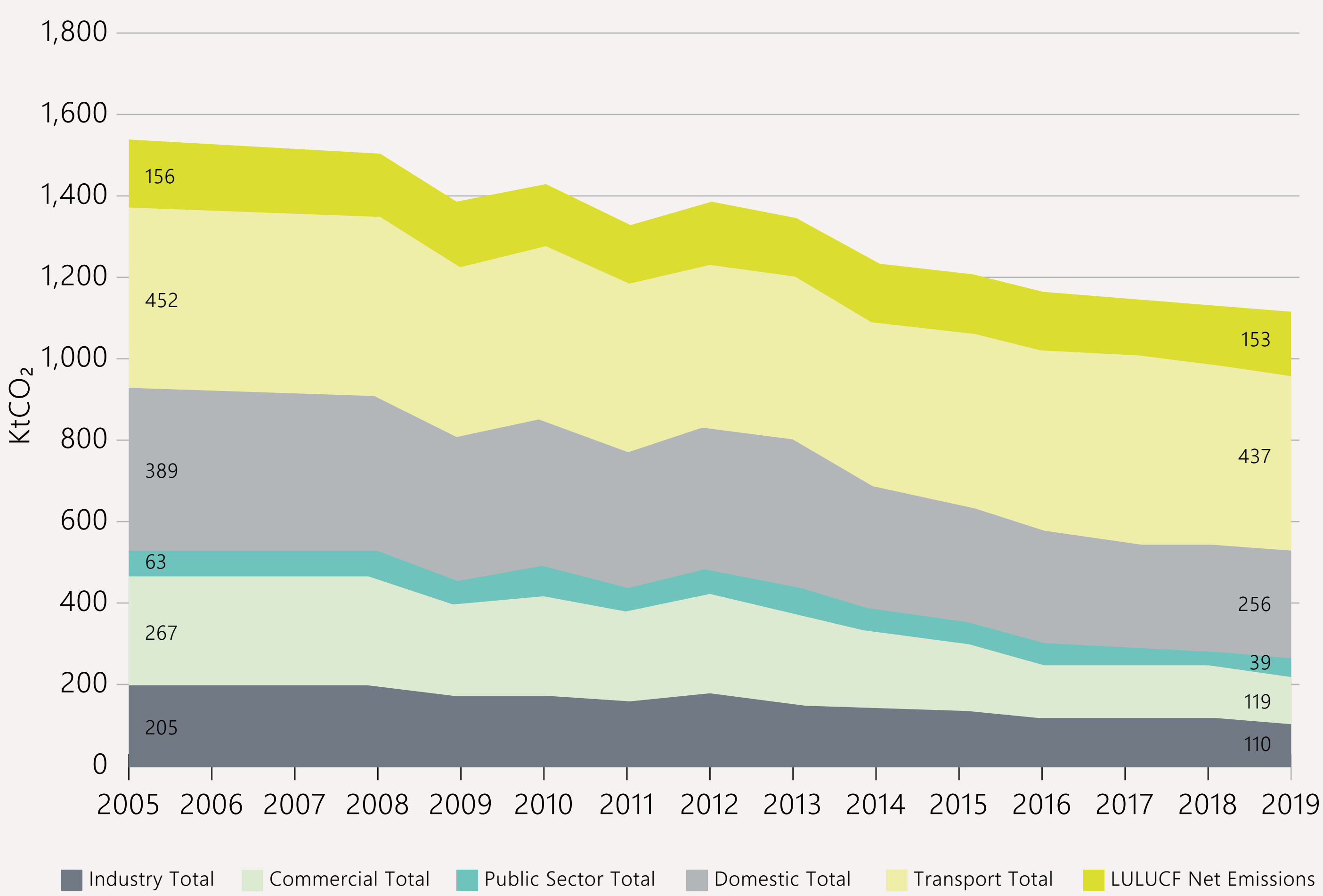
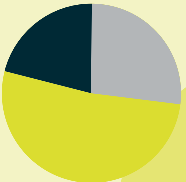
CO_2 Emissions by Sector in Peterborough



Setting the Scene: Peterborough Today



21%

of homes already high efficiency

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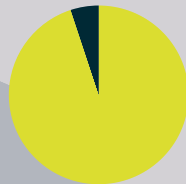
BUILDINGS

Currently 21% of Peterborough's buildings are insulated to a good standard, or do not have potential for further insulation. 52% can be upgraded cost-effectively with a payback under 5 years, while 27% have potential for insulation which would take longer to pay back.

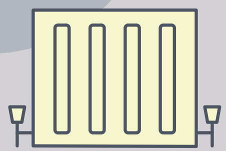
HEATING

95% of buildings currently use gas, oil or LPG for heating. The remainder already use some form of low carbon heating.



5%

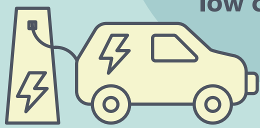
of heating already low carbon



fewer than

10%

of vehicles already low carbon

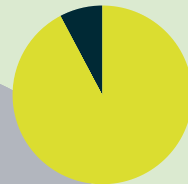


VEHICLES

Under 10% of cars and small vans currently owned in Peterborough are either plug-in hybrid or pure electric. The remainder, and vast majority, are petrol, diesel or hybrid.

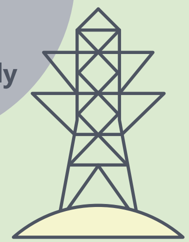
ELECTRICITY

91% of electricity consumed comes from the National Grid. At least 11 % of homes have solar panels, and the energy from waste scheme contributes significantly to local demand.



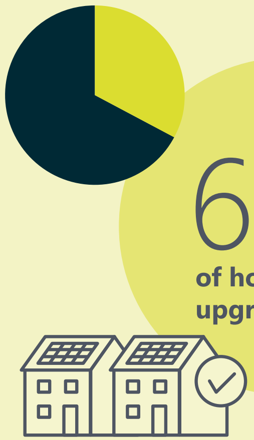
9%

of electricity consumed in Peterborough produced locally



Destination

The Destination: 2040



67%
of homes receiving upgrades

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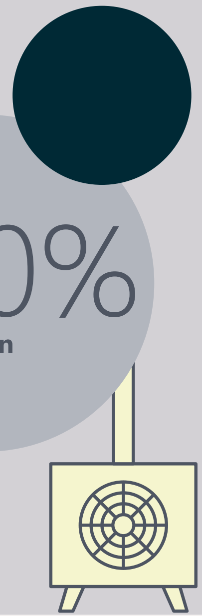
BUILDINGS

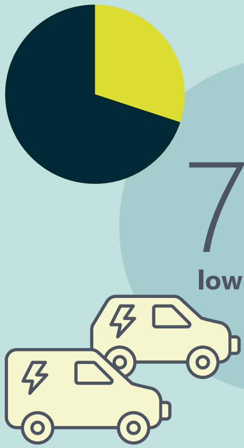
Around 67% of Peterborough's buildings will require insulation upgrades, bringing almost all homes up to a good standard of efficiency. The supply chain would need to provide upgrades to around 66,000 homes by the year 2040.

HEATING

All fossil fuelled heating systems need to be replaced in order to reach net zero. This can occur as current heating systems reach their natural end-of-life.



100%
low carbon



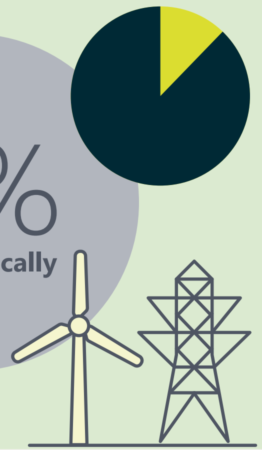
72%
low carbon

VEHICLES

Electric vehicle ownership is projected to rise rapidly, with pure electric and plug-in hybrid vehicles reaching 72% by 2040. Steps will need to be taken to cater for these owners with public charge points, and assist residents to install domestic chargers. These chargers will place new demands on the electrical distribution system.

ELECTRICITY

The push to generate low carbon electricity results in a greater proportion of Peterborough's energy being produced locally. As an upper bound analysis, using all available land for solar PV would generate most of the energy needed on an annual basis, however, using this much land is not likely to be possible in practice.



88%
generated locally

The Pathways

There are key similarities and differences between the pathways to net zero under each scenario that was modelled. Actions that are common across these scenarios are considered to be 'low regrets' and can be undertaken as soon as possible. Actions that are not common and are identified later on in the pathway will require decision points and early enabling actions to remove barriers.

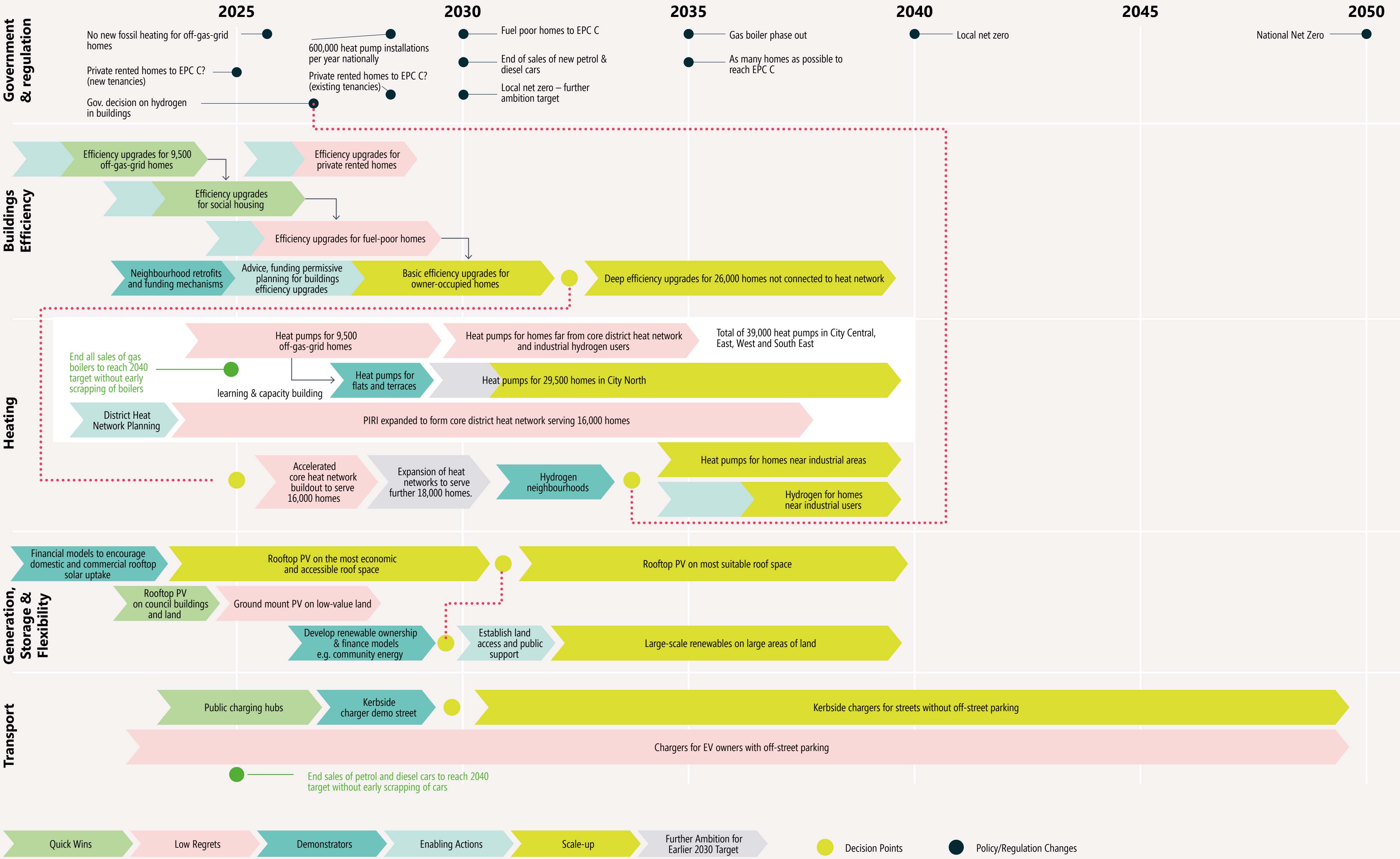
Low regrets

- Basic efficiency upgrades for almost every home with remaining upgrade opportunities
- Heat pumps installed in off-gas-grid homes, where neither district heat networks or hydrogen are likely to reach
- Heat pumps installed in on-gas grid homes which are far from any likely heat networks or industrial users of hydrogen
- District heat network expanding from the PIRI scheme to serve public, commercial and private buildings in core city centre locations
- EV chargers for homes with off-street parking and public charging points in key hubs such as retail parks, supermarkets, etc.
- Solar PV on rooftops and on low value areas of land

Key decisions

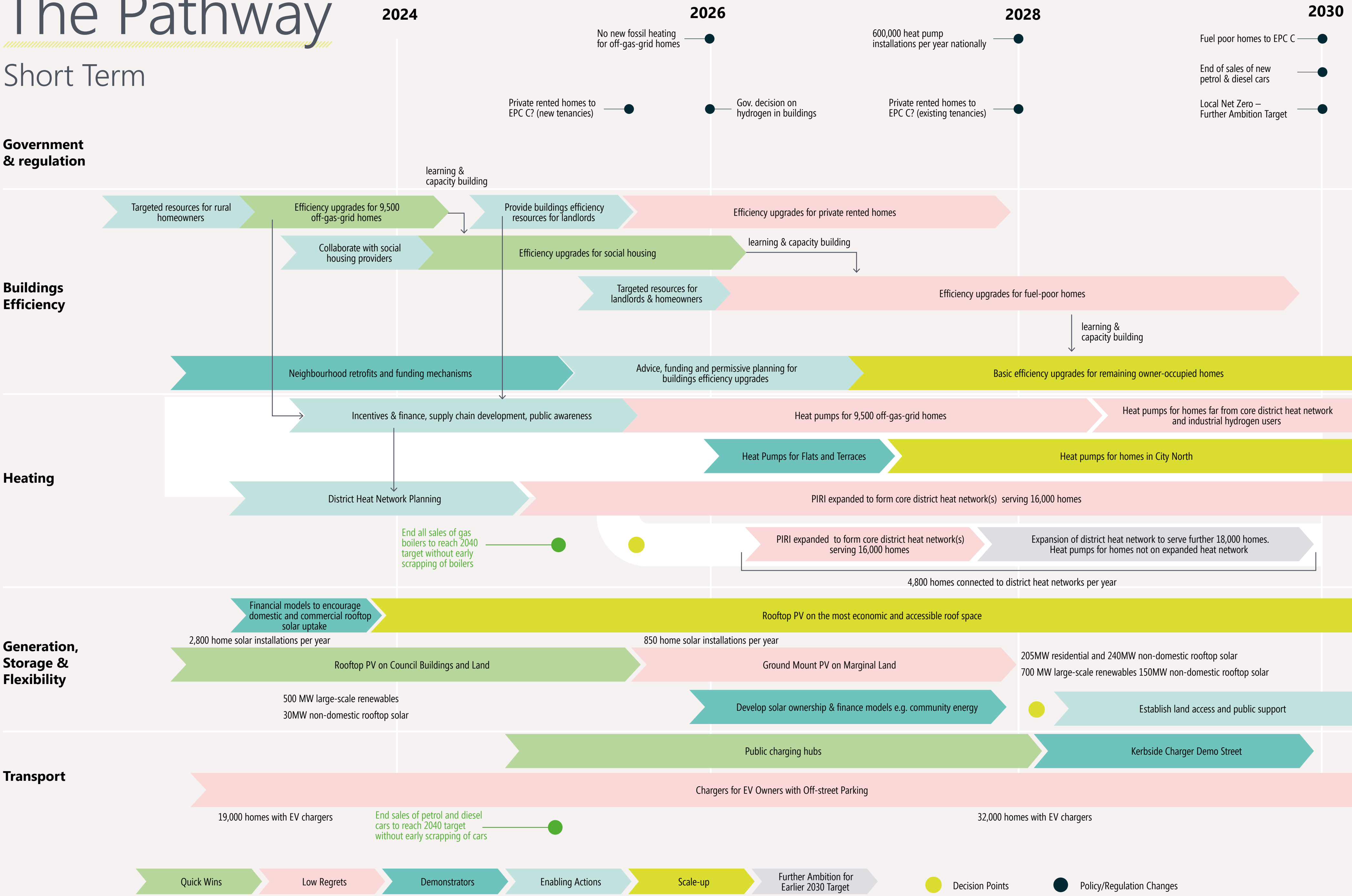
- Deeper building efficiency upgrades which will tend to have long payback periods, but can have additional benefits such as fuel poverty alleviation and employment creation
- Further expansion of heat network to serve many more homes beyond the core city centre areas – if this can be implemented in the near future it could provide additional carbon savings and put Peterborough on a path to net zero in a shorter timeframe, but would be an exceptionally ambitious scale of project
- Hydrogen to heat homes close to areas of industrial use instead of heat pumps: once more evidence is available around the viability, cost, emissions and policy around hydrogen for building heating in Peterborough, a decision can be made about homes in these areas.
- Further deployment of ground-mount solar PV to reduce emissions from consumption of grid electricity. In theory, very large areas of land could be used to produce most of Peterborough's energy requirements on an annual basis, though the occupation of this extent of land could be challenging. A balance can be found between larger heat network coverage or larger renewable deployment, although the scale of both in any combination is likely to be challenging.

The Pathway


2025
2030
2035
2040
2045
2050
Government & regulation
No new fossil heating for off-gas-grid homes
Private rented homes to EPC C? (new tenancies)
Gov. decision on hydrogen in buildings
600,000 heat pump installations per year nationally
Private rented homes to EPC C? (existing tenancies)
Fuel poor homes to EPC C
End of sales of new petrol & diesel cars
Local net zero – further ambition target
Gas boiler phase out
As many homes as possible to reach EPC C
Local net zero
National Net Zero
Buildings Efficiency
Efficiency upgrades for 9,500 off-gas-grid homes
Efficiency upgrades for private rented homes
Efficiency upgrades for social housing
Efficiency upgrades for fuel-poor homes
Neighbourhood retrofits and funding mechanisms
Advice, funding permissive planning for buildings efficiency upgrades
Basic efficiency upgrades for owner-occupied homes
Deep efficiency upgrades for 26,000 homes not connected to heat network
Heating
Heat pumps for 9,500 off-gas-grid homes
Heat pumps for homes far from core district heat network and industrial hydrogen users
Total of 39,000 heat pumps in City Central, East, West and South East
End all sales of gas boilers to reach 2040 target without early scrapping of boilers
learning & capacity building
Heat pumps for flats and terraces
Heat pumps for 29,500 homes in City North
District Heat Network Planning
PIRI expanded to form core district heat network serving 16,000 homes
Accelerated core heat network buildout to serve 16,000 homes
Expansion of heat networks to serve further 18,000 homes.
Hydrogen neighbourhoods
Heat pumps for homes near industrial areas
Hydrogen for homes near industrial users
Generation, Storage & Flexibility
Financial models to encourage domestic and commercial rooftop solar uptake
Rooftop PV on the most economic and accessible roof space
Rooftop PV on most suitable roof space
Rooftop PV on council buildings and land
Ground mount PV on low-value land
Develop renewable ownership & finance models e.g. community energy
Establish land access and public support
Large-scale renewables on large areas of land
Transport
Public charging hubs
Kerbside charger demo street
Kerbside chargers for streets without off-street parking
Chargers for EV owners with off-street parking
End sales of petrol and diesel cars to reach 2040 target without early scrapping of cars
Quick Wins
Low Regrets
Demonstrators
Enabling Actions
Scale-up
Further Ambition for Earlier 2030 Target
Decision Points
Policy/Regulation Changes

The Pathway

Short Term



Buildings

Overview

All zones of Peterborough see the majority of dwellings receive retrofits – the map shows how these are distributed. A total of 66,000 dwellings at a cost of over £800m for the 2040 target scenario receive retrofits. The number of retrofits is highest in the densely-populated city zones. However, there are a greater proportion of dwellings in these zones which do not receive retrofits, owing to the higher number of flats* and modern buildings. Retrofits are split into "basic" and "deep", explained on the following pages.

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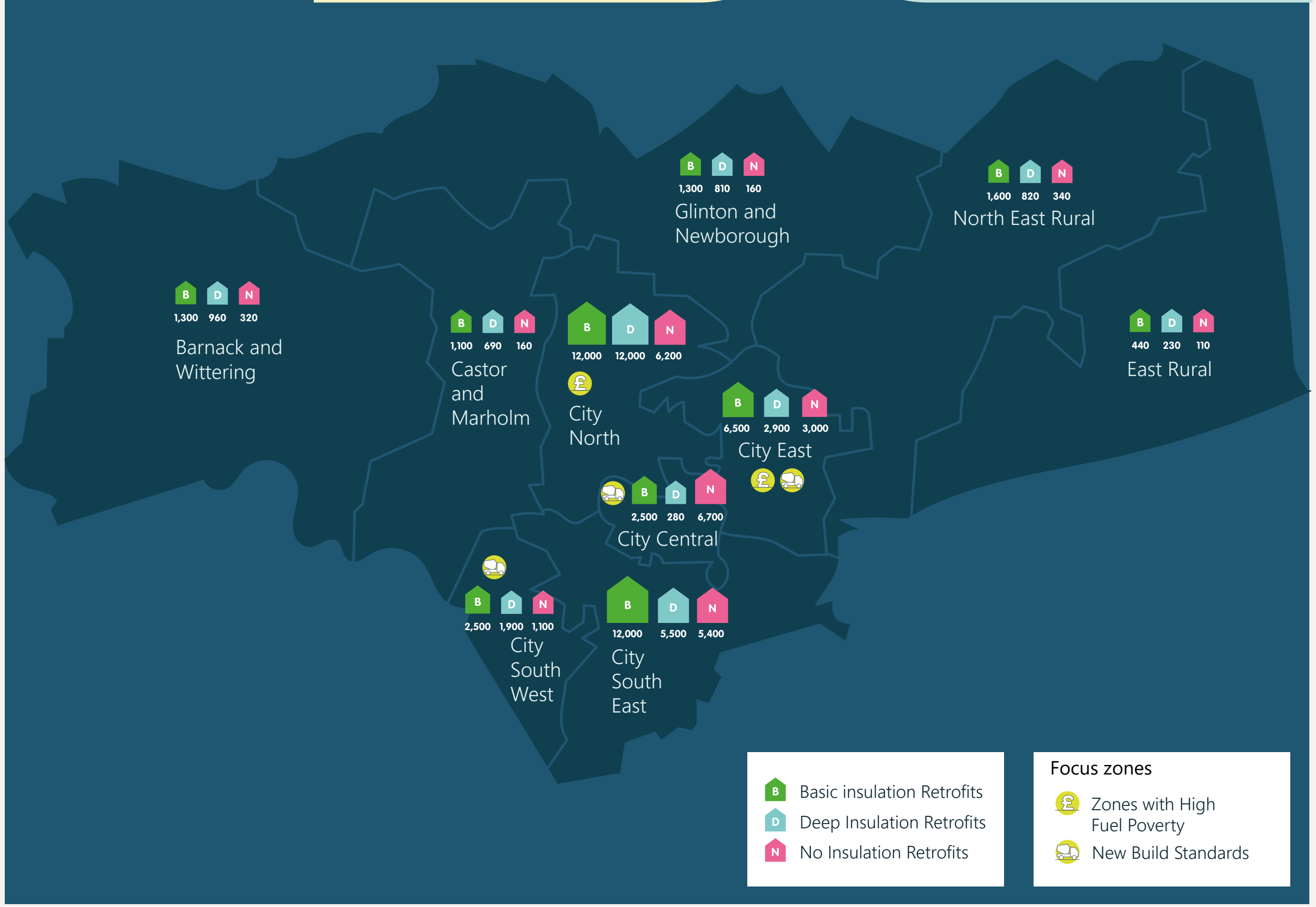
The scale of retrofits required in the more urban zones (particularly City North and City South East) is dependent upon the scale of the district heat network. If an expansive heat network is developed, then fewer domestic retrofits would be required.

The large scale improvement of dwelling energy performance overlaps favourably with higher rates of fuel poverty in City North and City East, where retrofits will help alleviate fuel poverty.

Areas where large numbers of new dwellings are expected to be built (particularly City North and City East) provide opportunities to ensure high efficiency and carbon standards are achieved.

up to
66,000
dwellings (75%) receiving retrofits

over
£800m
capital investment in domestic retrofits

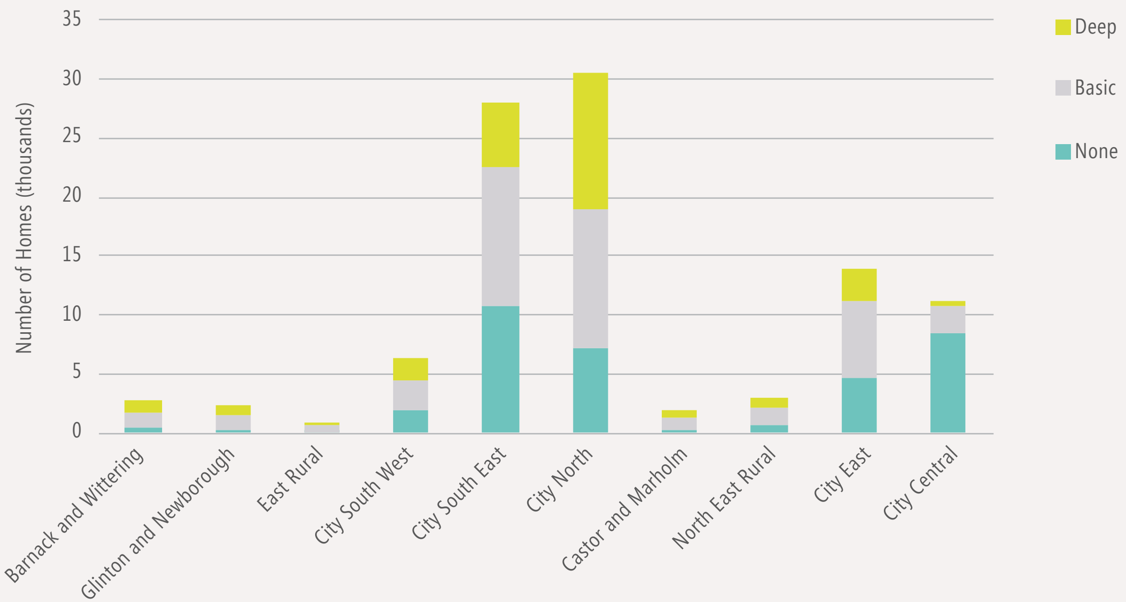


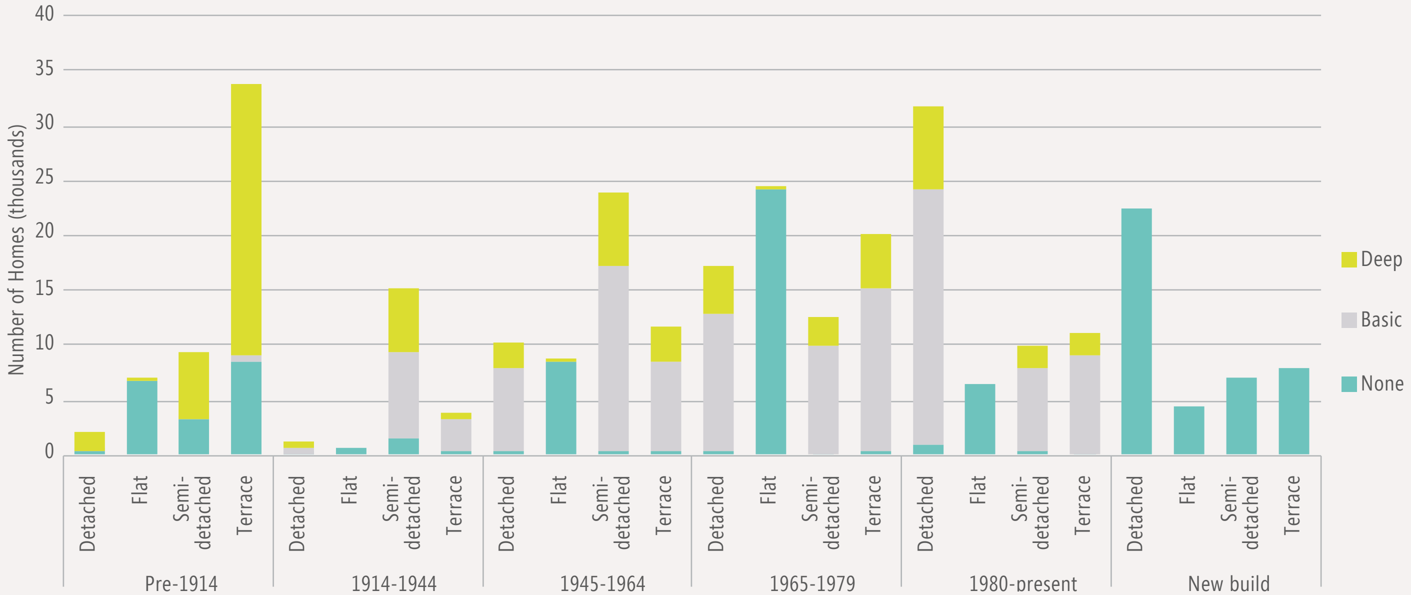
* Flats are considered individually and therefore are not often suitable for retrofit. However, they can be considered collectively as blocks to improve their thermal performance.

Zones and Dwelling Types

Retrofits are improvements to the fabric of domestic and non-domestic buildings to reduce heat loss. This retrofit can include loft and cavity wall insulation ("basic"), double or triple glazing, solid wall insulation, floor insulation, draught-proofing and door upgrades ("deep"). These measures can improve comfort and health of occupants, reduce bills, and make it easier to transition to low carbon heating systems, whilst also reducing the need to upgrade the electrical network. Since retrofits can reduce the size and cost of heating system needed, it makes practical sense to complete them before heating system replacements take place, or at the same time to minimise disruption to occupants.

The graphs show the extent of retrofits across each zone of Peterborough (above) and over the various housing types (below). Modern buildings have little potential for cost-effective retrofits, and opportunities in flats are limited. However, planned new builds present an opportunity to maximise insulation and include rooftop solar, EV charging and low-carbon heating at much lower cost than retrofit and remove the requirement for retrofit at a later date. This can be mandated through local and national new build standards. Retrofits for non-domestic buildings are included with the heating upgrades described later in this plan.

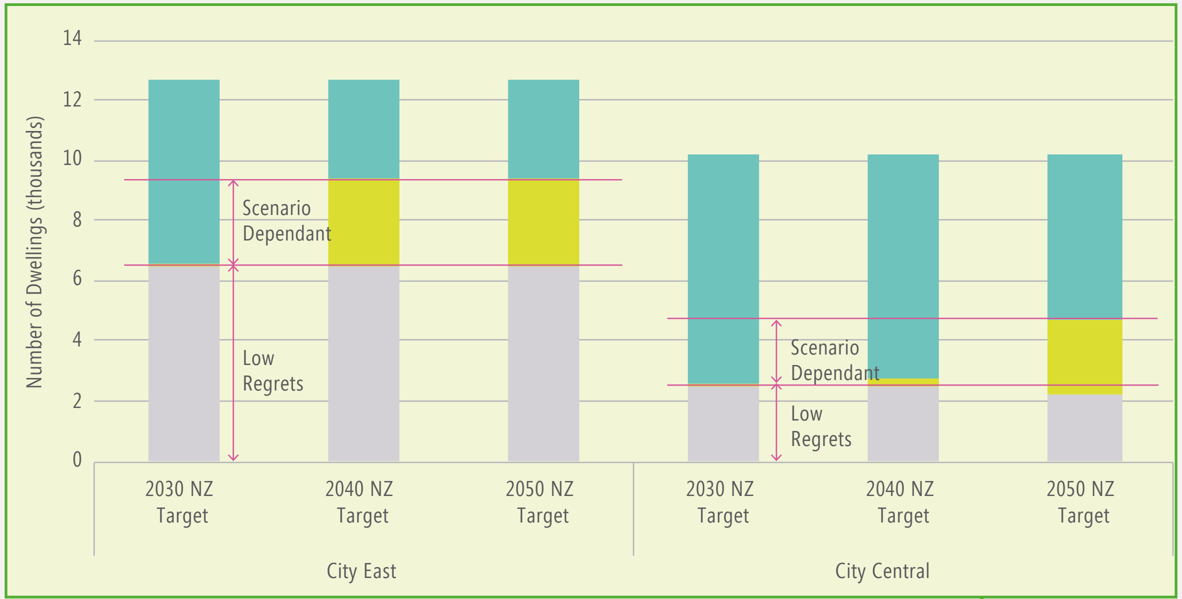


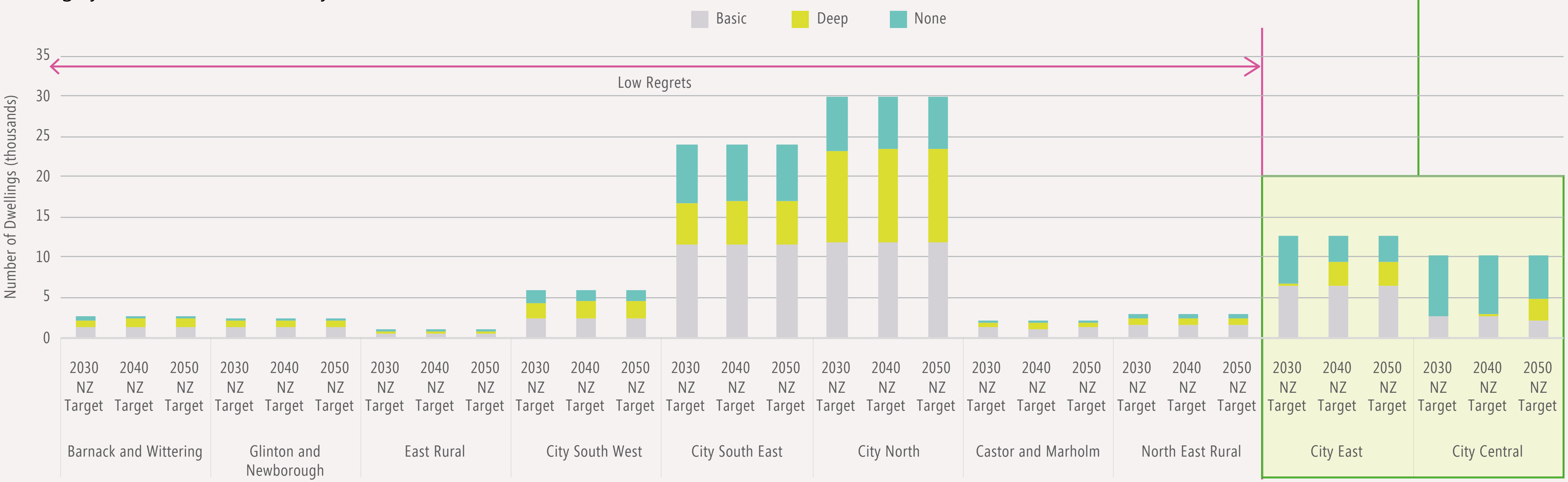


Low Regrets & Scenarios

The graph below compares the levels of domestic retrofit that are required in each of the scenarios. Because the vast majority of retrofits are consistent across the scenarios, they can be considered to be ‘low regrets’. These can be carried out even if there is uncertainty around the net zero target that will be aimed for.

The only zones where significant uncertainly is found are City East and City Central, where more deep retrofits are carried out in the scenarios with later net zero targets (shown in the graph
131 to the right). This is due to more dwellings being connected to heat networks in the 2030 scenario, and these dwellings not needing retrofits for the heating system to work effectively.





Focus Zones

City North and City East are **focus zones** for 'basic' energy efficiency upgrades due to the large number of existing dwellings requiring retrofit – 23,400 (79%) and 9,400 (75%) respectively. Both of these zones also have relatively high fuel poverty levels (right), meaning residents in this area will also benefit from reduced heating costs. The lower maps show the density of homes receiving basic upgrades in these areas.

City North

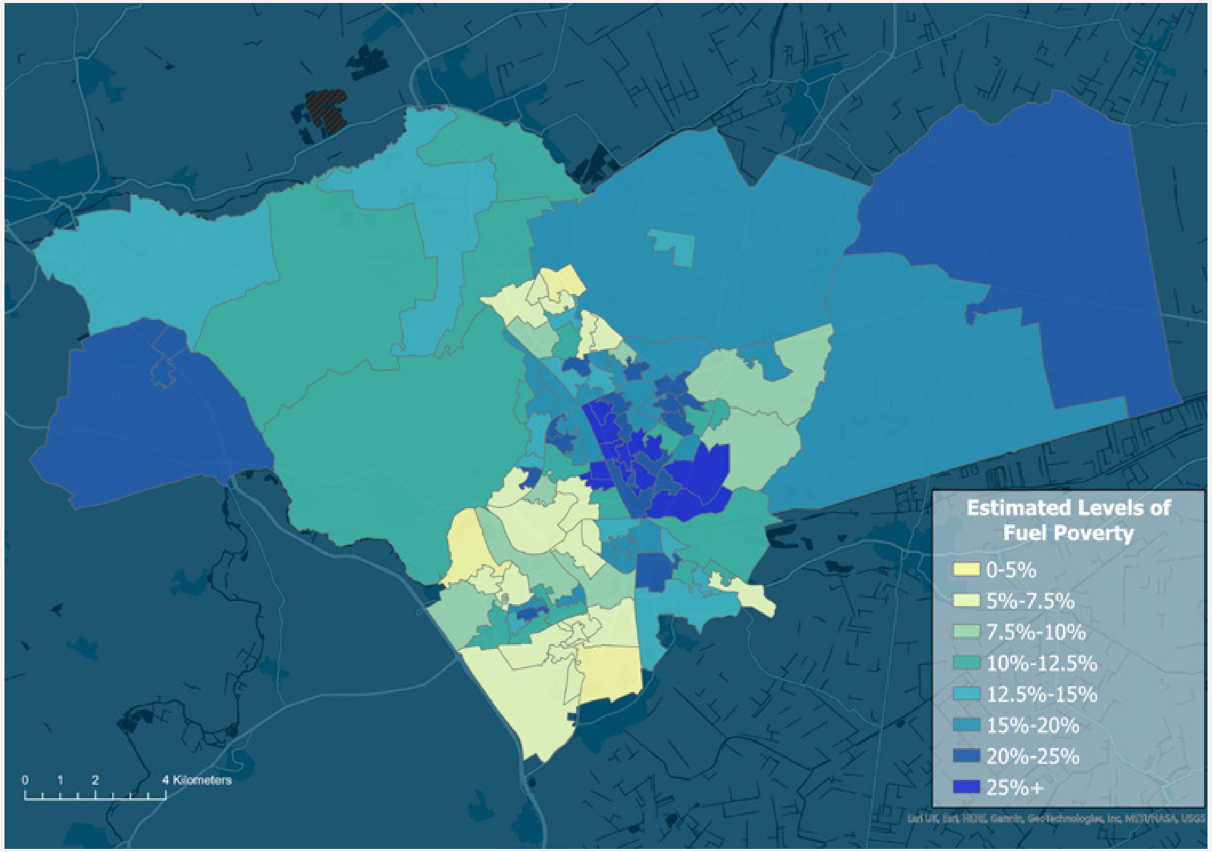
Housing in this zone is made up predominately of semi-detached and terraced dwellings, with approximately one-fifth being detached. Around 4,000 dwellings for each archetype receive basic retrofit. Energy efficiency upgrades are relatively
132 consistent in both the 2030 and 2040 net zero target scenarios. Housing archetypes receiving upgrades include:

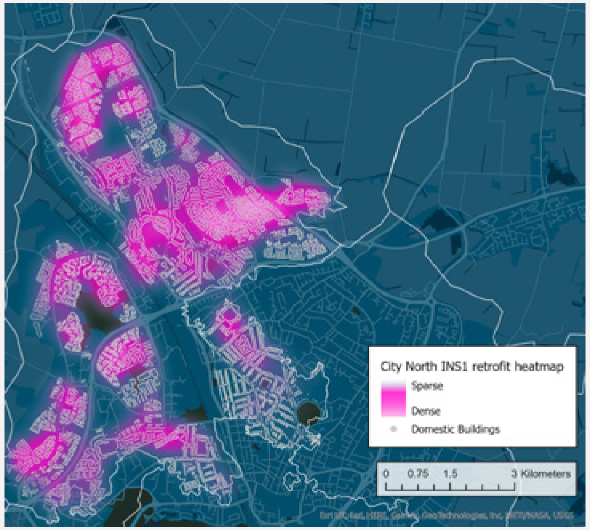
- Pre-1914 terraces (over 4,200 receiving deep upgrades)
- 1980-present detached (over 2,200 receiving basic upgrades)
- 1965-1979 terraces (almost 2,000 receiving basic upgrades)

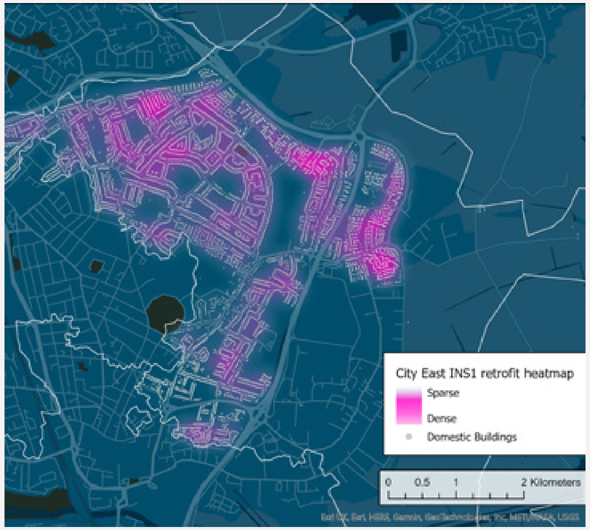
City East

Almost 4,000 semi-detached and 4,000 terrace dwellings require upgrades, with 1,500 detached dwellings also requiring upgrades. Housing archetypes receiving upgrades include:

- 1945-1979 semi-detached (over 1,800 dwellings receiving basic upgrades)
- 1945-1979 terraced (almost 1,900 dwellings receiving basic upgrades)







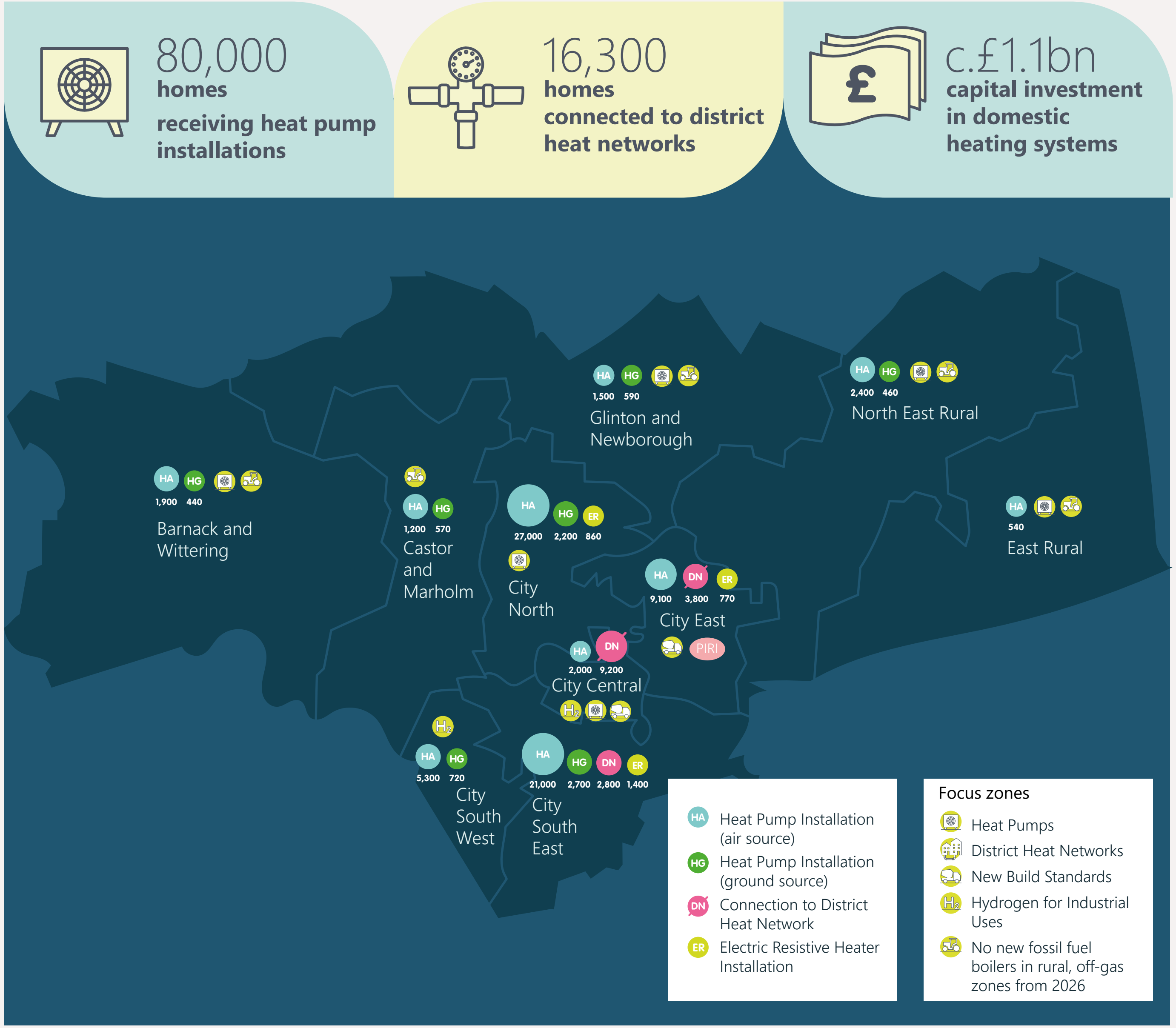
Note: INS1 = 'basic' retrofit

Heating

Overview

Fossil fuel boilers make up the majority of heating systems in dwellings and non-domestic buildings, and these account for a large proportion (38%) of Peterborough's emissions. To reach net zero, these will need to be replaced with low carbon heating systems. Heating systems can be replaced at their natural end-of-life, however early preparations are needed to ensure the low carbon options are available, straightforward and attractive when replacements occur, which can often be during a break-down. The sale of new fossil fuel heating systems would need to end by 2025 to meet a 2040 net zero target in order to avoid early replacements of working boilers (assuming a 15 year lifespan).

Air source heat pumps are the most suitable technology for decarbonising heating within Peterborough, with growing evidence* that they are suitable for the full range of property archetypes. Expansion of the PIRI heat network serves dense city centre locations (supported by some electric resistive heating), and ground source heat pumps are deployed for some homes in rural zones. Rural zones off the gas grid are low regret for heat pumps, with a end to new fossil heating installations for these homes set for 2025. Some of the City areas may have opportunities to use hydrogen for heating for homes near industrial users.



* https://es.catapult.org.uk/news/electrification-of-heat-trial-finds-heat-pumps-suitable-for-all-housing-types

Zones

The graph shows the selection of heating systems for each zone. These are mostly consistent between scenarios, though larger heat network coverage is a key feature of a more ambitious 2030 target. This is due to the heat networks using large centralised heat pumps to achieve a higher overall system efficiency than individual heat pumps for each dwellings. This advantage is important for minimising emissions in the 2030s, but by the 2040s the electricity grid is lower carbon, so the benefit is diminished.

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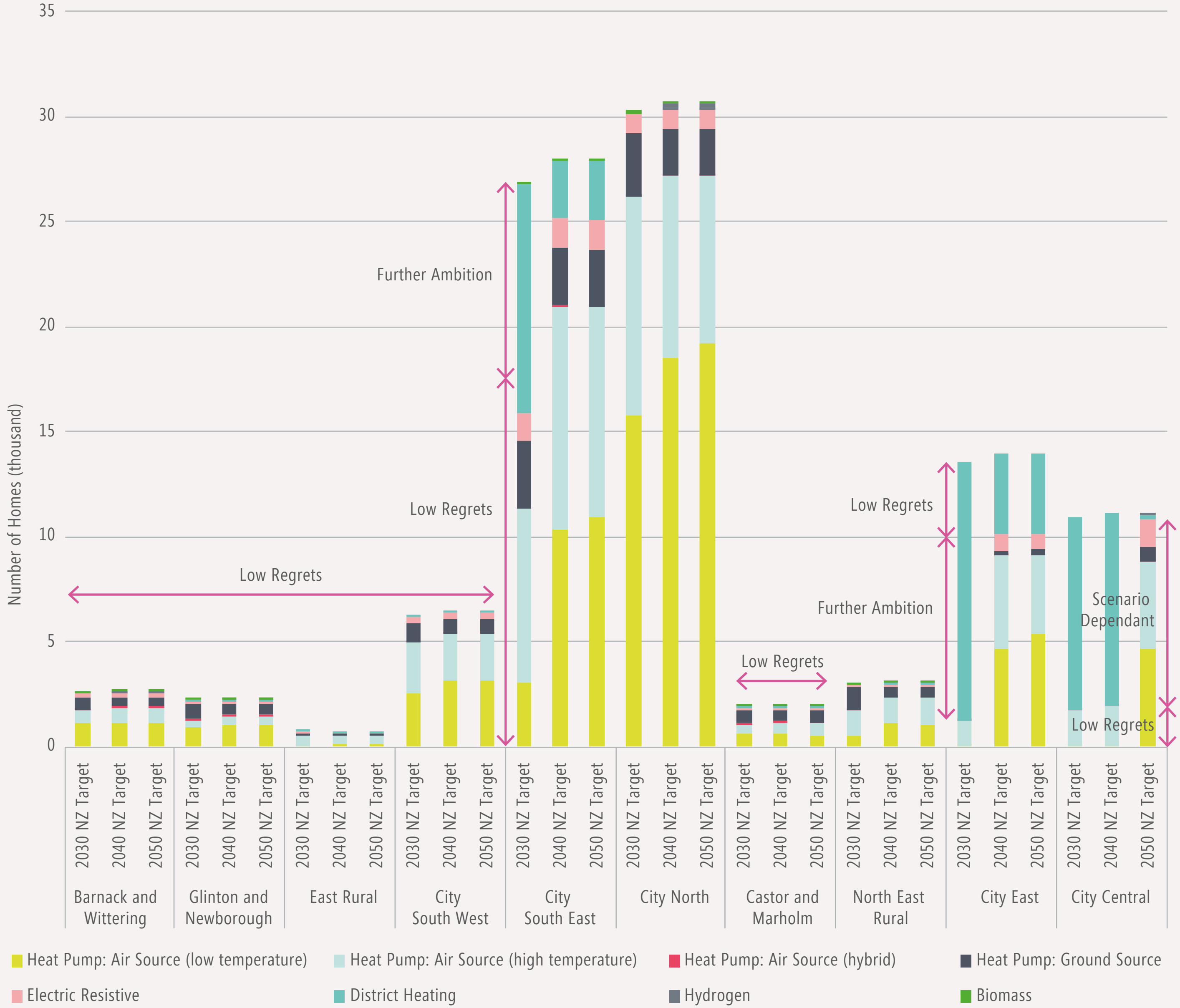
Importantly, this also means that the large scale building of heat networks (serving almost 33,000 homes) is only worthwhile in emissions terms if it can be achieved very quickly. By the 2040s, the expected decarbonisation of the National Grid will mean individual heat pumps will achieve similar emissions reductions. District heat networks could also be advantageous for dwellings (e.g. terraces) with limited space for the additional equipment required with a heat pump system.

Hydrogen boilers could also provide a low-carbon replacement for fossil gas boilers, but they are dependent on a supply of hydrogen becoming available at acceptable cost and carbon emissions, which is unlikely to happen before the mid-2030s at the earliest. This also assumes a positive Government decision on hydrogen for heating in 2026.



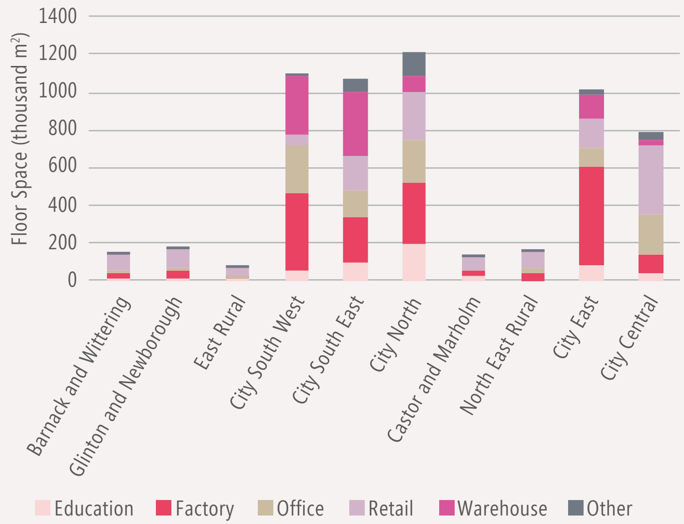
Non-domestic Buildings

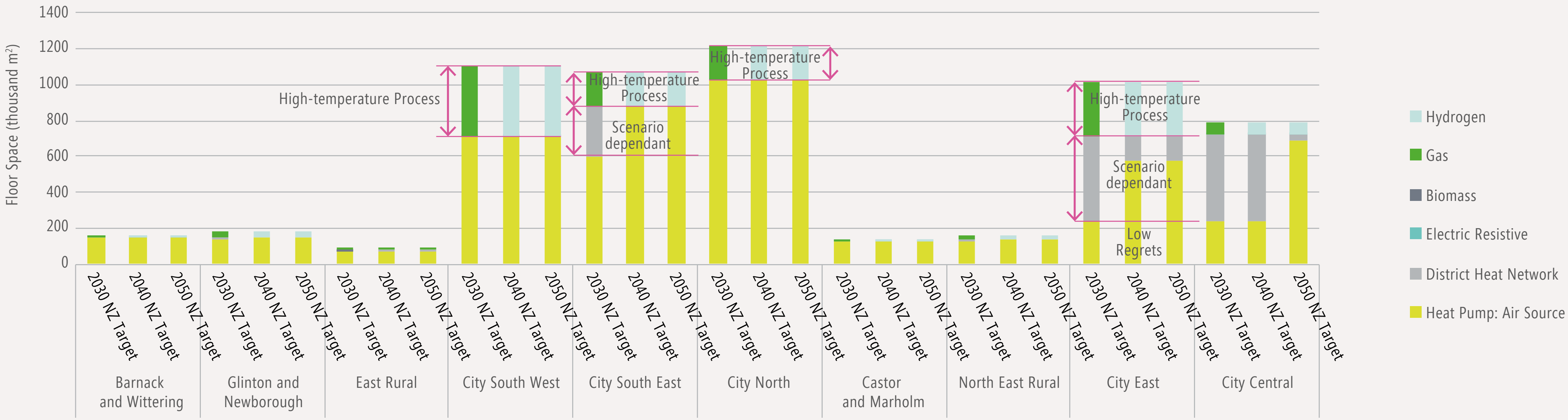
Non-domestic buildings follow a similar pattern to domestic. Most of the heat demand is for space heating and hot water, and can typically be decarbonised using heat pumps, or by connecting to district heat networks in areas of high heat density. A similar split occurs between the low regrets buildings that are likely to use the same heating technology regardless of the scenario that is followed, and those that switch from heat pumps to district heating if aiming for a 2030 target, as buildings in areas looking to decarbonise quickly need to make the most efficient use of the carbon in the national grid
136 until it becomes decarbonised (shown in the graph below).

Building energy efficiency upgrades are bundled with the heating system upgrades shown here.

Some non-domestic buildings need high temperature heat for specialised industrial processes (see graph on the right for breakdown of non-domestic building types). The only viable alternative to fossil gas for this purpose is hydrogen. Since hydrogen is assumed to become available in the mid-2030s, these buildings are unable to transition from fossil gas until just prior to the 2040 net zero target date therefore requiring significant planning and rapid deployment once available.

Types of Non-domestic Building





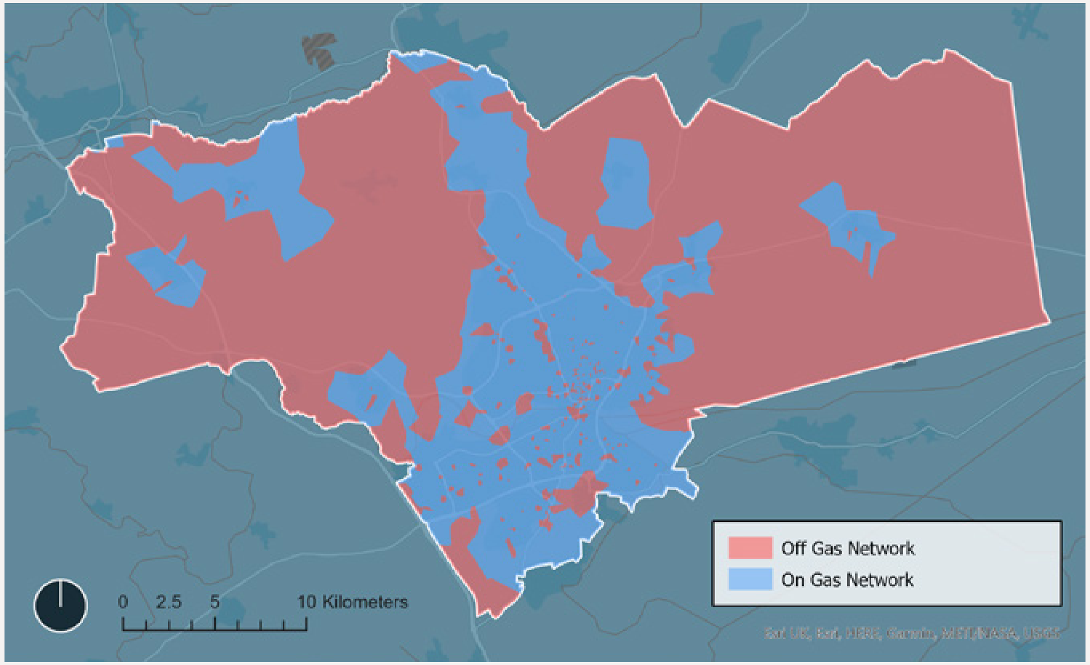
Low Regret Zones

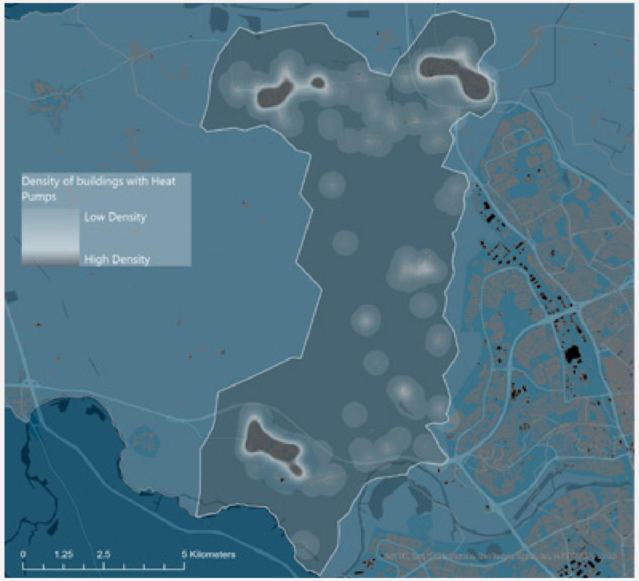
Barnack and Wittering, East Rural, Castor and Marholm, and North East Rural, and Glinton and Newborough are all rural zones within Peterborough that are predominately off-gas, with domestic off-gas properties totalling around **3,400**.

The government's Heat and Buildings Strategy proposes to end the installation of fossil-fuelled heating systems in off-gas dwellings from 2026, meaning rural properties (shown in upper map) will decarbonise in an earlier wave than most of
137 the housing stock.

With no gas network to carry hydrogen, or dense areas of dwellings to make a heat network financially viable in rural zones, it is very likely that heating will be electrified, making them **low regrets** for heat pump installations. Of these rural zones, Castor and Marholm and North East Rural have the most headroom in the electrical network to begin installing heat pumps before a need for capacity upgrade arises.

Electrification of heating typically requires the building to be insulated to a certain level to ensure that both capital and operational costs are kept low.





Heat Pump Density in Castor and Marholm

Heat Pump Density in North East Rural

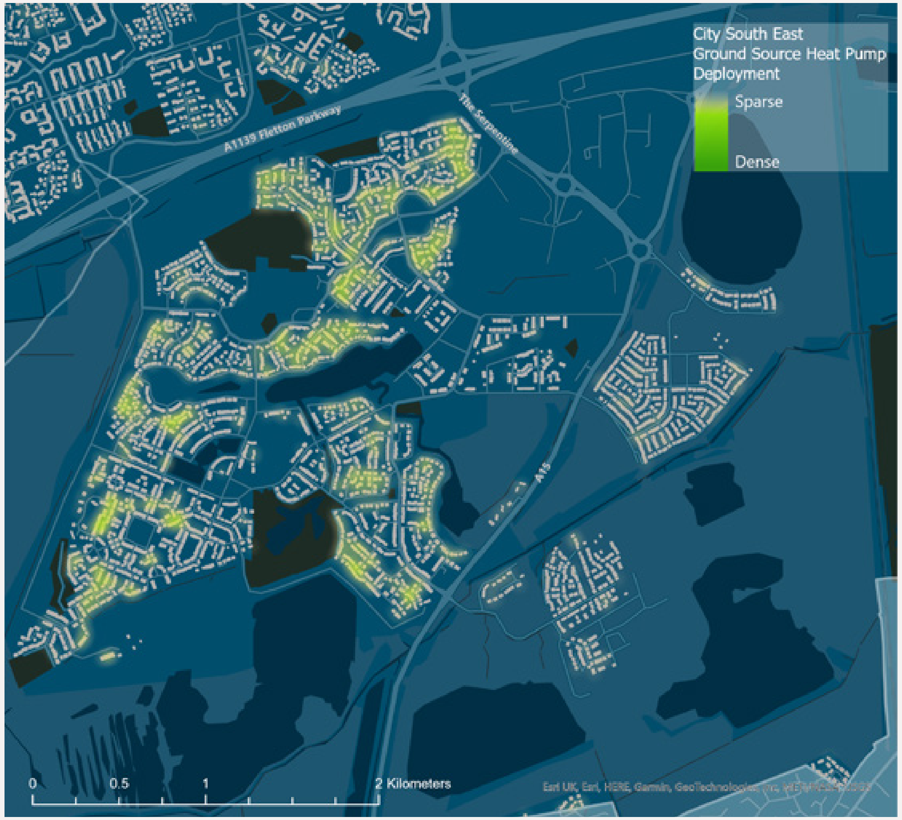
Heat Pump Focus Zones

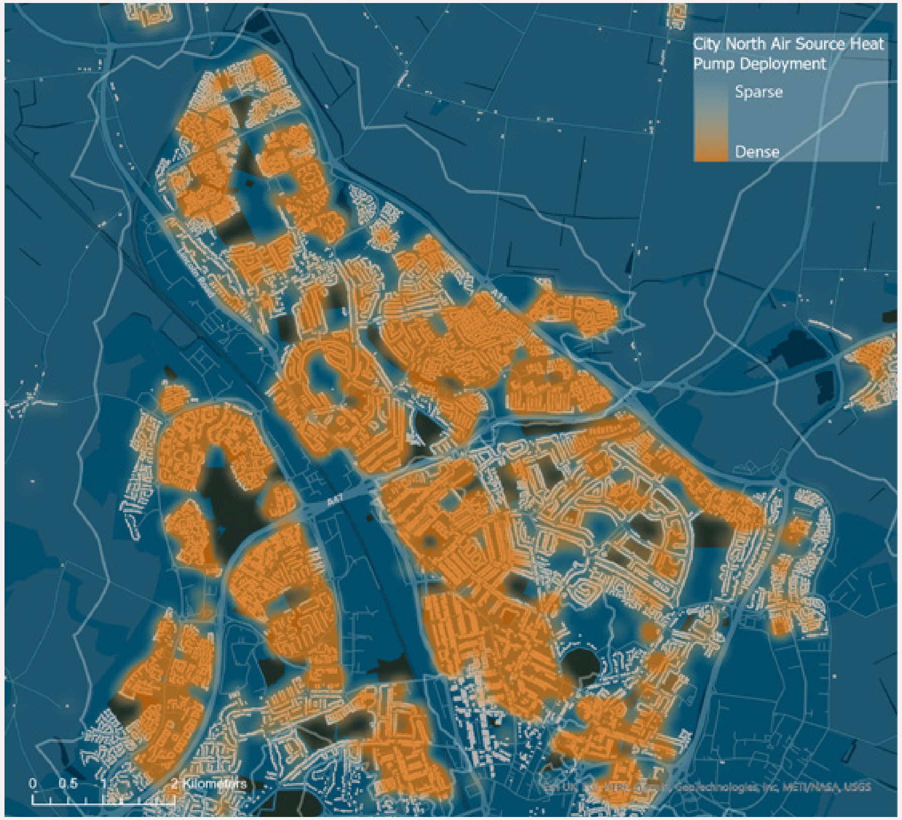
City North has the largest roll-out of air source heat pumps, numbering at least 29,400. This will require significant supply chain scale-up, citizen awareness and buy-in, and attractive commercial offerings to compete with existing fossil fuel options. This zone also has available demand headroom in its electricity network to allow for roll-out to begin immediately.

Given the large number of heat pumps planned, eventually network capacity upgrades and/or flexibility solutions will be required to meet the increased electricity demand.

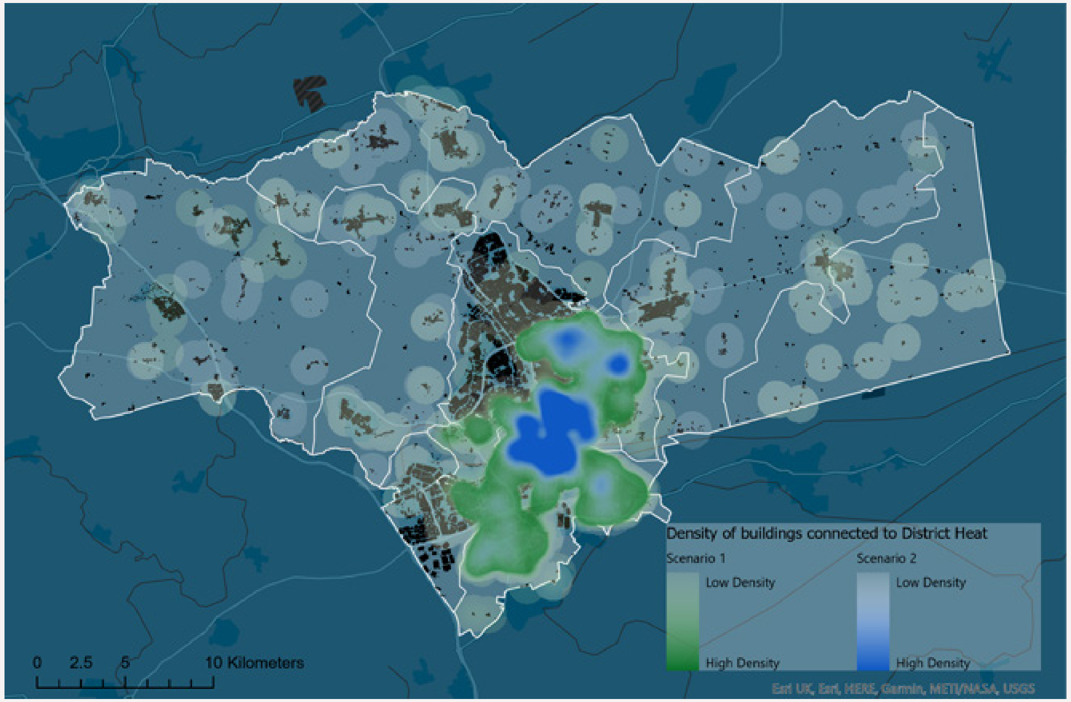
Air source heat pumps are typically the most cost-effective heat pump type due to their lower capital costs compared to ground source heat pumps. However, in City South East (left), a cluster of GSHPs could be considered due to the properties being detached and having a significant amount of land available to use as the heat source. For large properties, the higher heat demand can justify the higher upfront cost of ground source, since it achieves higher efficiencies and lower running costs.

Where clusters like this exist, small communal systems could also be considered.





District Heat Networks (DHN)



	Domestic Peak Demand (MW)	Non-domestic Peak Demand (MW)	Total Peak Demand (MW)	Domestic buildings connected
City East	4.8	6.8	10.2	3,800
City Central	20.6	18.4	35.4	9,200

Heat supplied through underground pipes from a centralised energy centre, or a network of decentralised energy centres, tends to be the most suitable solution for denser urban zones, particularly where there are large numbers of dwellings that require either too expensive or impractical retrofit to make them suitable for heat pumps. Heat networks cause less disruption in dwellings during installation compared to some other options, though there are wider considerations such as traffic disruption during pipe laying, and space restrictions in city centres.

The 2040 scenario (blue area on map) shows district heat networks proposed predominately in dense areas around the city centre.
The Peterborough Integrated Renewables Infrastructure (PIRI) project, already underway, provides a valuable starting point for a heat network that can be extended to serve other areas proposed by this plan. Regardless of decisions made on the eventual extent of the heat network, the full PIRI scheme forms a low-regrets core. Heat networks across the city should be built to common standards to allow them to expand and merge at future dates however this would require a long-term planning approach to ensure that network infrastructure can be planned appropriately.

In the core area (blue), 16,300 properties are connected to district heat networks. In the higher ambition 2030 scenario (green), this would increase to 34,200, taking the place of some heat pump installations.

In 2030, the carbon content of the electricity supply will still be high enough to warrant minimising use of grid electricity, and therefore a more efficient heat network is preferred by the model to decarbonise quickly and at scale. For a 2040 target, the carbon content of national grid electricity is expected to have reached a low level, meaning fewer homes connect to a heat network and instead opt for individual heat pumps.

The Green Heat Network Fund* will have quarterly application rounds from March 2022 until 2025, and could provide funding for heat networks in Peterborough.

* https://www.gov.uk/government/publications/green-heat-network-fund-ghnf

City Central Heat Network

Within the City Central zone, there are three areas (shown in the maps) with potential for district heat network deployment due to the higher heat demand density (a large amount of heat requirement in a small area).

The mixture of domestic and non-domestic buildings allows for more of a balanced load across the network at any given time. Nevertheless, anchor loads (such as large schools, hospitals, leisure centres) with a steady and constant heat requirement should be sought if possible.

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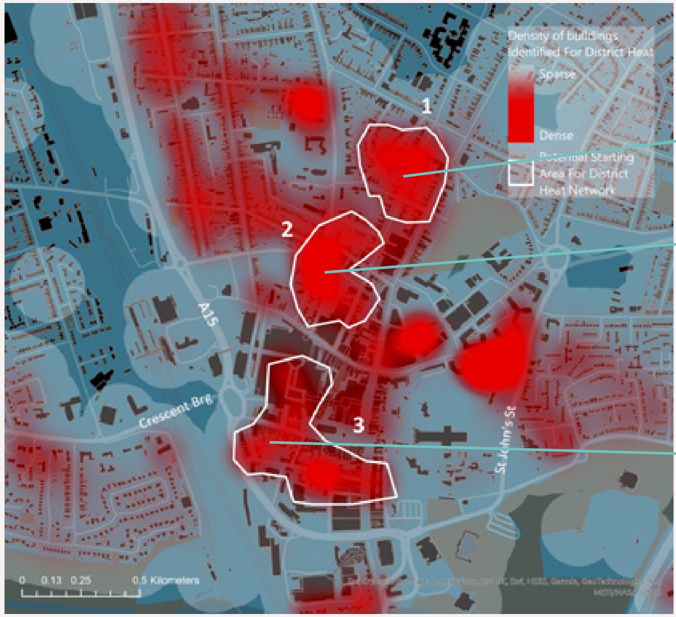
The table shows the split of domestic and non-domestic properties and the peak demands. (Note: peaks are not additive as domestic and non-domestic peaks will not occur at the same time.)



	Number of Domestic Dwellings	Number of Non-Domestic Properties	Domestic Peak Demand (MW)	Non-Domestic Peak Demand (MW)	Total Peak Demand (MW)
Top DHN (1)	283	61	0.69	0.33	0.87
Middle DHN (2)	297	78	0.67	0.49	1.0
Bottom DHN (3)	165	321	0.39	3.2	3.4

Gas Network

The gas network in Peterborough is operated under license by Cadent and currently supplies gas to the majority of dwellings in Peterborough (extents of the high-pressure network shown in the map). It is used predominantly for domestic heating, hot water and cooking, but also supports a range of non-domestic and industrial local energy demands.

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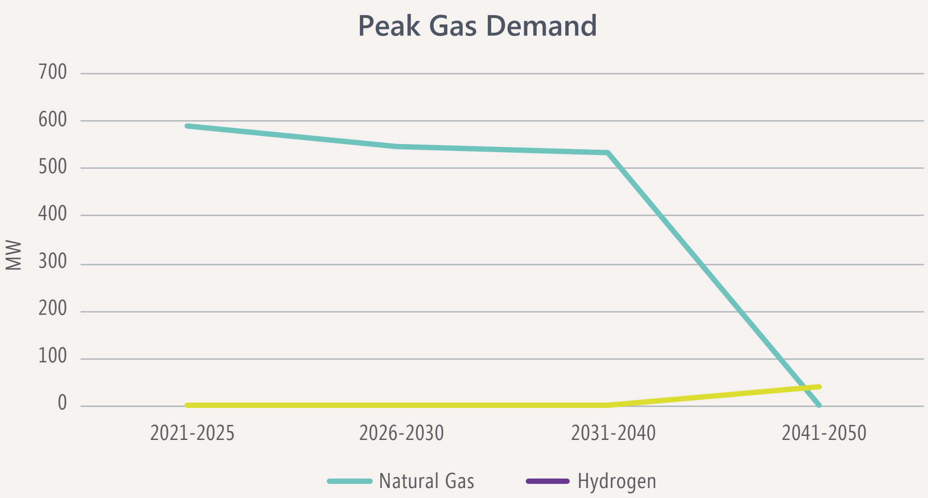
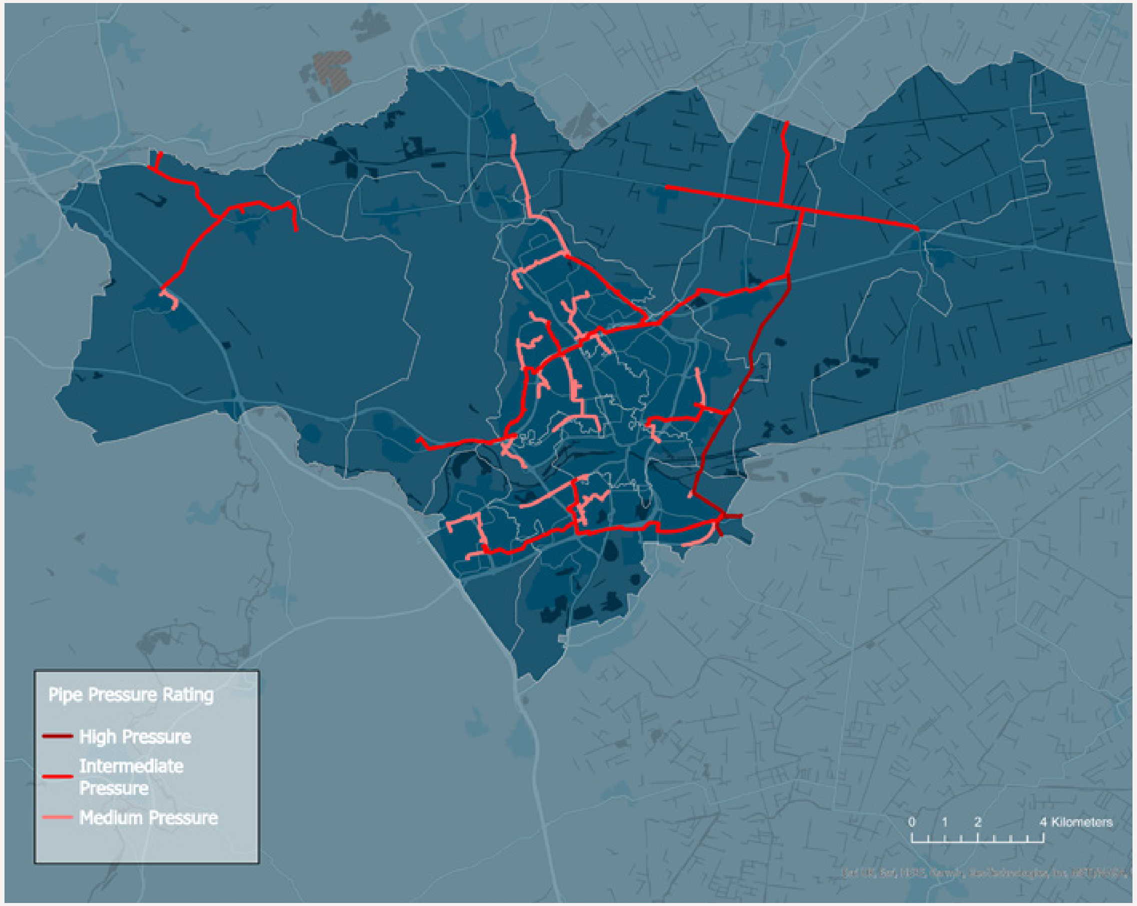
The current total gas consumption across Peterborough is around 1,370 GWh per year. Meeting the net zero goal would mean a steep decline in fossil gas consumed across Peterborough, illustrated in the graph below (based on following the 2040 net zero pathway).

Meanwhile, parts of the gas network could be repurposed to supply hydrogen around industrial areas – this is detailed on the following page.





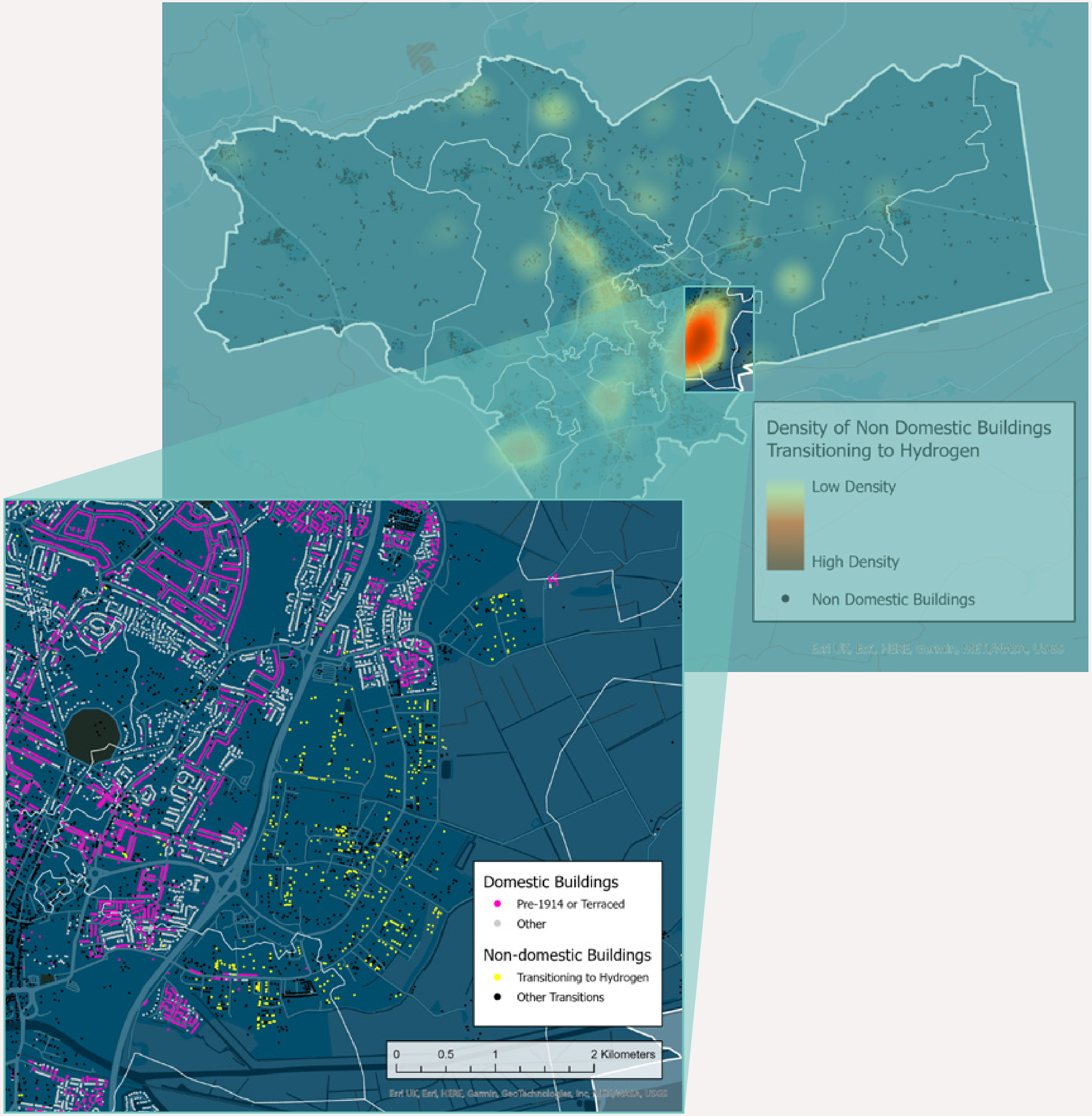
Map of the high-pressure gas network in Peterborough.

Hydrogen

It is assumed that hydrogen will become available in the mid 2030s from the East Coast Hydrogen scheme and therefore cannot contribute to the 2030 target. Even by 2040, the use of hydrogen for building heating is likely to be minimal, as the cost and carbon factors modelled for hydrogen* result in electrification of heat being preferred.

There are, however, uses of fossil gas in industry for high temperature processes that would be difficult to electrify, and this is where hydrogen could be usefully deployed. Once these industrial clusters are supplied by hydrogen, it could make sense for nearby buildings, including any homes
142 in the area, to also be heated by hydrogen, avoiding the disruption, upfront cost and space requirements of heat pump installation. This could be valuable in dwellings where space for heat pump equipment is constrained and insulation is poor, such as the pre-1914 terraces in City East and City Central.

Recognising that there is uncertainty associated with the cost and carbon projections used for hydrogen, near-term focus can be centred on the identified heat pump and district heat network focus zones, keeping options open for areas outside the focus zones. The UK government is expected to clarify its strategy on the use of hydrogen for heating buildings in 2026, which will give a steer on the decisions for these areas.



* Hydrogen production cost based on BEIS figures; carbon intensity based on the East Coast Hydrogen project feasibility study

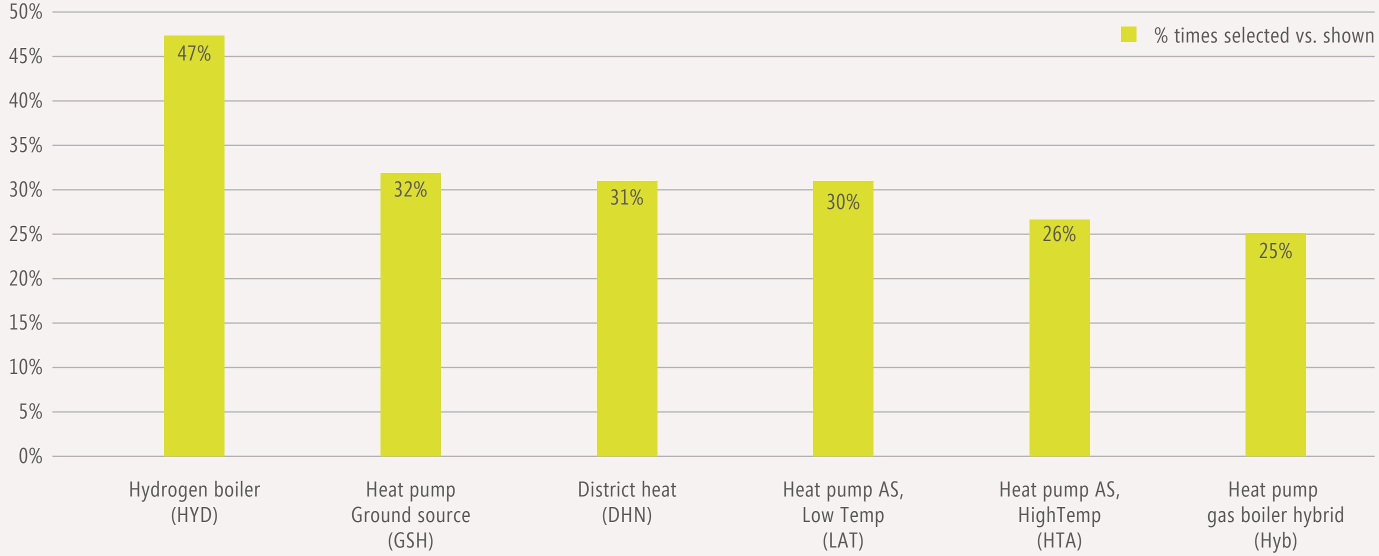
Public Survey

ZERO CARBON VOTE

A survey was carried out by Energy Systems Catapult using the "ZeroCarbon.Vote" platform to engage a sample of Peterborough's population (approximately matching demographic, household tenure, etc). Participants were presented with heating technology options relevant to their specific house type, and a little information about each option (e.g., relative capital and running costs, disruption, etc). They then expressed preferences and provided a justification for their preferences. The results give an indication of the extent to which (based on the simple initial information provided to them) residents' preferences align with the potential recommendations for each zone within the plan.

Residents in most zones voted for a spread of relevant technologies, with district heat networks featuring more in urban areas and various heat pump technologies more in rural areas. Hydrogen boilers were also frequently voted for, where that option was offered*.

Running cost was the factor most often cited in making these choices, with installation cost cited about half as often. Disruption to the home was cited less, and disruption to the street was cited by very few. However, heat pumps and district heat networks would actually fit this set of preferences better than hydrogen boilers, which are likely to have higher running costs.



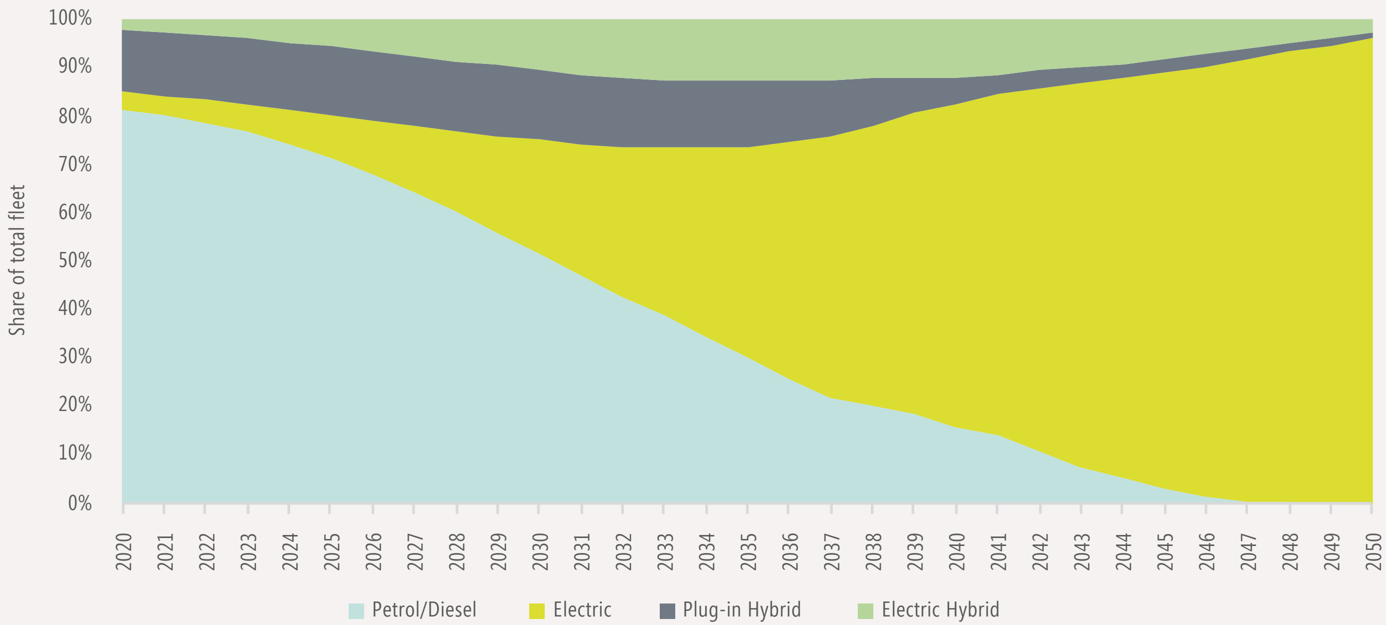
* Three of the heating options were provided to each respondent. This therefore shows some favour towards hydrogen boilers (being picked more than one-third of the time) and some disfavour towards high temperature and hybrid heat pumps (being picked less than one-third of the time).

Transport

EV Overview

Electric vehicles (EVs) are expected to grow significantly as a proportion of total vehicle fleet, as costs match or fall below those of petrol and diesel vehicles, local clean air zones favour clean vehicles, and national policy phases out petrol and diesel vehicle sales by 2030 and hybrids by 2035. Reaching net zero ahead of the national target would require encouragement for residents to shift to electric vehicle purchases earlier.

Projections of an increasing proportion of
145 private electric vehicles are used to anticipate the electricity demand across Peterborough for charging these vehicles, and the associated infrastructure upgrades that would be required.



80,000
Electric cars (including plug-in hybrids) by 2040

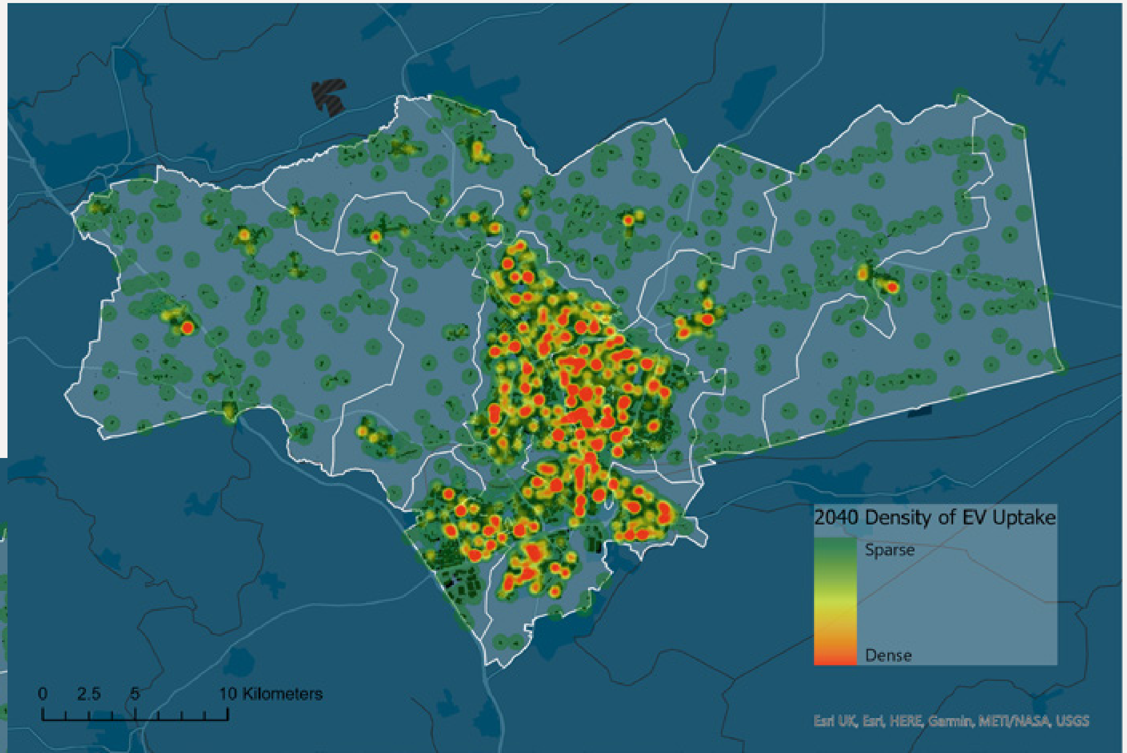
78 GWh/year
Energy consumption for charging in 2040

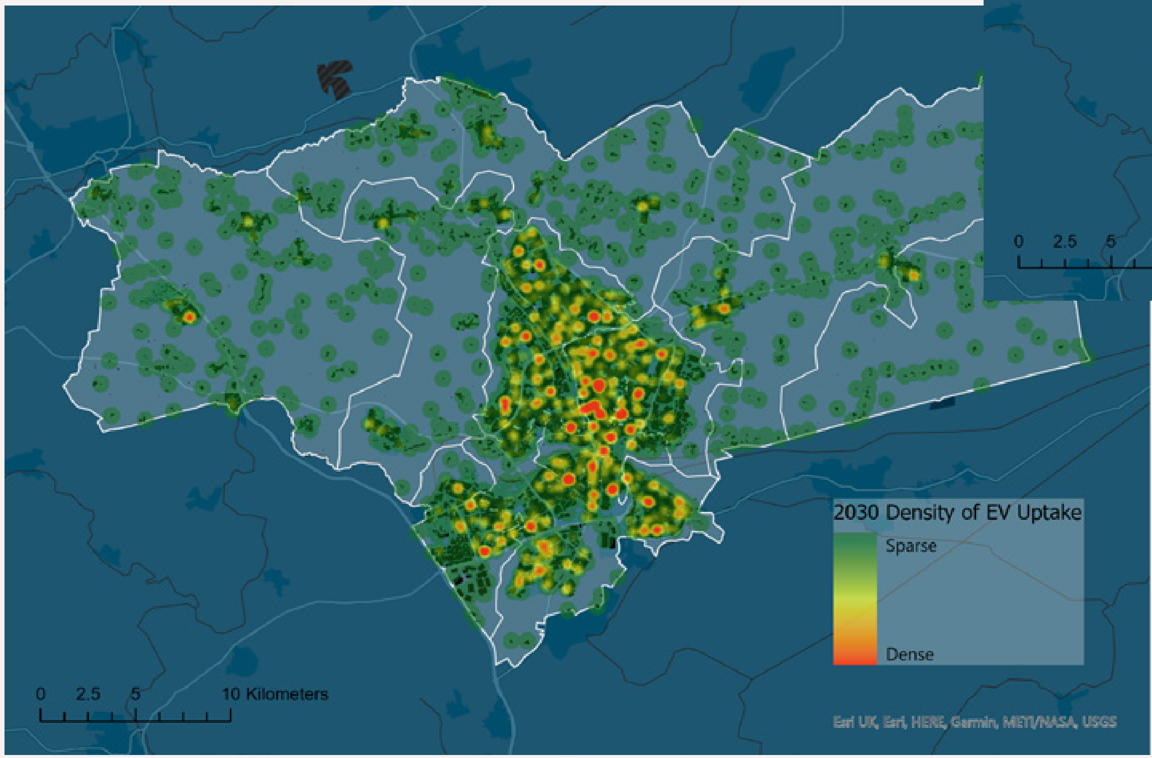
53,700
Domestic chargers installed

£24m
Install costs for domestic chargers

EV Projections

Based on national projections, fully electric and plug-in hybrid vehicles in Peterborough are expected to grow from their current level to 24,000 vehicles (24% of the total fleet) by 2030 and over 80,000 (72%) by 2040. To reach net zero before 2050, this transition would need to happen faster still, with the sale of new petrol and diesel vehicles having to end by 2025 if early replacement of vehicles is to be avoided (assuming a 15 year vehicle lifespan). A low emissions zone could help accelerate the transition.





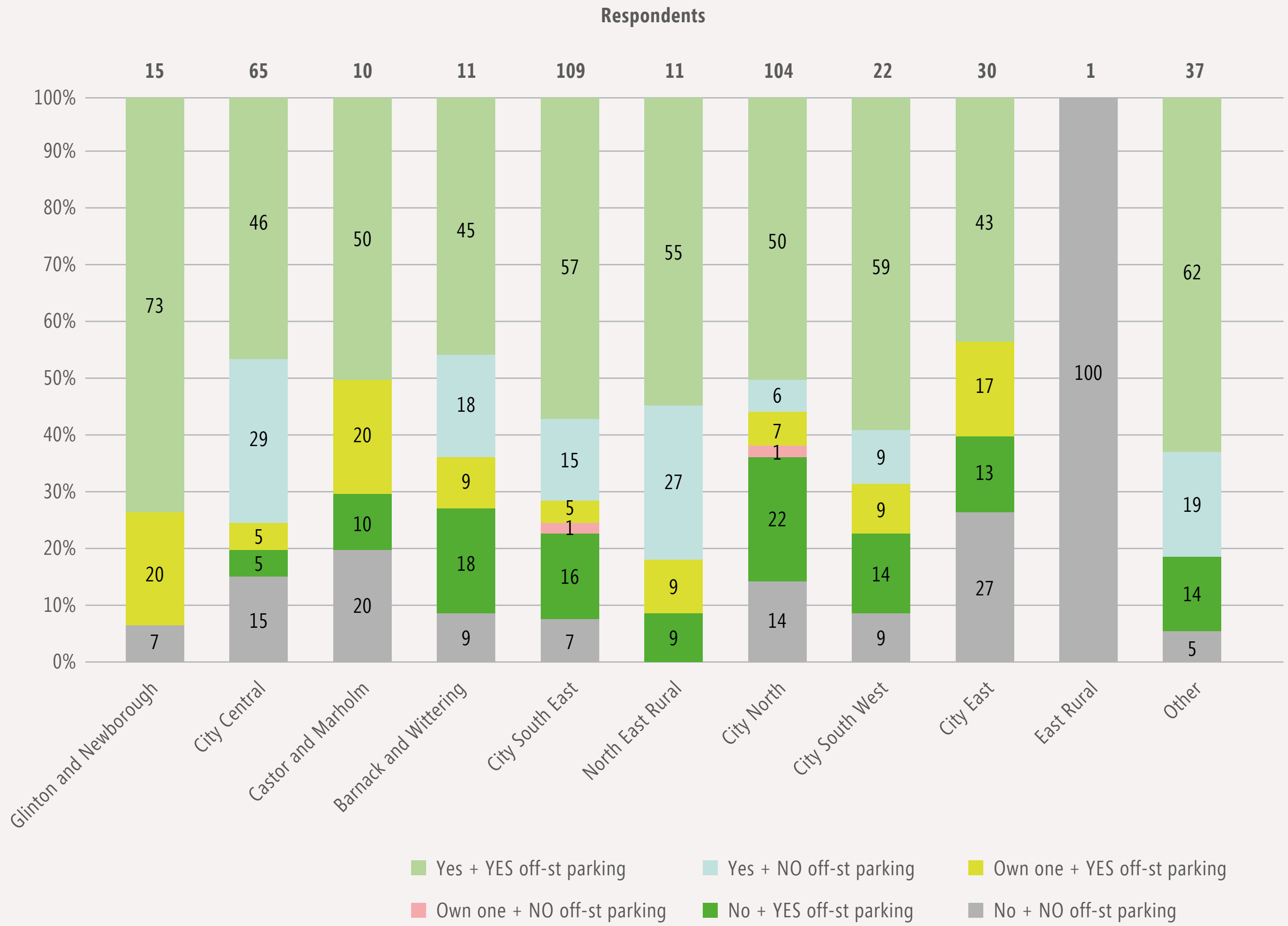
Charging infrastructure will need to be installed to keep up with demand, and provide consumer confidence to encourage this transition. A mixture of publicly accessible and private residential chargers will be required.

EV uptake is naturally higher in the more densely populated areas of Peterborough. The far lower density of homes in the rural areas results in correspondingly fewer EVs, although the number of vehicles per household will tend to be higher.

Off-Street Parking and Charging

Analysis of respondents from a sample* of residents engaged through the ESC's "ZeroCarbon.Vote" survey provides some insight into the influence of availability of parking and charging infrastructure and their vehicle choices.

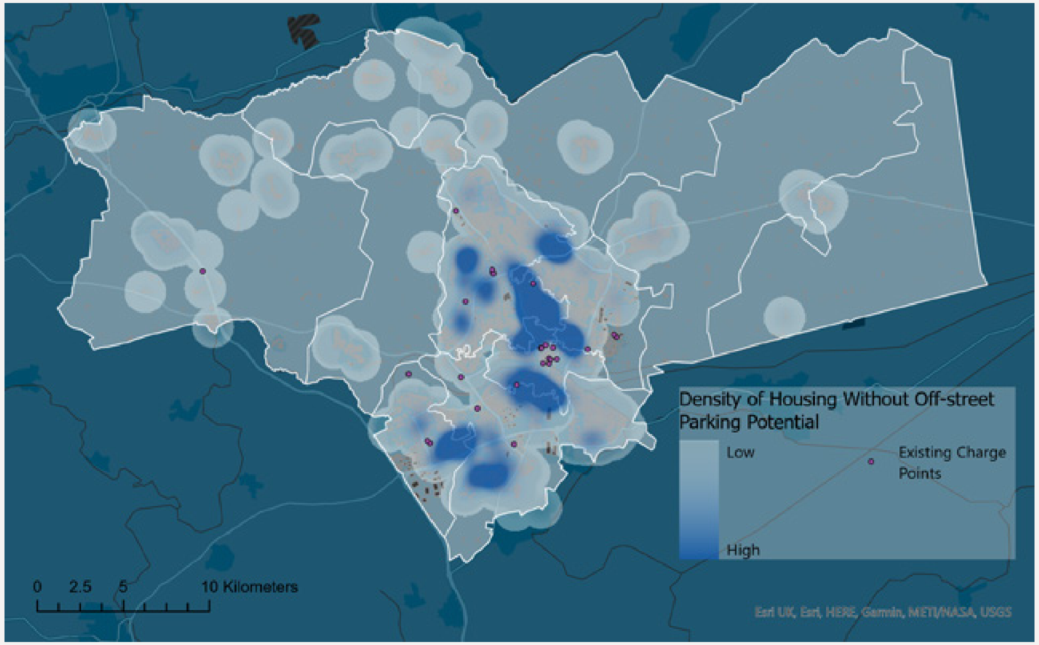
- The majority of respondents **(74%)** are either considering an EV as their next car (66%) or already own one (7%).
- Of those who are considering an EV as their next car, **80%** have off-street parking.
- However, of those who are not considering an EV as their next car, **54%** have off-street parking.
- Of those who live in City Central, **45%** reported they have **no off-street** parking, the highest proportion of any area.
- City East (40%) and City North (36%) have the largest proportion of respondents who are **not considering an EV** as their next car

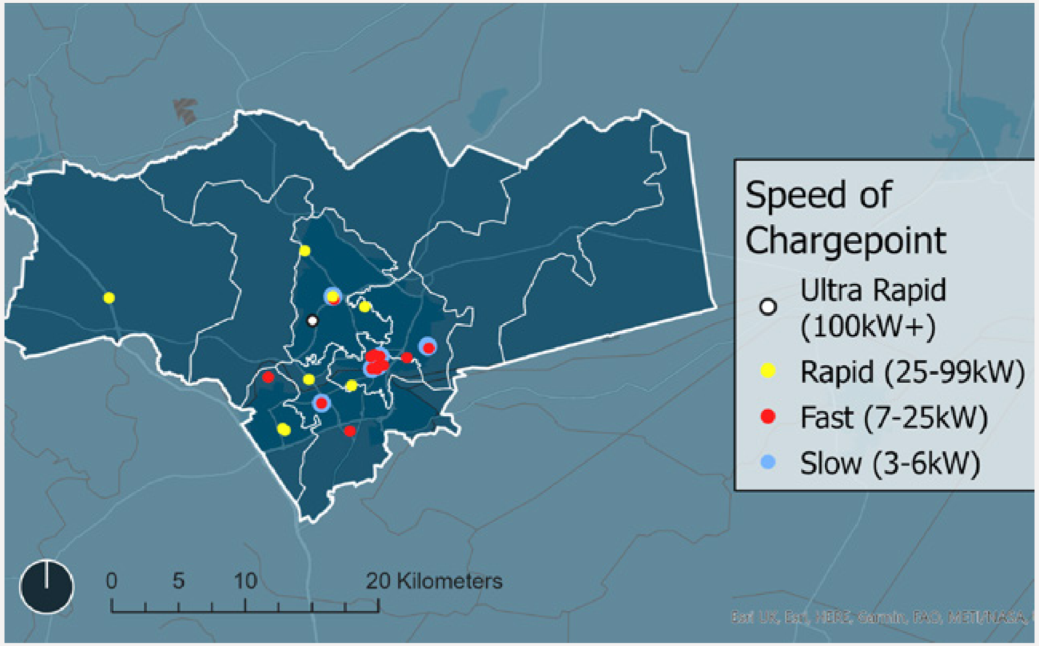


NB: low number of votes in East Rural zone

* 535 residents completed the survey. Details of breakdown by zone, demographic, etc can be found in the Evidence Base. Numbers may not sum due to rounding.

EV Charging Infrastructure





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Residents with off-street parking are assumed to charge their vehicles at home, whereas those without are expected to require public charging hubs, including kerb-side and site-based charging (e.g. car parks).

Areas of high density housing without off-street parking exist towards the city centre, and there is a number of fast and rapid chargers already installed in these areas. However, given the projected increase in demand from EVs, a subsequent increase in charging infrastructure is required in these areas, and this could include a large increase in kerb-side technologies.

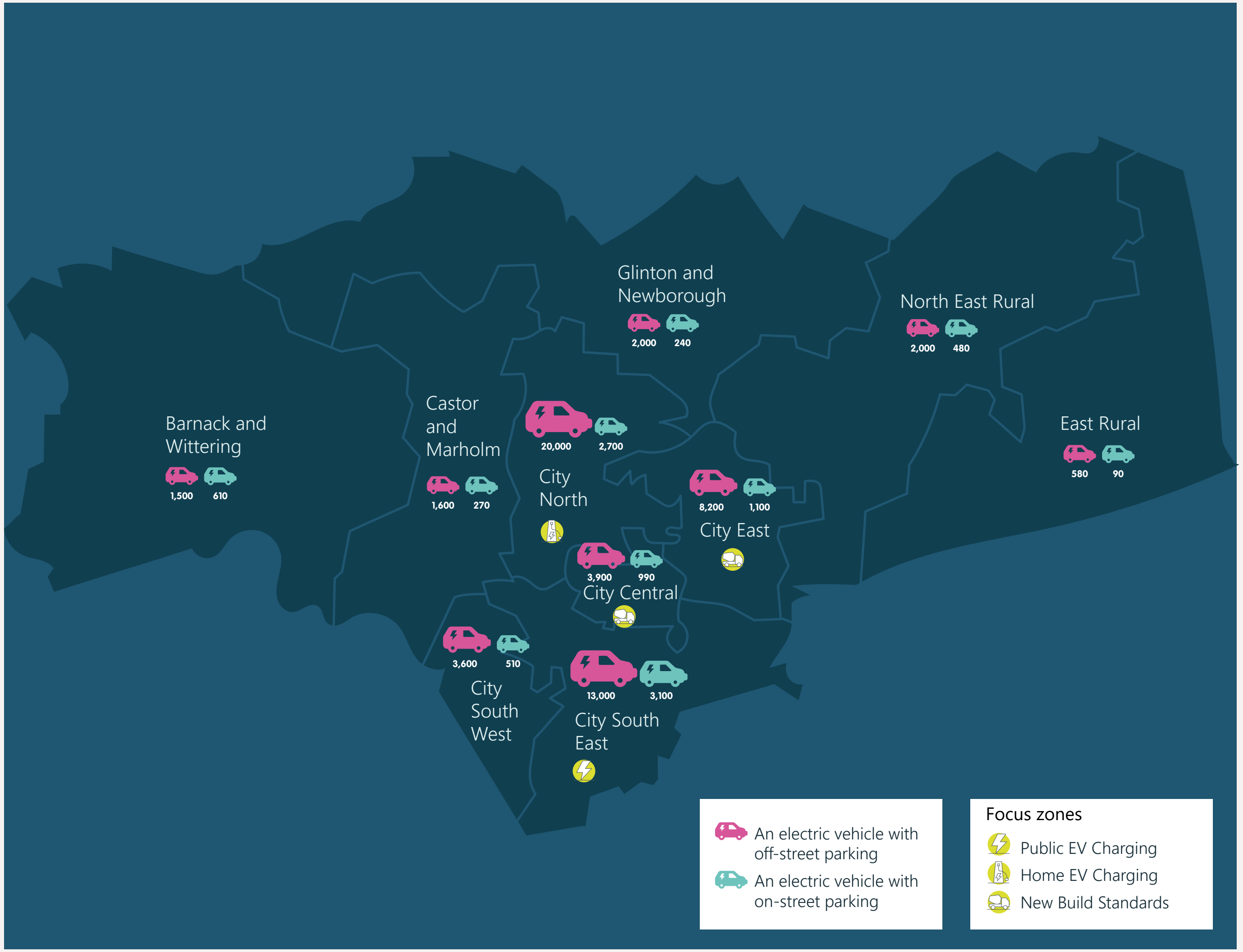
The ZeroCarbon.Vote results show that there is a proportion of respondents who are not considering purchasing an EV and don't have off-street parking. Having more readily available charging infrastructure near to their homes may encourage their transition to EVs

EV Focus Zones

The City South East area has high EV uptake anticipated, with plenty of capacity on the electricity network. City South East is therefore a **focus zone** for public EV charging infrastructure that includes both car parks and on-street charge points.

The City North area has the fastest expected roll-out of EVs, and given there is capacity on the network, this has been identified as a **focus zone** for installations of home chargers.

149 Zones where substantial numbers of new homes are anticipated can ensure EV charging is fitted during construction, incentivising EV ownership and avoiding the need for costlier retrofit. Strategic transport planning in these areas to provide access to quality public transport and active travel routes could encourage behaviour changes that reduce car dependency, while promoting health.



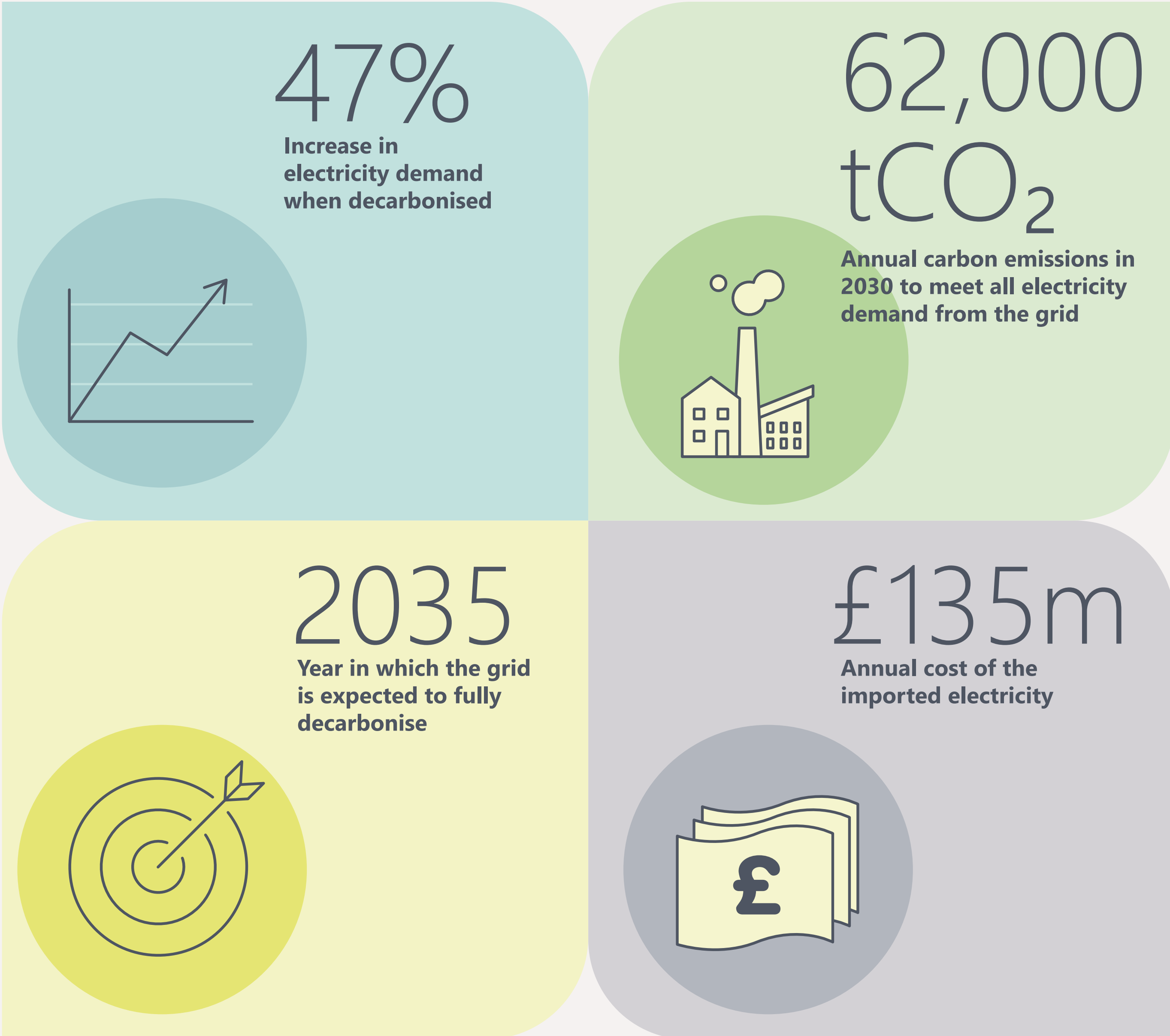
Local Generation

Overview

Electrification of heat and transport is core to decarbonisation, and this will increase Peterborough's annual demand for electricity from 880 GWh to 1,290 GWh by 2040.

If this electricity demand is supplied by the national grid, then Peterborough's rate of decarbonisation will be limited by the rate that the grid decarbonises. This is likely to limit Peterborough's ability to meet the more ambitious 2030 target, as the grid is expected to reach zero carbon by 2035 at the earliest.

To aim for the earlier target, Peterborough could explore generating more electricity locally in a low carbon way. Even for a 2040 target, local renewable generation can bring economic benefits, reduce emissions earlier, and contribute to the decarbonisation of the national electricity system. There are a number of options for this which are explored on the following pages.



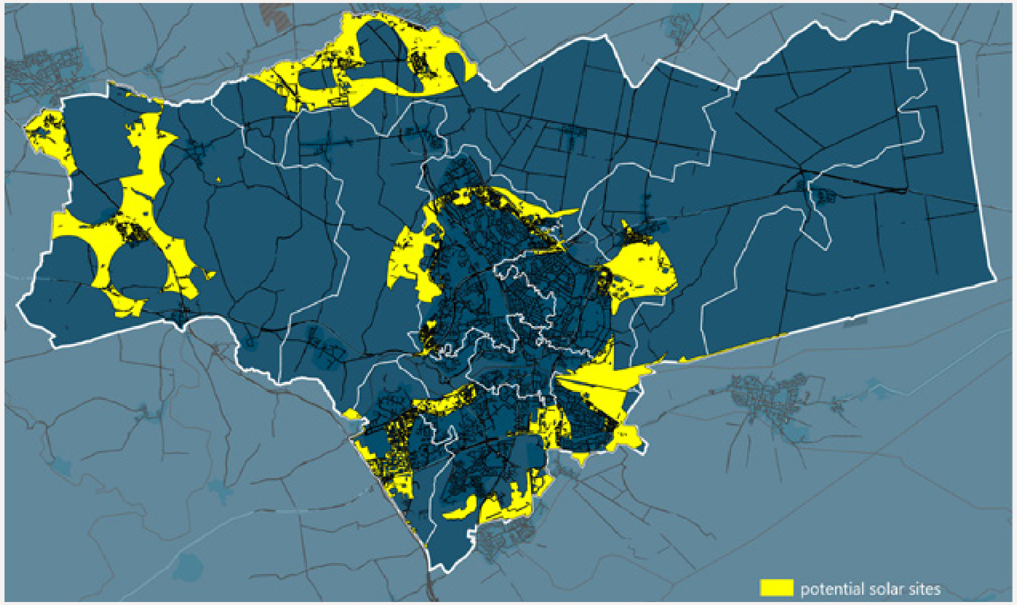
Large-scale Renewables

Large-scale renewable generation, particularly ground-mounted solar PV and wind turbines, is the most cost-effective way to produce low-carbon electricity, due to economy of scale. However, arrangements such as power purchase agreements would be required to capture this value locally, rather than it being exported to the national grid. Many examples of community ownership models can be found in the UK, with local residents enjoying income or bill savings from the schemes. The requirements for land purchase, planning permission, public acceptance and connection to the grid can put limits on their
152 scale and deployment.

To give an impression of scale, land in Peterborough has been assessed for its suitability for ground-mounted solar, with the areas highlighted in yellow on the map having potential for development, totalling just under 40 km^2 (4,000 hectares). Just over half of this space was used in the cost-optimisation to build solar, resulting in a capacity of **$1.35GW_p$** being installed. This would produce 1,975 GWh of electricity annually, covering all of Peterborough's consumption on a net annual basis, including electrified heating and car charging.

This quantity of ground-mounted solar is **representative of the amount of local renewable energy which would be needed to reach net zero targets** ahead of the national grid, but the energy could be generated by a mix of sources including wind (requiring a wind resource study). If less ground-mounted solar is installed, emissions reductions would need to be found elsewhere, for example by increasing the number of properties connected to district heat networks, or deploying more roof-mounted PV.

Since solar generation will occur in the daytime and vary between the seasons, Peterborough would still need to import from the electricity network when supply from local generation does not meet demand, and export to the network when there is excess supply. Battery storage would enable more of the generated solar to be utilised.



Zone	Capacity Installed by ESC's Model (MW_p)
Barnack and Wittering	88
Glinton and Newborough	91
East Rural	8
City South West	151
City South East	412
City North	239
Castor and Marholm	47
North East Rural	216
City East	87
City Central	11

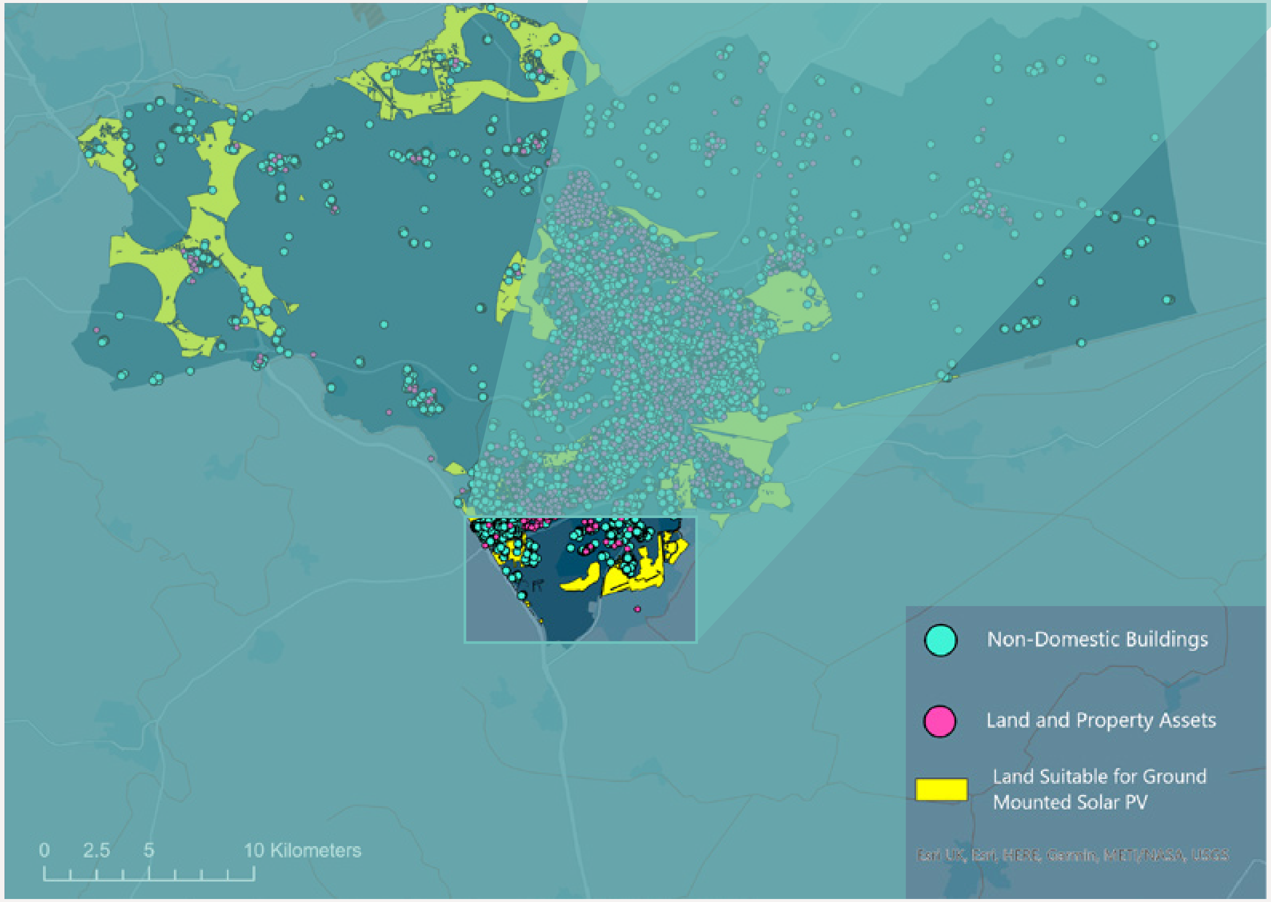
Managing Local Generation

It is not expected that ground-mounted solar would be built upon a single piece of land, but over a large number of distributed plots across Peterborough. This would enable a local energy marketplace to be created where generation assets could be matched with off-takers requiring electricity, allowing local businesses to directly benefit from the production of locally generated low carbon electricity.

The map highlights where the PCC-owned assets and non-domestic buildings are alongside land which has been deemed suitable for ground-mounted solar. As an example, there are warehouses in City South East where potentially suitable land has been identified for solar PV. These businesses could be direct consumers of the generated electricity. Similarly, buildings owned by PCC could also engage in similar contracts.

Due to the variable nature of solar, storage and flexibility could optimise the benefits realised. Battery storage could be co-located with ground mounted solar, which would reduce the land available for solar panels, but increase the value generated from the project. Co-located battery storage can also help to smooth generation and participate in grid balancing services, increasing revenue streams available.

Long term storage, such as hydrogen production and storage, could support inter-seasonal balancing and allow excess summer generation to be utilised in the winter, as well as providing a hydrogen source for harder to decarbonise industrial buildings and processes.

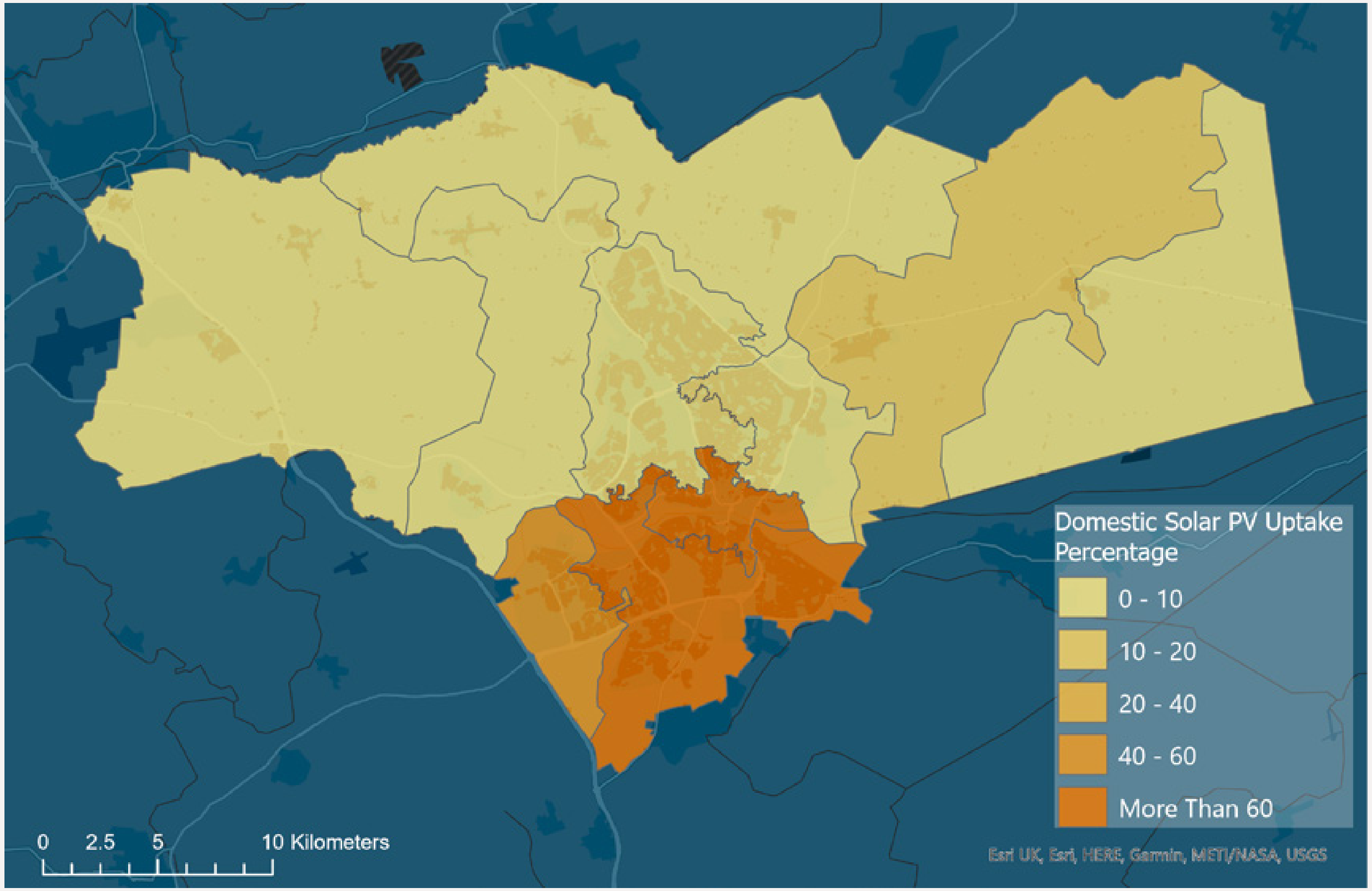


Domestic Solar PV

Although likely to be more expensive per kW generated than ground mounted solar, domestic PV makes use of roof space that would otherwise be unused and can provide direct financial benefits to householders (funding can be more complicated where the building owner is not also the bill payer). A large rollout of domestic PV is of value regardless of the net zero target date chosen and therefore is **low regret**.

Based on roof orientation and pitch, homes are identified for solar PV suitability. If fully developed, these could contribute 360MW of low carbon generation. In this plan, **157MW**
154 of this potential is built at a total capital cost of **£166 million** under the 2040 scenario. This accounts for a significant proportion of homes having already installed solar, based on available government feed-in tariff data. More of the potential could be deployed to compensate for a smaller buildout of ground-mounted solar.

The map (right) shows the percentage of dwellings in each zone where solar was deployed in the 2040 scenario. Domestic PV is more cost effective when as much of the energy generated as possible is consumed by the dwelling. It is therefore sensible to explore deploying the solar as a package in conjunction with electrified heating and transport in a home and looking at battery storage options. The economic case for batteries is likely to change rapidly with the emergence of novel incentives such as time-of-use tariffs and falling battery costs.



Domestic Solar Focus Zone

City North is a zone with relatively high levels of fuel poverty. Generating electricity on-site can reduce the requirement to purchase electricity from suppliers which can reduce costs to the household (depending on how the PV installation is paid for). The roll-out of a scheme like this could start with social housing by working with key stakeholders.

A roll-out of 7MW of solar PV could be undertaken in the City North zone under both 2030 and 2040 net zero scenarios and therefore is seen as a focus zone.

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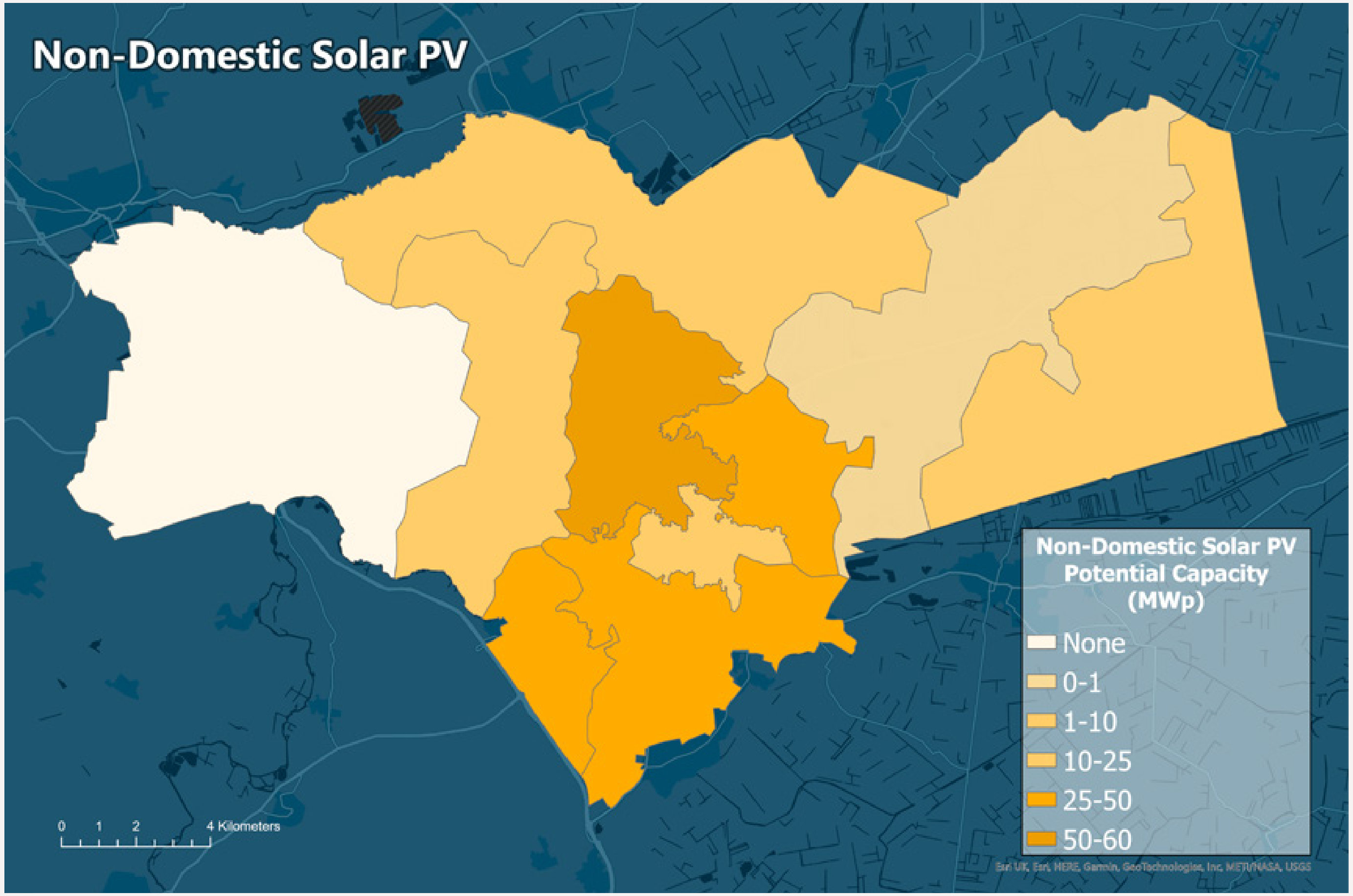
Non-Domestic Solar

Non-domestic solar installations are larger than domestic and so have the potential to be more cost-effective, although complexity can arise in realising the benefits if the building owner is not also the bill payer. Similarly to domestic, the analysis for this plan has shown that a significant roll out of non-domestic solar is a sensible part of a plan regardless of the net zero target date. These projects would therefore be low regret, and should give confidence that it is an appropriate investment. The map opposite shows a potential capacity for non-domestic solar deployment, based on available roof space and
156 assumptions about the extent to which it could be developed.

Non-domestic building construction is more variable than domestic, and it is not possible to say if a building is suitable for PV without a site survey of the roof construction, load bearing capacity and the extent to which other building services such as cooling vents are present.

Sites to target initially for further survey might be those with the largest amount of roof space available on single buildings. City North has a large number of significant educational and industrial sites, while City South West and City South East also have a significant number of factories which could be utilised.

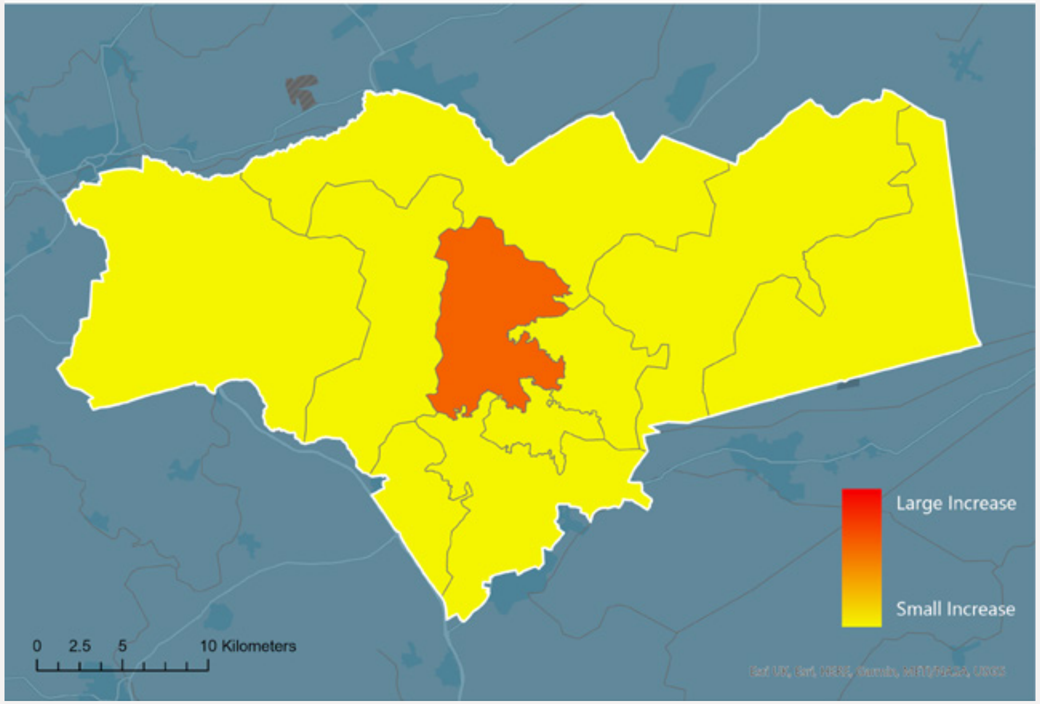


240 MW
Non-domestic solar potential

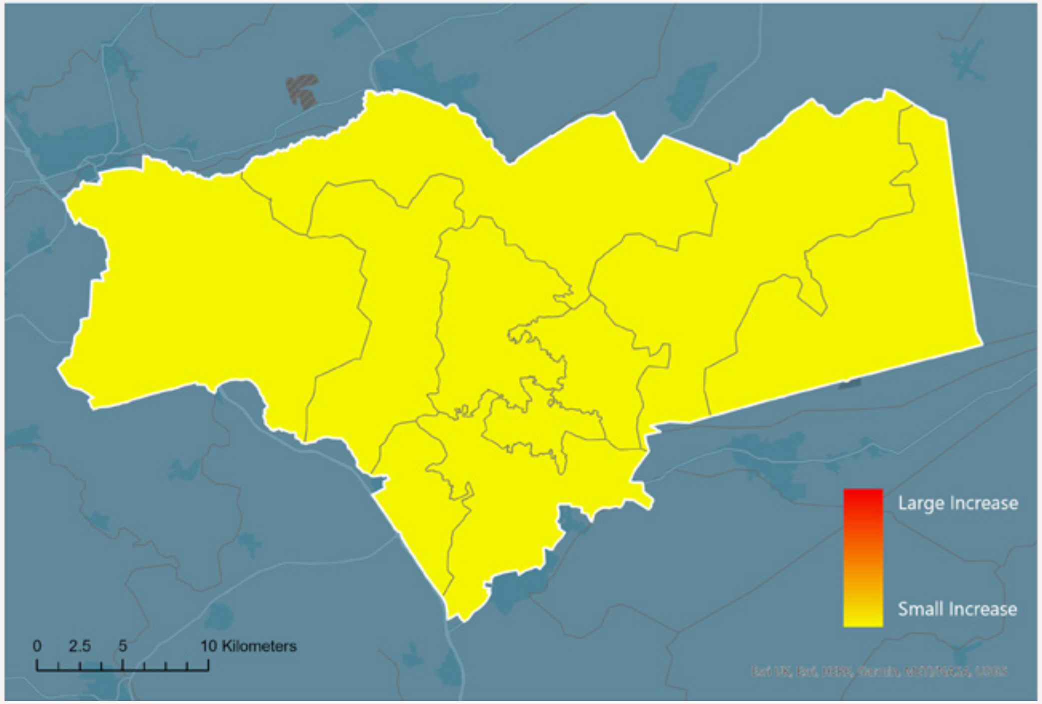
City North, South East and South West have a large number of factories with rooftop space for PV

Networks, Storage & Flexibility

Upgrading the High Voltage Network



Increases in the required capacity on the high voltage feeder network



Increases in the required capacity on the high voltage substation network

Electrification of heating and transport increases demands on the electricity networks, which will trigger a need for capacity upgrades in areas. The maps show the need for capacity increase as a proportion of the current capacity in each zone. However, this could be met through a combination of conventional investment in capacity alongside flexibility and storage, explored in following pages.

Present day capacity on the high voltage network will accommodate electrification without the need for capacity upgrade in most zones. Only in City North do we see a requirement for a large upgrade of the feeders.

The high voltage network consists of substations on land owned by the distribution network operator, supplying feeders which run to secondary substations, which in turn serve multiple streets.

Upgrading the Low Voltage Network

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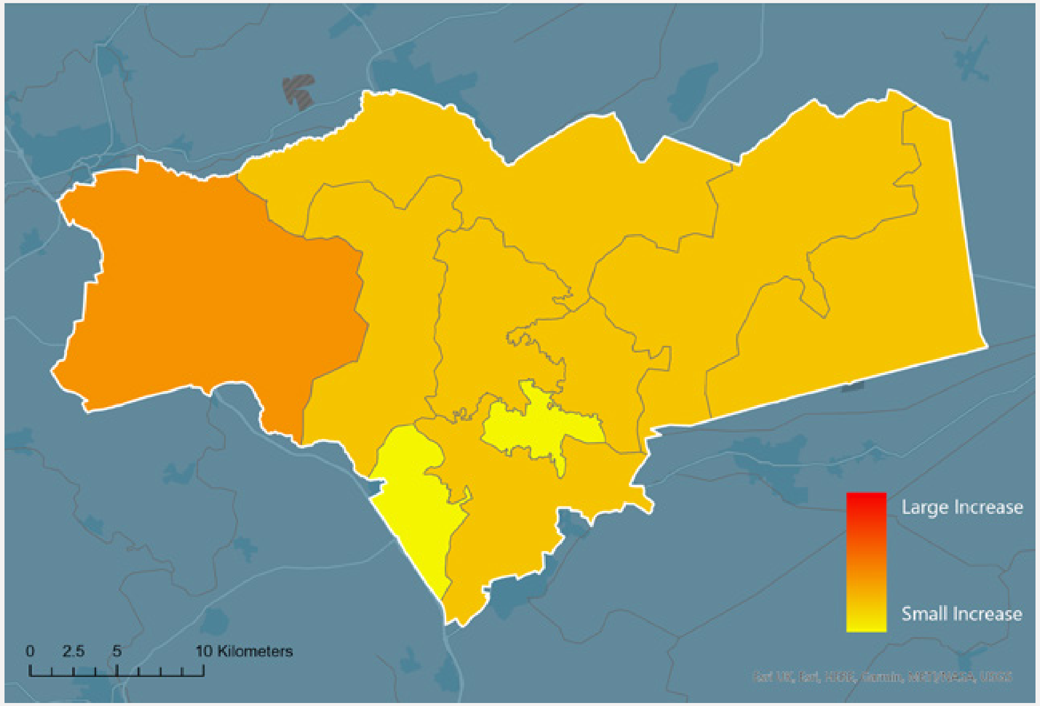
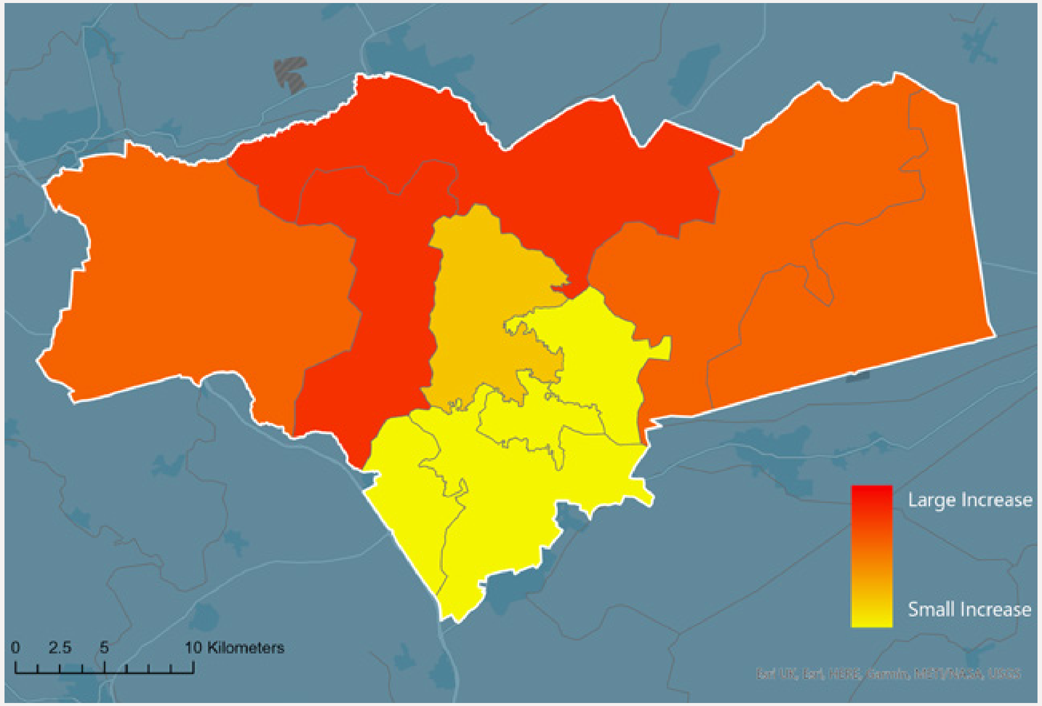


Increases in the required capacity on the low voltage feeder network



Increases in the required capacity on the low voltage substation network

The low voltage network consists of smaller neighbourhood substations, supplying feeders which run under pavements or roads to each building or on overhead wires in rural areas.

The maps show the need for capacity upgrades as a proportion of the current capacity in each zone. This part of the network sees a need for significant capacity upgrades to both substations and feeders in most zones (over 3x increase for several substations), particularly rural zones. The rural areas of Peterborough require the largest increases proportionately, compared to the urban areas which start from higher capacities presently.

This significant increase in demand is an opportunity to take advantage of flexibility. DNOs could tender for flexibility services on the market and look to delay upgrades.

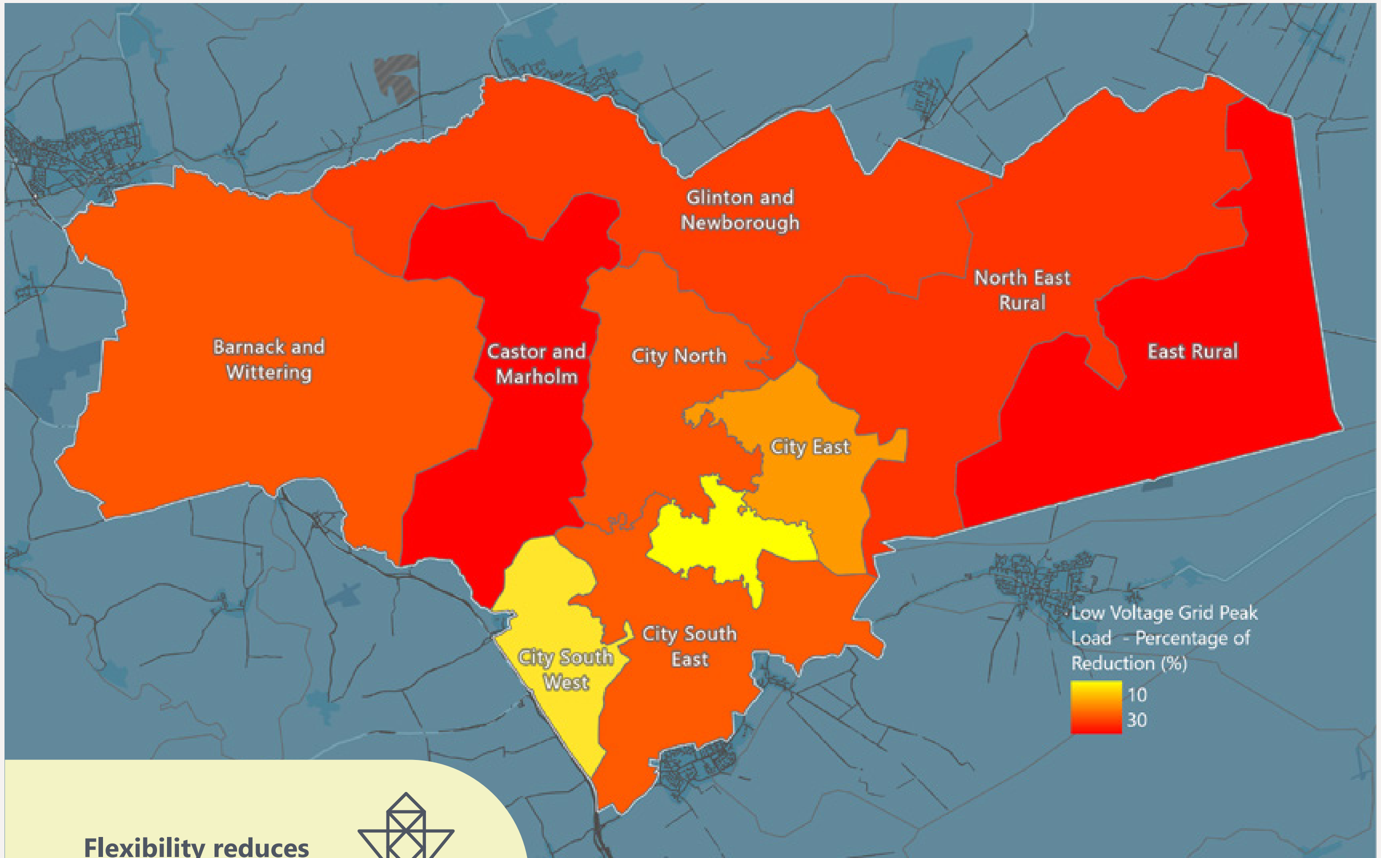
However, further work would be needed to identify solutions, aligning with the DNOs' business planning processes.

Demand Side Flexibility

Aside from the capital cost, the need for capacity upgrades discussed in previous pages could slow down the rollout of low carbon technologies. The regulatory process (i.e., RIIO) can limit the pace of investment in capacity. Flexibility provided by demand side response and storage could help to shift demand from peak times, reducing the need for capacity upgrades.

Demand shifting provided by charging EVs overnight and using large thermal stores in homes with heat pumps has been modelled to explore the benefits of flexibility. These measures were found to reduce the overall peak electrical
160 demand for Peterborough by **20%** in 2030. However, these reductions in DNO costs do not come for free and could have significant cost, and space implications for households.

Barnack and Wittering has been selected as a **focus zone** as it currently has very limited headroom. This creates an opportunity for both behind-the-meter solutions such as installing storage in homes, and in front of the meter solutions such as the DNO procuring flexibility services.



Flexibility reduces the upgrade requirement by 18MW.

Implementation

Overview of Implementation

Recognising the scale of the transition needed to support Peterborough's net zero ambitions, this LAEP is broken down into:

- Near-term components made up of "Quick Wins" which can be carried out in the near-term without major blockers. & "Low Regrets" projects which are common under various scenarios but may require further enabling action before they can be progressed
- Long-term components made up of "Enabling Actions" which need to be carried out ahead of time to pave the way for later solutions & "Decision Points" where the most appropriate solution is chosen at some point in the future once more information is known. These decision points may be needed before widespread scale-up and deployment of solutions.

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Some of these are summarised opposite which along with other components feed into The Pathway. The Pathway is followed by a series of Next Steps which highlight the aspects Peterborough should consider to progress the LAEP; working with the Key Stakeholders to determine roles in supporting the implementation of this LAEP.

QUICK WINS

- Deployment of roof-top solar on council-owned buildings and land.
- Replacement of council fleet vehicles with EVs.

LOW REGRETS

- EV charger roll-out for those with off-street parking.
- Deployment of energy efficiency measures and heat pumps in rural off-gas grid areas.
- Ground-mounted PV deployment on land of low arable quality.

ENABLING ACTIONS

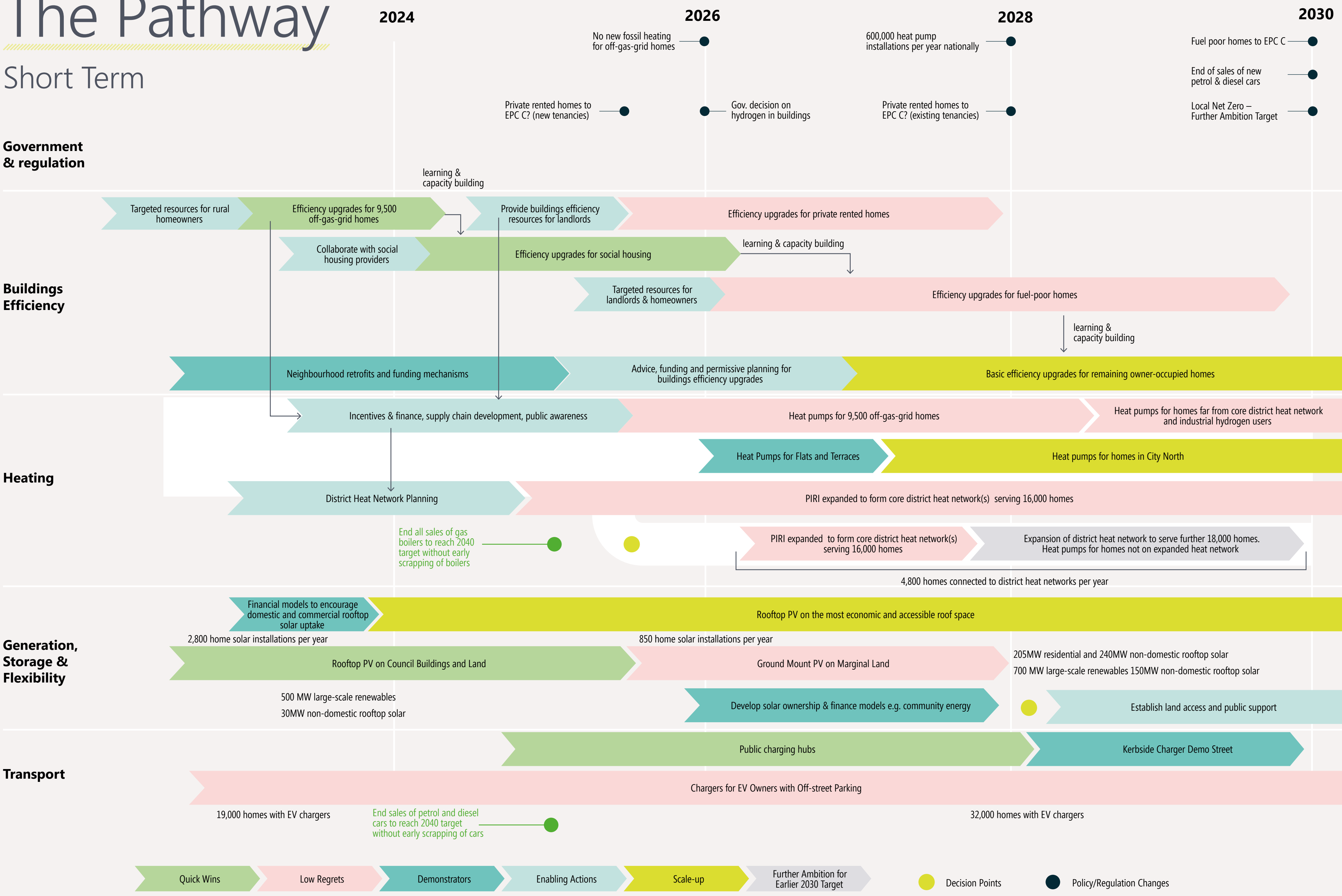
- Seek advice, funding and planning permissions for energy efficiency roll-out.
- Work with experts to plan the DHN and establish a business case.
- Collaborate with social landlords to identify dwellings for retrofit.
- Target an information and engagement campaign at rural homeowners around energy efficiency and heat pumps.

DECISION POINTS

- Scale of the district heat network: core city, or more expansive.
- Off-street EV charging by EV Hubs, kerbside charging, or something else.
- Extension of hydrogen into domestic dwellings near to an industrial use.
- Appetite politically and locally for large-scale solar and onshore wind generation.

The Pathway

Short Term



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Outline Priority Projects

In creating the LAEP, near-term projects have been identified that PCC could start the process of implementation. These near-term projects are either:

- Low regrets – are common under various scenarios but may require further enabling action before they can be progressed.
- Quick wins – are carried out in the near-term without major blockers
- Focus zones - are specific areas within the LAEP boundary that have a cluster of near-term components

The purpose of identifying specific outline priority projects is to provide PCC with projects that can immediately be implemented to make progress
165 towards net zero. The following section specifies details of these near-term projects, including details such as locations and financial information

PCC Projects: Social Housing

North of Peterborough City Hospital, the Ravensthorpe area of Peterborough has a large number of social houses. Some of these houses are suitable for rooftop PV.

South of the Highlees Community Primary School is a large number of social houses which have been proposed for retrofit.

South of Hartwell way, there is a cluster of social houses which are proposed for rooftop PV. This is based on rooftop orientation – some of these homes will already be fitted with PV, which will need to be established at the address level.

Areas such as these, with a high concentration of dwellings of the same archetype, are ideal for PCC to begin low-regret and quick win projects.

PCC Projects: Schools

City North has several schools with a large area of roof space that are suitable for solar PV installations. Schools are reasonable candidates for solar PV as they are used during the day, however, the high-generation period of the year is typically during the summer holiday when the school is not in use. Yet, solar PV installations will reduce their electricity import requirements, thus reducing their electricity bills and also reducing their carbon emissions.

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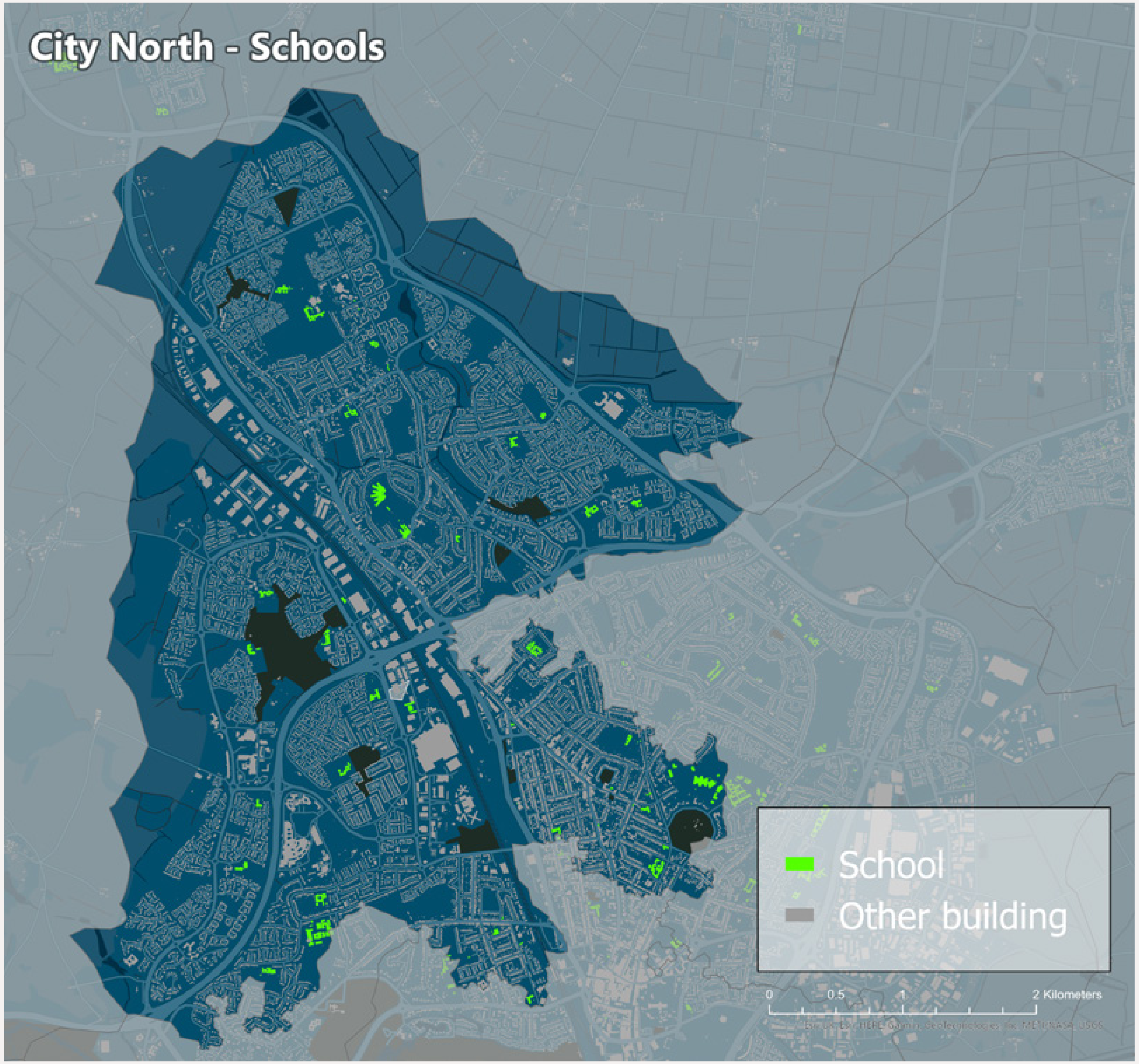
Previous Public Sector Decarbonisation Scheme (PSDS) assessments for schools align well with this plan for the most part – assuming PCC ownership – typically focussing on PV and heat pumps. However, co-ordination is needed for schools in areas suitable for heat networks, to ensure plans align and opportunities to join heat networks are not missed. For example, Beeches and Bewster schools near the city centre have PSDS assessments based on individual heat pump installations, but would be prime candidates for district heat connections in this plan.

Schools could also integrate other assets such as batteries and work with local flexibility markets to help optimise the balancing of supply and demand locally. Feasibility studies would need to be undertaken on each site to understand the exact potential.



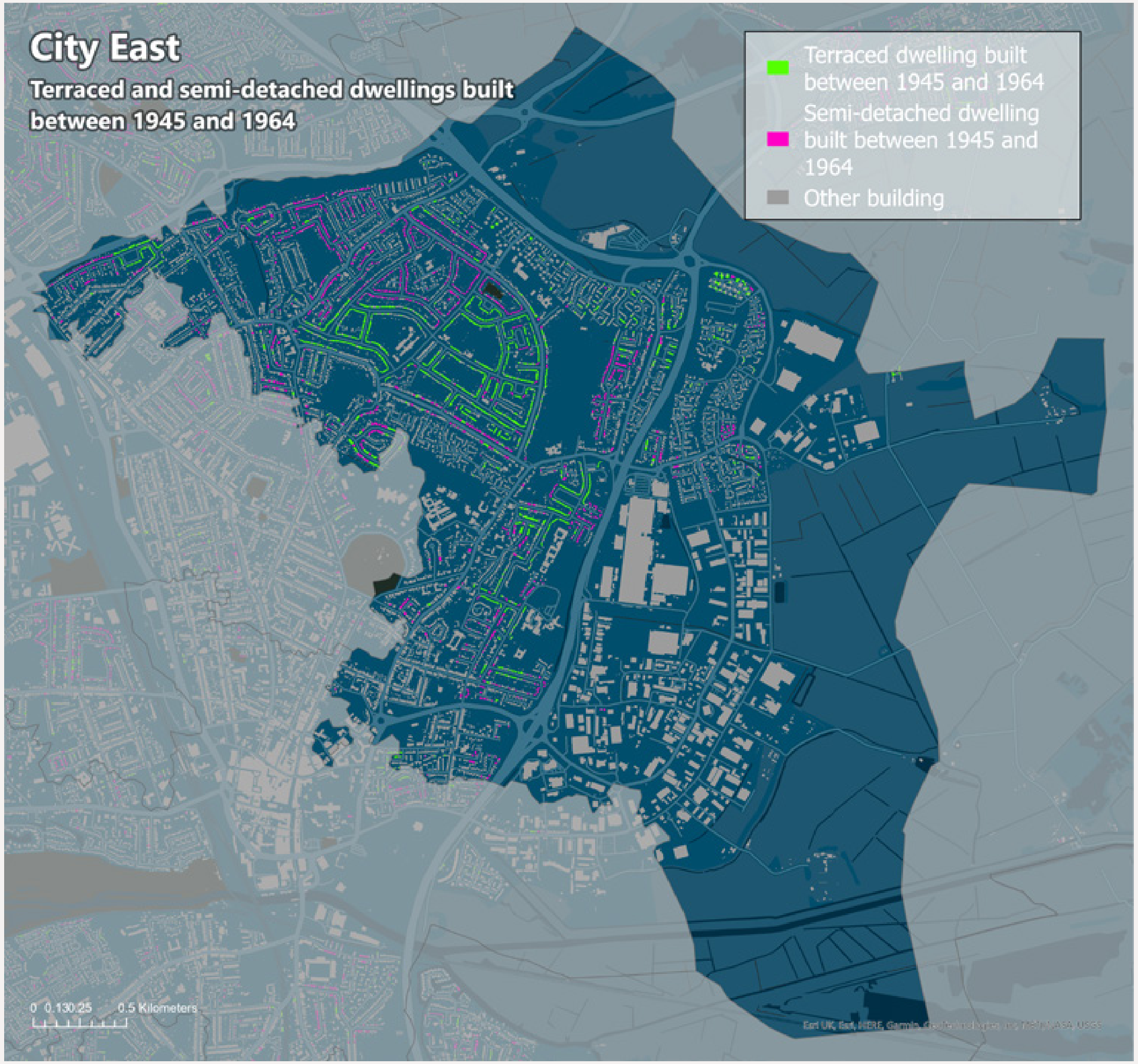
Domestic Retrofit in Fuel Poor Areas

City East has one of the highest levels of fuel poverty in Peterborough (~20%). The Local Authority Delivery scheme, Energy Company Obligation, and Social Housing Decarbonisation Fund* could provide a portion of funds for retrofit in theses areas where appropriate.

Around 1,400 semi-detached dwellings which were built between 1945-1964 can be retrofitted with basic measures at a cost of £2.2m. Many of these dwellings are located in Garton End.

Approximately 1,000 terraced dwellings built between 1945-1964 can be retrofitted with basic measures at a cost of £1.6m. These are mostly near Dogsthorpe in the north west of the zone.

Further survey work is required to assess the dwellings to undergo retrofit.



Note: Highlighted dwellings are post-war terraced and semi-detached dwellings in an area with relatively high fuel poverty; the household themselves may not be classified as fuel poor.

* https://www.gov.uk/government/publications/sustainable-warmth-protecting-vulnerable-households-in-england/sustainable-warmth-protecting-vulnerable-households-in-england-accessible-web-version

Domestic Retrofit

Basic retrofit projects in fuel poor areas are low-regret options. For rural, off-gas areas, the Home Upgrade Grant* scheme can provide funding for low income households with inefficient homes.

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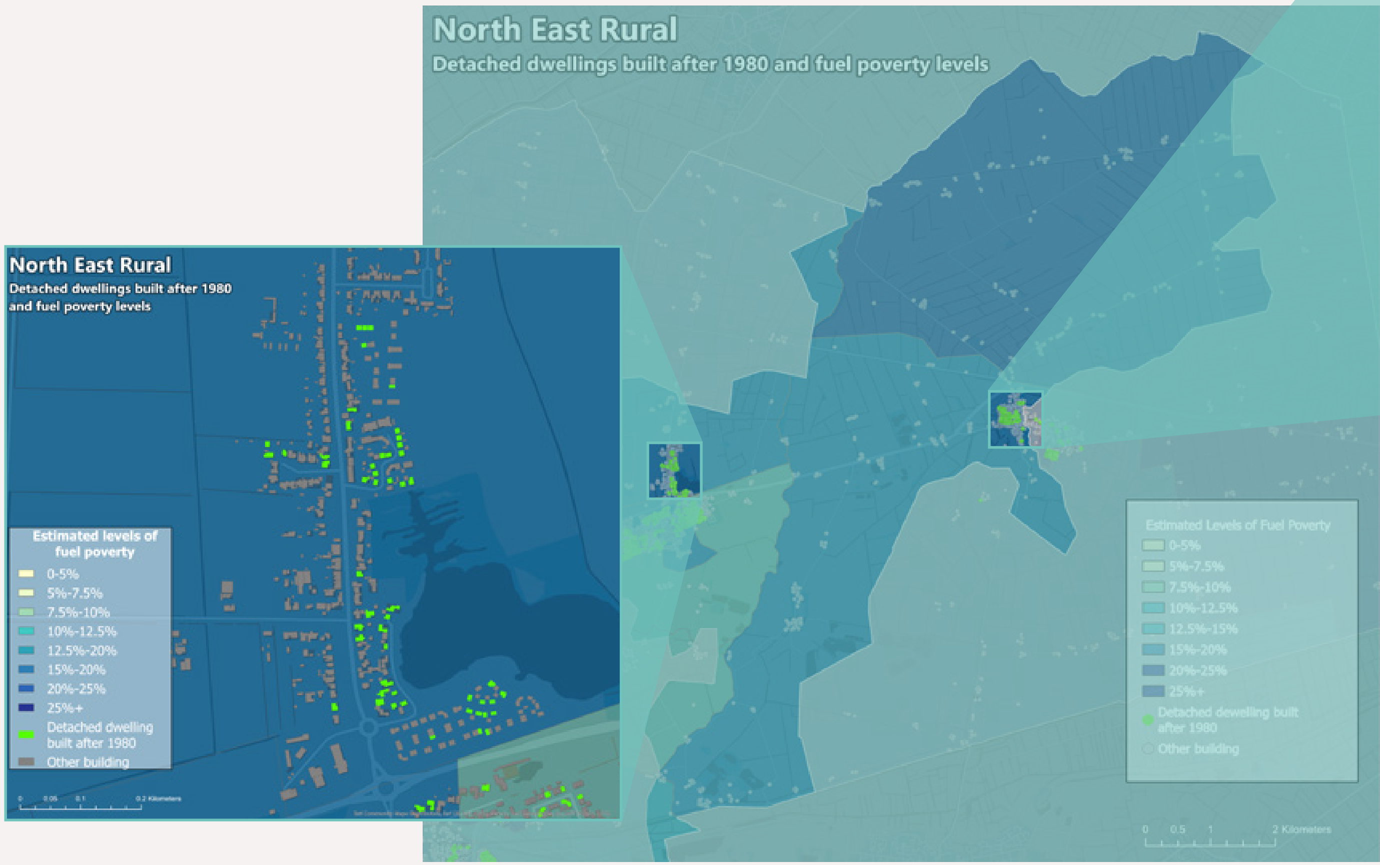
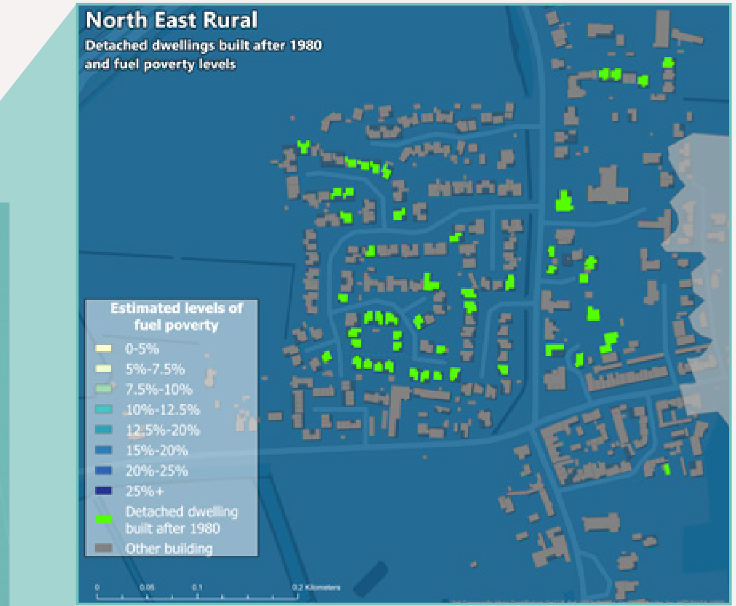




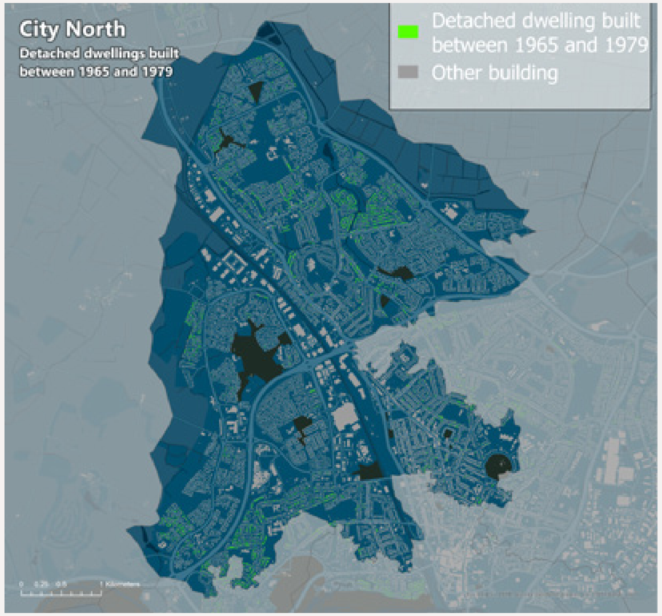
Detached homes built after 1980 may be suitable for loft insulation top-up and/or cavity wall insulation.

Zone	North East Rural
Building Type	Post-1980 detached
Number of homes	c. 425
Total Cost	£630,000

Note: Highlighted dwellings are post-1980 detached dwellings in an area with relatively high fuel poverty; the household themselves may not be classified as fuel poor.

* https://www.gov.uk/government/publications/sustainable-warmth-protecting-vulnerable-households-in-england/sustainable-warmth-protecting-vulnerable-households-in-england-accessible-web-version

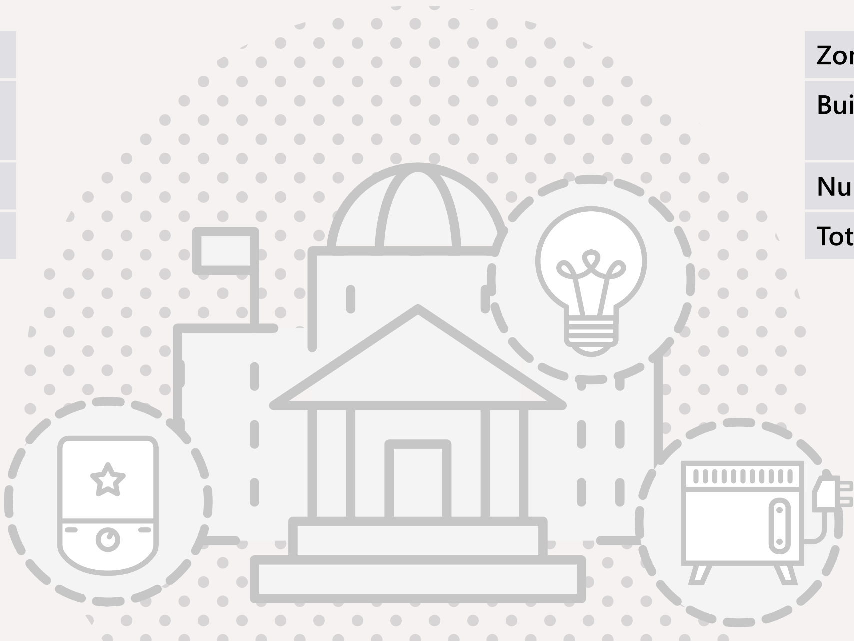
Domestic Retrofit

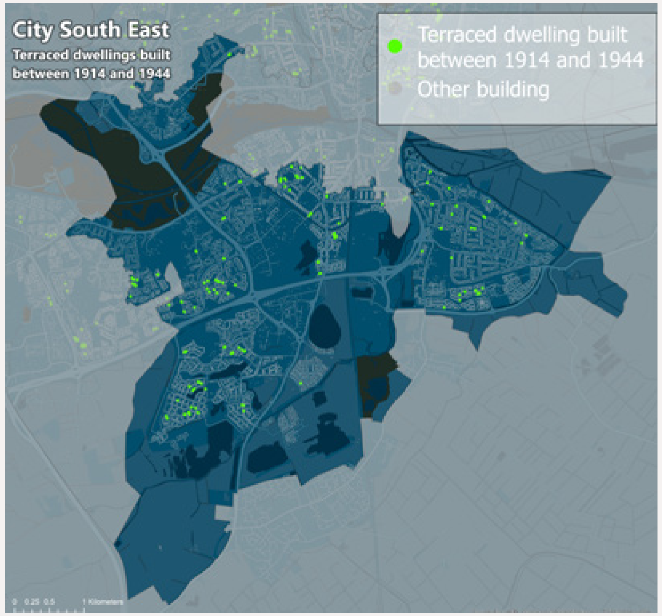


Zone	City North
Building Type	Detached dwellings built between 1965-1979
Number of homes	c. 1,250
Total Cost	£2m

A large number of homes in these areas are private rental or owner-occupied. Work can be undertaken in partnership with residents and landlords to help realise energy efficiency savings through the installation of basic retrofit measures such as cavity wall and loft insulation. Various delivery mechanisms can be tested and best practises can be developed for wider adoption in the area.

Social Housing	Prioritise assets which are in direct control to develop supply chains.
Delivery Mechanism	Develop scheme to demonstrate value of delivery mechanism such as Energisprong





Zone	City South East
Building Type	Terraced built between 1914-1944
Number of dwellings	c. 120
Total Cost	£195,000

Domestic PV

Specific homes to be targeted for such projects can be decided based on a number of socio-economic factors e.g. fuel poverty, and further feasibility studies should be undertaken to fully understand options and potential benefits to individual households. Site surveys will also be required to identify limits based on localised DNO restrictions. For example, some dwellings identified would have a peak capacity of over £3.68kW and therefore would require an application to be submitted.

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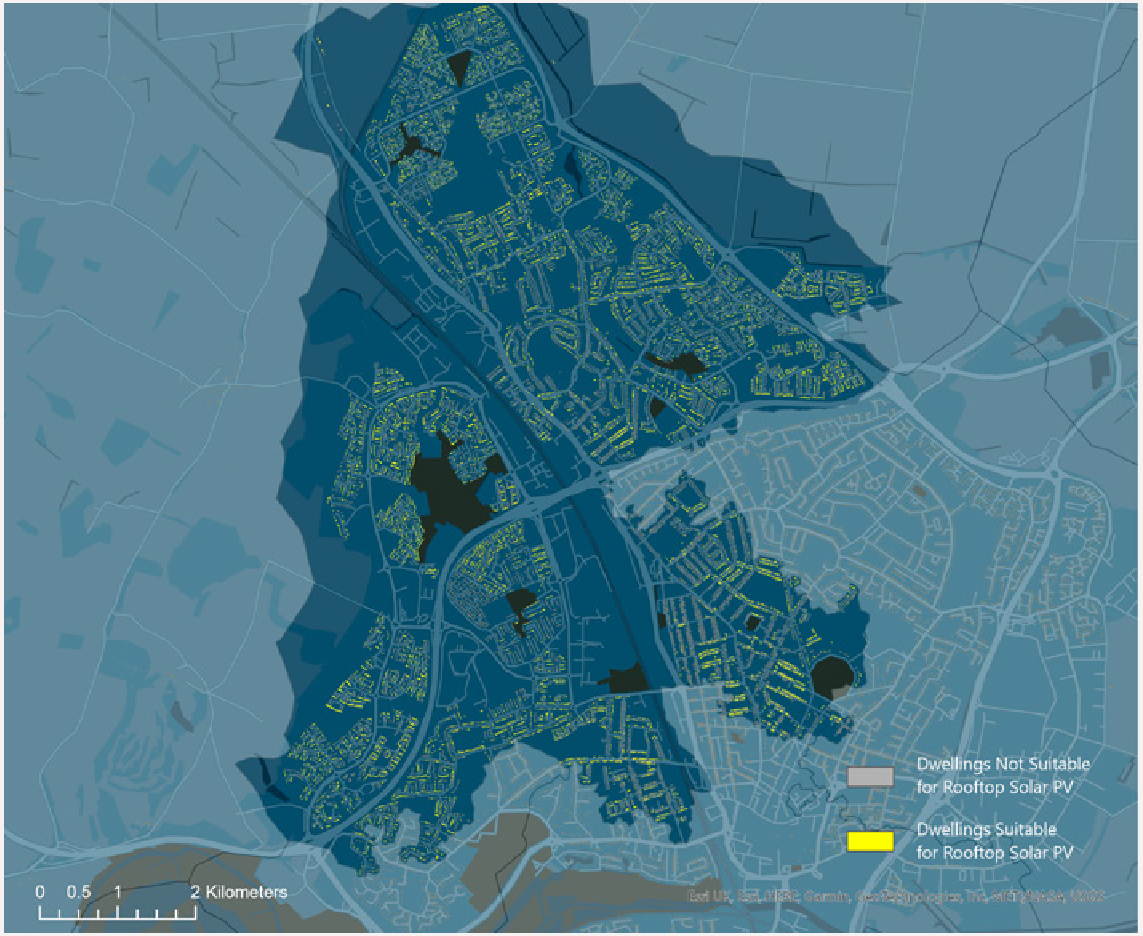
Fuel Poverty	Prioritising fuel poor areas to reduce bills
Social Housing	Supporting roll-out in owned assets
Solar Together	Supporting community buying programmes to reduce cost

Zone	City North
Size	83,550m²
Number of homes	c. 2,275
Total Cost	£19.6m



City North dwellings suitable for solar PV

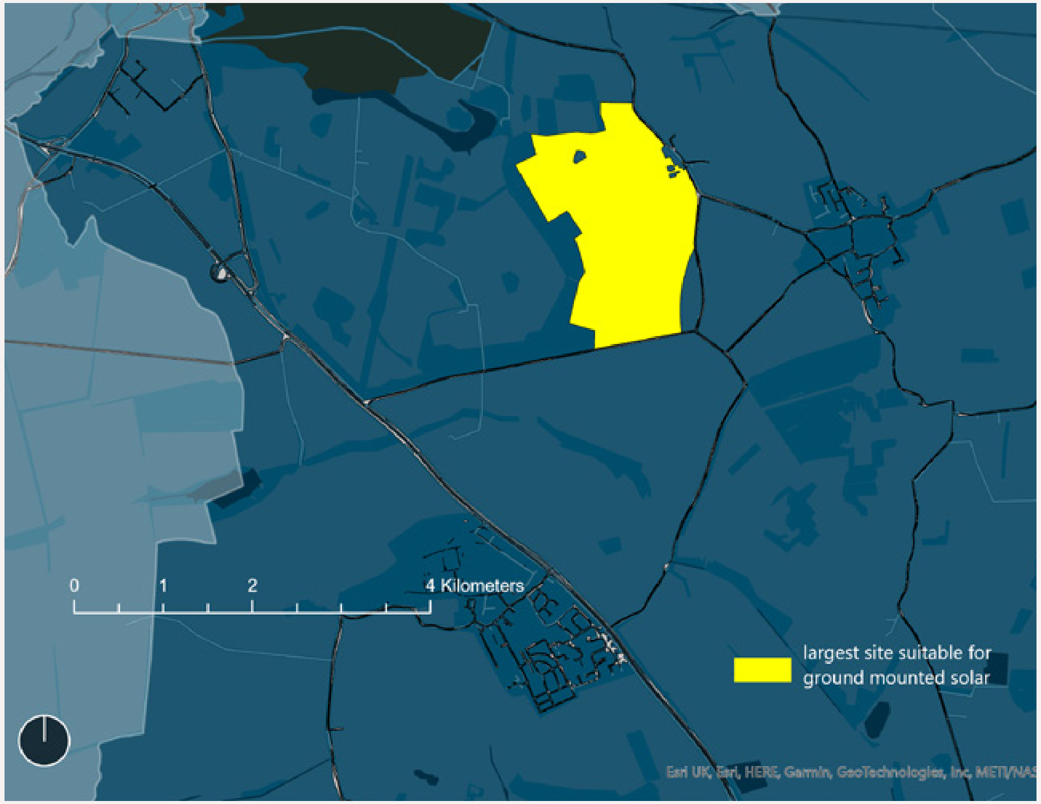
Commercial PV

Zone	Barnack and Wittering
Size	10MW
Total Cost	£9m to £12m
IRR	Up to 9%
Payback period	Around 10 years

This 125.5 hectare site in Barnack and Wittering is a potential site for ground-mounted PV, with potential for an array of up to 75MW. An array of this size would be one of the largest in the UK, hence, it is expected that a smaller array would be deployed then potentially expanded over time.

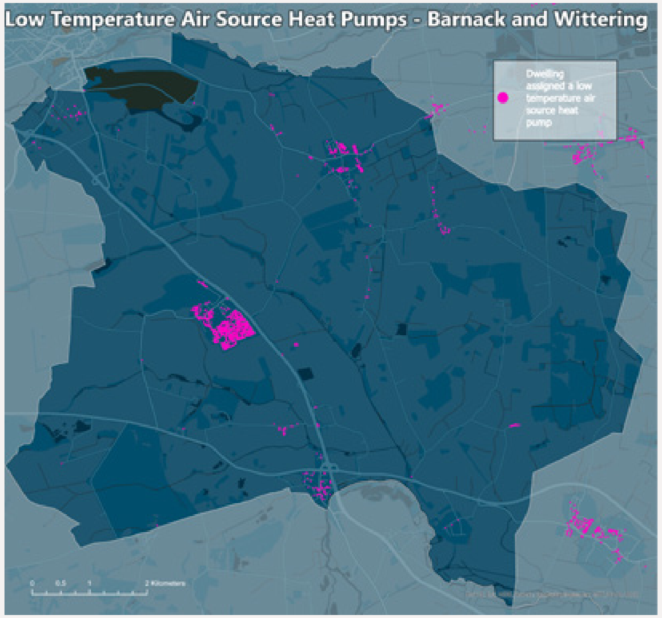
As an illustration, a 10MW solar PV array would cost in the region of £9-12m and have a best-case basic payback period of around 10 years (assuming a 10p/kWh power purchase agreement).

Options: Highlighted in the table opposite are ways in which land owners can create value, depending upon their risk appetite.



Project Development	Local authority owns the land and builds a project on it.
Investor	Local authority partners with an organisation and jointly invests.
Land Lease	Local authority leases the land it owns for others to develop ground mounted PV.
Energy Off-Taker	PCC, via power-purchase-agreements, can secure low-cost electricity with low associated emissions counting towards their footprint.
Energy Off-taker - Utilities	Via a power purchase agreement (PPA), a utilities company can be an off taker of all or some of the generation.

Air Source Heat Pumps



Zone	Barnack & Wittering
Number of homes	c. 1,100
Total Cost	£9.1m

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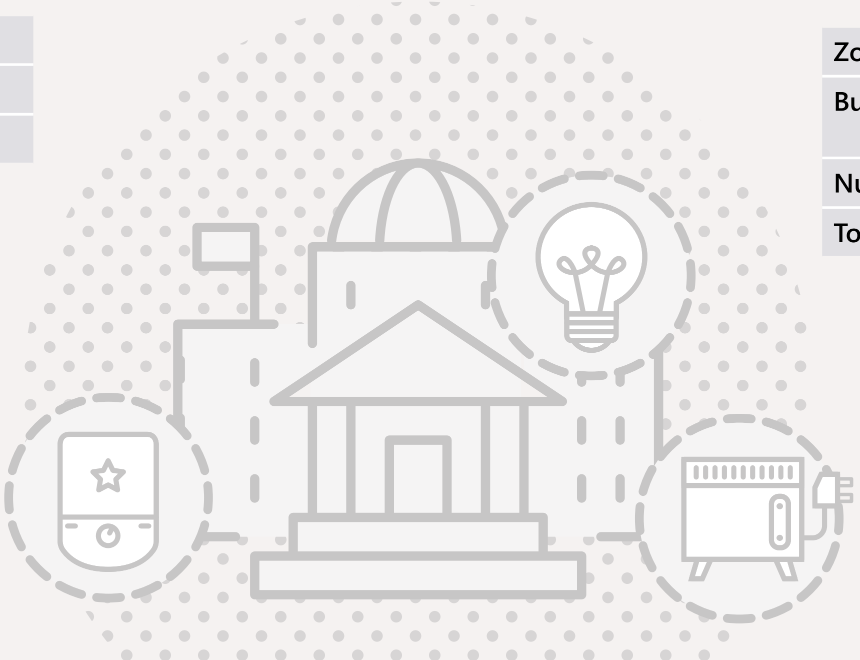
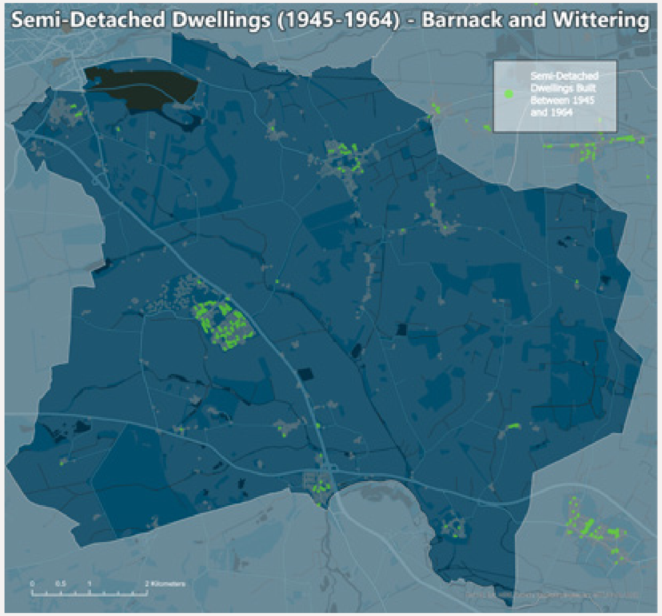
Air source heat pumps are an extremely efficient low carbon technology which can provide the heating requirements for residents and businesses.

Circa 1,100 homes in Barnack and Wittering are proposed to have their heat decarbonised via low temperature ASHP, and on the right we highlight a particular project that could support that endeavour.

Funding	Local Authority can help in funding mechanisms for roll-out of heat pumps
Skills	Local Authority can support the up-skilling of personnel required to deliver projects





Zone	Barnack & Wittering
Building Type	Semi-detached built between 1945-1964
Number of homes	c. 175
Total Cost	£1.4m

District Heat Networks (DHN)

These two proposed networks represent a combination of domestic and non-domestic buildings. The City Central zone is heat dense i.e. buildings requiring heat are closely packed therefore requiring less piping between heat loads which keeps the cost lower. Flats and non-domestic buildings can act as great anchor loads for a heat network, strengthening the business case.

Further work would need to be conducted to assess the feasibility of connecting the buildings.

City Central	Total Peak Demand (MW)
DHN 1	0.9
DHN 2	1.0

Owner	The LA can own the asset and generate a return on investment.
Off-taker	The LA can be a consumer on the network.

The map above shows non-domestic buildings (yellow), flats (green), terraces (blue), semi-detached (turquoise) and detached (pink) buildings.

Next Steps

Taking LAEP Forward: Next Steps

The Local Area Energy Plan for Peterborough has highlighted initial 'low regret' outline priority projects for consideration. In order to take these projects forward and assess the role Peterborough City Council (PCC) wishes to play in the future low carbon system, ESC has developed an initial approach illustrated on the following page.

Prioritise

The first stage recommends PCC works to prioritise the projects identified within the LAEP and commissions desktop feasibility to assess their viability in meeting the councils aims and objectives. Prioritisation of the LAEP projects should be influenced by what is currently within the PCC's direct control, for example social housing or land assets owned by the council. Projects should then be assessed in line with PCC's own regional targets to assess impact on fuel poverty, air quality, local economic growth plans etc.

Prioritisation should also include understanding the role PCC wishes to play as regional decarbonisation projects are further developed. For example, PCC could work with a partner organisation to assess its risk profile, its desired role in any future energy system and then look to match outcomes against different types of local energy business models.

Prioritised projects should subsequently undergo desktop feasibility to assess their viability and to understand the low carbon interventions and renewable technologies required in further detail. This could include sizing commercial renewable technologies, assessing co-located storage options, consideration of network connection requirements and an initial outline business case.

Assess

In the next phase of energy project development, various options can be assessed with the aim of exploring investible delivery mechanisms. Dependent on project type, a partner organisation with experience of innovative business modelling can assess how technologies can be connected and delivered to residents in a way that matches the risk profile of PCC and the role they wish to play. This could include assessing different types of Smart Energy Tariffs that incorporate costs for retrofit for social housing, exploring ways for PCC to invest into infrastructure projects while ensuring commercial revenues are secured or assessing business models where PCC are an off-taker or customer.

Connect

Further consideration should be given to how technologies and projects can be connected together through Smart Local Energy Systems, which can aggregate to unlock private investment and create numerous co-benefits. Once a firm Capital Investment Plan has been formed and initial sources of investment and funding have been identified, the Design phase needs to firm up assumptions made dung desktop feasibility. This involves working with partner organisations with engineering expertise to assess spatial, planning and structural considerations. Connection costs should be fully understood and a finalised capital investment plan produced.

Engage

Engagement is another key part of taking outline priority projects identified in the LAEP forward. Key stakeholders need to be identified and consideration should be given to how residents are consulted and bought into the potential benefits of decarbonising homes and estates. A partner organisation with strong digital engagement experience and relationships with network operators can support this process.

Unlocking Investment

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PRIORITISE

- Prioritise LAEP outline priority projects where assets are owned by PCC
- Assess largest CO_2 emission benefit across outline priority projects
- Assess outline priority projects against regional targets (fuel poverty, air quality etc)
- Assess risk profile and role of PCC as investor/ facilitator/ off-taker

ASSESS

- Undertake desktop feasibility to understand;
  - Granular low carbon intervention costs for retrofit
  - Update EPC surveys for social housing
  - Size commercial renewable technologies and assess co-located storage
  - Assess network impact and costs
  - Develop business case

CONNECT

- Assess business model delivery routes including;
  - Domestic PPA & Smart Energy Tariffs for social housing solar PV/battery storage
  - Assess whole house retrofit energy performance contracts for social housing
  - Assess models for district heat inc. Heat as a Service
  - Consider connecting projects into Smart Local Energy Systems to aggregate for investment
- Identify funding sources and develop capital investment plan

ENGAGE

- Identify critical stakeholders needed to deliver priority projects
- Engage stakeholders to include;
  - Network Operators
  - Local Residents
  - Community Energy Groups
- Engage investors

DESIGN

- Undertake engineering design to assess;
- Planning considerations
- Spatial requirements
- Structural considerations
- Grid connection costs
- Project design to RIBA Stage 3
- Update capital investment plan

Energy Systems Catapult is well placed to help Peterborough City Council and other stakeholders with these to move from LAEP towards design and delivery.

Stakeholders

Risks

There are risks and benefits associated with each of the technologies and options presented in this LAEP. Because of these, Peterborough's actual transition is expected to vary from what has been presented. Therefore, before making any widescale and significant commitment to one option or technology over another, evaluation of multiple factors will be needed. The key risks associated with this LAEP are summarised below. Consideration of these aspects during implementation must be reflected as outcomes may necessitate an update to this LAEP, in addition there may be additional market, policy and regulatory change that could also result in a need to reconsider aspects of the pathway and LAEP.

Risk	Description	Mitigation
Domestic and non-domestic heat decarbonisation using hydrogen	The LAEP is based on projected figures for hydrogen availability, carbon content and cost; these have influenced the heat pump and heat network focus in a number of zones	Focus zones of least regret identified for heat pump and district heating; moving forward, consideration of UK heat strategy and Cadent plans will be needed before planning wider scale-up
Domestic heat decarbonisation and resident acceptance	Transitioning away from fossil gas boilers to heat pumps or district heating will require innovative solutions to overcome resident acceptance of solutions that are more expensive to purchase and potentially disruptive	Focusing implementation in off gas grid areas reduces risk associated with picking a technology type, where heat pumps would be a low regret solution. These areas could be used to test models and approaches that appeal to residents before considering wide scale up
Level of district heating	The rationale of transitioning large numbers of homes to district heating is based on the ability to cost effectively provide districting heating systems in comparison to other options. This LAEP has only been able to consider the effectiveness of the proposed district heating areas at a high level, where more detailed consideration will be needed	Considering domestic areas around the PIRI project, which could potentially be extended, reduces risk, although further detailed heat network assessment would be required in this instance and for any other areas
Level of local generation (solar PV)	The significant proposed level of Solar PV is most effective at reducing carbon in the earlier years of the plan and therefore presents many considerations; recognising that it is primarily related to the requirement to cost effectively reduce carbon emissions ahead of the decarbonisation of grid supplied electricity	Further consideration of the benefits to Peterborough, potential operating models, system design (e.g. considering smart local energy systems), land use and whether large volumes of locally generated renewable energy should be exported to the grid
Non-domestic buildings and suitable solutions	The decarbonisation options that have been assessed are based on high level information regarding the buildings, their energy systems and the operation/processes of the site. More detailed information will be required to refine preferred solutions	Identify an approach to better understand non-domestic buildings and preferred solutions, potentially targeting the City East area where a high proportion of industrial site types have been identified; this could also inform consideration of hydrogen to this area

Risk	Description	Mitigation
Practicality and disruption associated with heat decarbonisation	Both heat networks and heat pumps can work in most of the building types in Peterborough, however, replacing gas based boilers with these options presents challenges; for example, installation costs and the potential disruptive internal works associated with adapting/changing the heating distribution system	Focusing any transition away from gas in the identified areas of least regret; aligning with the associated hydrogen based risk. In addition, consider any wider roll out once UK heat strategy is in place
Social and community benefits and impacts	Each heat decarbonisation option results in varying benefits and impacts; for example, heat pumps could result in lower energy bills than a hydrogen or heat network system but the installation cost would likely be notably greater without policy intervention	Use socio-demographic indicators when considering implementation; alongside targeting where corresponding whole home based solutions, such as providing deeper retrofit and domestic solar PV systems can best support those residents in most need
Funding and investment	The LAEP has not considered how identified interventions will be funded.	Peterborough will need to work with regional partners and central government to identify potential funding routes
Ability to rapidly scale and implement measures; considering supply chain and impacts of implementation rates	The ability to achieve a net zero target ahead of the UKs 2050 target will require the scale up and deployment of measures far beyond anywhere near current or historical rates; in addition, the benefit of measures (e.g. solar PV) also depends on the ability to install extremely quickly and at highly ambitious scales	Consideration of the corresponding projections for implementation will be needed to determine if and how ambition can be met.

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