GREATER MANCHESTER
LOCAL ENERGY MARKET
DOING THINGS DIFFERENTLY FOR THE ENVIRONMENT

Local Area Energy Plan

Manchester, Greater Manchester

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Context

Greater Manchester (GM) is committed to achieving carbon neutrality by 2038. To support this, it has a vision of each of its districts transforming their infrastructure, homes and buildings to be part of a smarter local energy system. Recognising the climate emergency, national Net Zero[*] commitments and the need to translate the strategic vision to an implementable plan of action, Greater Manchester is supporting each district in the development of a Local Area Energy Plan (LAEP).

This LAEP aims to define the extent of the transformation needed across each district (including a focus on identifying first steps to progress), and provide a robust evidence base and plan to help engage businesses and citizens in accelerating towards the GM carbon neutral goal and Manchester's net zero goal.

Local Area Energy Planning

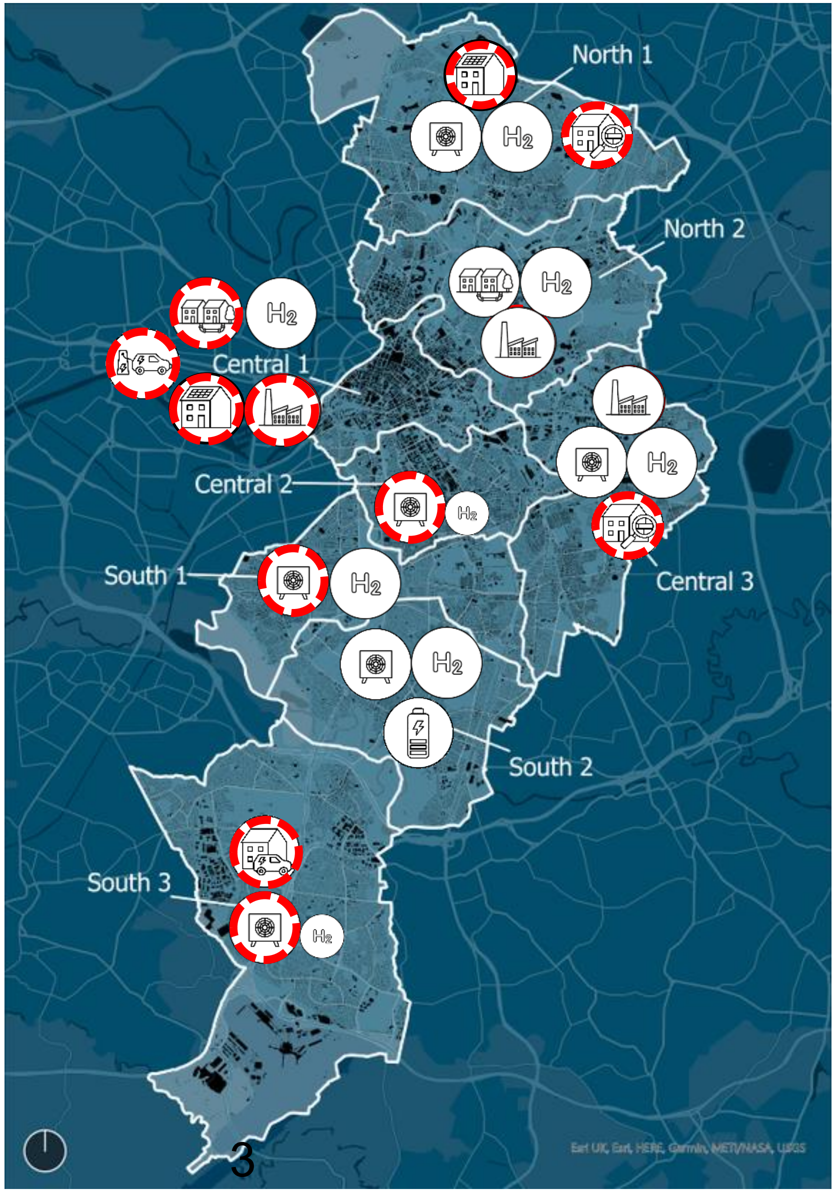
Energy Systems Catapult (ESC) developed the concept of Local Area Energy Planning (LAEP) as a mechanism of applying a whole system approach to the planning and design of Net Zero Local Energy Systems. The technologies and future trends considered and assessed for meeting Greater Manchester's carbon neutrality targets include: thermal insulation, heat pumps, district heating, electric resistive heating, hydrogen boilers, solar photovoltaics (PV), wind turbines, hydropower, electric vehicles (EVs), demand flexibility and energy storage.

Scenarios for achieving Carbon Neutrality in Manchester

The two scenarios which have been more deeply analysed to inform this LAEP are:

- **Primary Scenario – Leading the Way:** this scenario focuses on meeting the carbon budget and carbon neutrality target by making use of **measures within Manchester's local control** where at all possible.
- **Secondary – An Alternative Future Local Energy Scenario:** we have assumed hydrogen options for residential heating and non-domestic buildings becomes available in Manchester from 2030 onwards (aligned to HyNet Phase 3[†]) and the repurposing of the gas grid to hydrogen as an option.

[*] Climate Change Act 2008 (2050 Target Amendment) Order 2019
[†] HyNet North West is being delivered by a consortium of partners, each of which will lead a different part of the project. Progressive Energy is leading the development of the low carbon hydrogen production plant and the CO_2 pipeline, while Cadent is leading development of the hydrogen pipeline



Local Priorities and Measures

Manchester has been geographically sub-divided into 8 areas for the purposes of modelling and to understand what is needed for decarbonisation at a more local level. These divisions have been made along the 33-11kV substation boundaries, grouped into roughly equal numbers of dwellings.

The map opposite shows the 'First Steps Priority Areas' and 'Long Term Deployment Areas' that have been identified for different areas within Manchester. This is based on a synthesis of the results from the two scenarios alongside other considerations such as network constraints.

Long-term Deployment Areas

- Heat pump prevalent zone
- Hydrogen for heat opportunity area
- Non-domestic opportunity area
- District heat prevalent zone
- Flexibility & storage opportunity area

First Steps Priority Areas

- Retrofit priority area
- District heat priority area
- Home EV charging priority area
- Heat pump priority area
- Solar PV priority area
- EV charging hub priority area

1. INTRODUCTION

Context

Greater Manchester is committed to achieving carbon neutrality by 2038. To support this, it has a vision of each of its districts transforming their infrastructure, homes and buildings to be part of a smarter local energy system. Recognising the climate emergency, national Net Zero[*] commitments and the need to translate the strategic vision to an implementable plan of action, Greater Manchester is supporting each district in the development of a Local Area Energy Plan (LAEP). This aims to define the extent of the transformation needed across each district (including a focus on identifying first steps to progress), provide a robust evidence-based plan to help engage businesses and citizens in accelerating towards the carbon neutral goal. Manchester City itself has committed to a more ambitious target of net zero by 2038 as outlined in the Zero Carbon Framework.

Energy Systems Catapult developed the concept of Local Area Energy Planning (LAEP) as a mechanism of applying a whole system approach to the planning and design of Net Zero Local Energy Systems. Bury was one of the first Local Authorities in the country to work with Energy Systems Catapult, Electricity North West (ENWL) and Cadent in piloting a data-driven whole system approach in 2018. Since this initial pilot, Greater Manchester has launched its Five-Year Environment Plan, which includes a commitment to be carbon neutral[†] by 2038, and an accompanying science-based carbon budget. Alongside this, there have been significant updates to the supporting whole system modelling approach, including the latest technology attributes and costs, updated building data and network data, changes in EV uptake projections and more detail in options for decarbonising non-domestic buildings. The most significant update has been the addition of hydrogen in line with HyNet[‡] projections, as an option that in certain scenarios can be used to decarbonise heat demand in domestic and non-domestic buildings. This is key as achieving carbon neutrality will require the transition of Manchester's heating systems from natural gas fired boilers to electrified heating systems, district heating networks or converting the gas network to hydrogen.

Modelling Approach

We have used the ESC-developed EnergyPath Networks tool to produce a series of future local energy scenarios for Manchester (these are discussed in the Technical Annex). This tool seeks to develop a full range of decarbonisation options for the local area and then use an optimisation approach to identify the combination that best meets the carbon ambitions in a cost-effective way across the whole system.

For the impact of the energy system outside of the boundaries of Manchester, the national Energy System Modelling Environment (ESME) – an internationally peer-

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[*] Climate Change Act 2008 (2050 Target Amendment) Order 2019
[†] Carbon neutrality is defined by the Tyndall Institute's study for GM as below 0.6 Mt CO_2/year across GM
[‡] HyNet North West is being delivered by a consortium of partners, each of which will lead a different part of the project. Progressive Energy is leading the development of the low carbon hydrogen production plant and the CO_2 pipeline, while Cadent is leading development of the hydrogen pipeline

reviewed national whole energy system model – has been used to identify the lowest-cost decarbonisation scenarios for the UK energy system to then feed into the local modelling.

These scenarios have been used to inform the development of a primary and secondary scenario that illustrate a potential cost effective vision for carbon neutrality in Manchester. These explore the actions and investment needed in different areas of Manchester between now and 2038 to reduce its emissions in line with Greater Manchester's ambitions for carbon neutrality. The scope of emissions in this plan covers those resulting from domestic, industrial and commercial consumption of electricity, gas & other fuels; home charging of personal electric cars; and process emissions from large industrial installations. Out-of-scope are emissions from agriculture, all usage of liquid fuels for transportation, and electricity use for vehicles other than personal cars.

It should be noted that techno-economic optimisations (i.e. the scenarios that have been considered and modelled) are imperfect. Many low carbon solutions have benefits and drawbacks that cannot be easily represented in modelling approaches. This appreciation has been used to shape the LAEP; however, as the LAEP is taken forward, new significant insight may result in a requirement to update this.

Scenarios for achieving Carbon Neutrality in Manchester

A core aspect of the scenario analysis has been the consideration of resulting emissions (following the implementation of the components that make up the scenarios), and how these relate to the GM carbon budget. This has strongly influenced the creation of this LAEP, recognising the need to cut emissions rapidly.

Once plans for all local authorities' missions can be compared against the carbon neutrality target at a GM level, subsequent consideration will be required to determine how these remaining emissions are decarbonised. Of note, the scope of modelling completed does not include all the transport emissions included within the scope of the GM carbon budget, but these will be considered when the plans for all ten local authorities are analysed centrally at a GM level.

These scenarios explore uncertainties, considering implications of different choices and behaviours by policy makers, businesses and individuals, the development and take up of technologies and the balance between different options where they exist. Within the scenarios, the key technologies that are likely to be important in cost effective local system designs have been considered, as well as some that are more expensive but may have popular support. Technologies that consistently appear across a broad range of scenarios and are resilient to sensitivity analysis warrant prioritisation in preparing for transition; this approach has led to the identification of the priority areas within this LAEP.

Conclusions from the scenario analysis have been used to develop this LAEP. This represents a point-in-time plan of intent, as the basis for Manchester taking important implementation steps over the next 5 years to engage industry and businesses, build momentum around a shared plan and support the identification and creation of opportunities for smarter local energy systems. Progressing this LAEP can help to realise the potential of a local energy market for GM and support meaningful action and progress on reducing emissions.

Both the primary and secondary scenarios make assumptions around changes to behaviour, advances in technology and innovation, whilst recognising uncertainty in key areas such as the potential use of hydrogen for transport and heating in homes and buildings, as well as advances in energy storage and controls. While it is not a prescriptive plan to be followed exactly, it does provide a detailed spatial evidence base and supporting data that can be used to inform the planning and coordination of activity in Manchester over the coming years. Where hydrogen for building heating does become available (as per the secondary scenario), it is expected that all the components within the primary scenario (heat pumps, district heating, solar PV, EV charging, building fabric retrofit and flexibility and storage systems) will still be needed to decarbonise Manchester; any uncertainty is generally around the scale of deployment. Therefore, it is deemed low risk to demonstrate how to deploy these components and prepare for significant scale-up.

In summary, the scenarios have been developed in response to the science-based carbon budget for GM: defining a credible plan for Manchester, based on currently deployable technologies, to support an understanding of the actions, pace and scale of change as well as the investment needed. Insights from the scenarios that consider the role of hydrogen (in decarbonising domestic and nondomestic buildings), including aligning with the timeline for phase 3 of the HyNet project (which envisages low carbon hydrogen becoming available at scale from the early 2030s), have been used to set out heat decarbonisation priority areas. The scenarios also seek to understand the costs, benefits, uncertainties, opportunities and risks to decarbonisation by 2038 that a hydrogen-based approach would bring. Combining the insight from these scenarios informs the plan for Manchester.

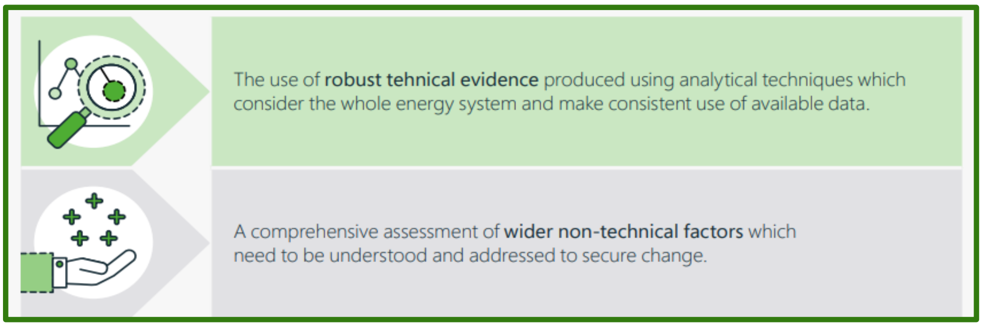
This LAEP has also considered previous studies including the Decarbonisation Pathway for Greater Manchester study completed in 2020 by Navigant on behalf of Cadent Gas and Electricity North West[*] and is aligned to the latest guidance on Local Area Energy Planning developed with Ofgem, the ambitions of Greater Manchester and wider UK Net Zero commitments.

In accordance with the Ofgem LAEP Method[†], which provides guidance and framework for LAEP done well, this plan has been developed through the use of robust technical evidence which considers the whole energy system for Manchester and consistent use of available data and assumptions.

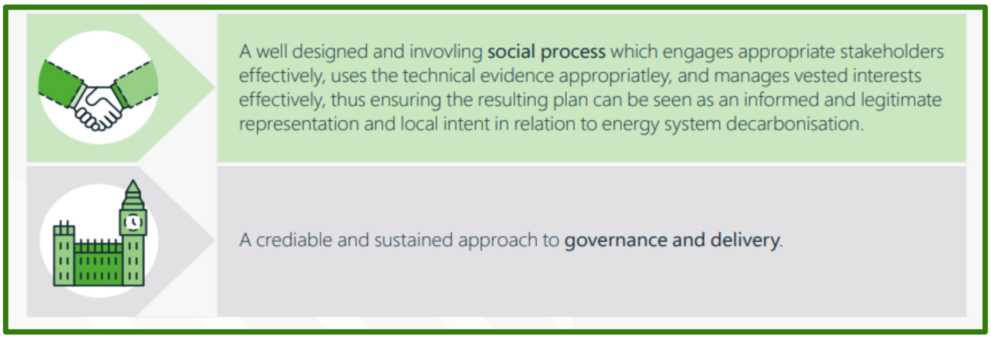
It has also sought to consider wider non-technical factors which influence the deliverability, pace and scale of change required for decarbonisation.

[*] Decarbonisation Pathway for Greater Manchester, Reaching carbon-neutrality in a balanced scenario by 2038, Navigant, July 2020

[†] From LAEP: The method https://es.catapult.org.uk/reports/local-area-energy-planning-the-method/



The next steps of the development of the plan are expected to comprise wider stakeholder and public consultation on the plan to inform its further development and also the approach of both Greater Manchester and Manchester in its ongoing governance and delivery.



The approach differs from the Ofgem methodology where it has taken advantage of the data and engagement available at the Greater Manchester Combined Authority (GMCA) level, streamlining the approach and reducing the need for separate processes with each local authority.

Report Structure

The report is set out in the following structure: it summarises the key aspects of the plan and its supporting modelling and analysis and is presented in five parts (9 chapters), supported by an accompanying technical annex.

Chapter 1: (this chapter) sets out the context and the approach taken to modelling, developing the scenarios and supporting technical evidence and associated assumptions and limitations and relevant supporting information

Chapter 2: sets out the vision to reach carbon neutrality in Manchester informed by the scenario analysis. The primary scenario demonstrates how Manchester could meet Greater Manchester's decarbonisation ambitions across each of its key areas by 2038 in a practical way. A series of first steps is also presented that focus on demonstration and scale-up of some of the key components that will be needed to decarbonise Manchester.

Chapters 3-7: set out some of the key aspects of the primary and secondary scenarios and what this means in relation to implementation for Manchester including Fabric Retrofit (Chapter 3), Heating System Zones (Chapter 4), EV charging and infrastructure (Chapter 5), Local Energy Generation and Storage (Chapter 6), and Energy Networks including electricity, gas and heat (Chapter 7). They also consider key uncertainties and dependencies informed by the wider scenario analysis and specific areas of investigation

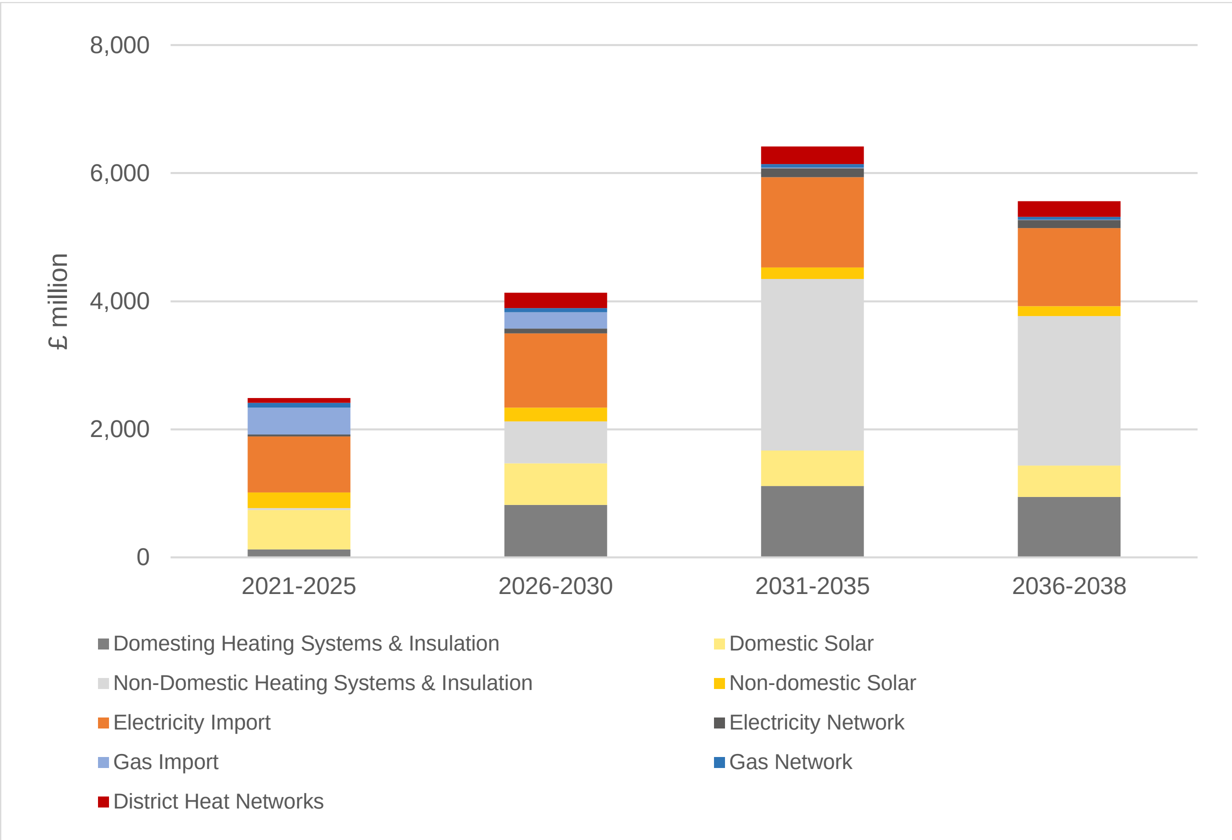
Chapter 8: sets out the estimated system costs and investment needed for implementation of the primary scenario. This includes definition of the total system costs between now and 2038 across different areas of Manchester, the capital investment at key time steps in infrastructure and key technologies within the scope of the analysis.

Chapter 9: summarises the key findings and recommended actions to support implementation and ongoing review and monitoring in the context of national and regional energy strategy, carbon budgets and associated policy and regulation.

This Local Area Energy Plan aims to support Manchester City Council to transition to an affordable and decarbonised energy system and to support the delivery of Greater Manchester's commitment to carbon neutrality by 2038 alongside Manchester's net zero goal.

Decarbonising Manchester local energy system by 2038 is achievable and expected to require capital investment of £13.2b. Total energy system costs including capital investments, operations and energy consumed are between £17.5b and £18.6b to 2038[*]; the upper chart illustrates the breakdown of this expenditure over time for different components (for the primary scenario). The lower chart shows how implementing the transition reduces annual carbon emissions[†]. The cumulative emissions over the period 2021-2038 in this scenario are 9.9 Mt of CO_2e (from a range of 9.7 to 10.0 Mt CO_2e across the scenarios assessed), of which 4.6 Mt CO_2e is due to grid electricity consumption[‡].

Cumulative CapEx and energy costs over time (primary scenario)

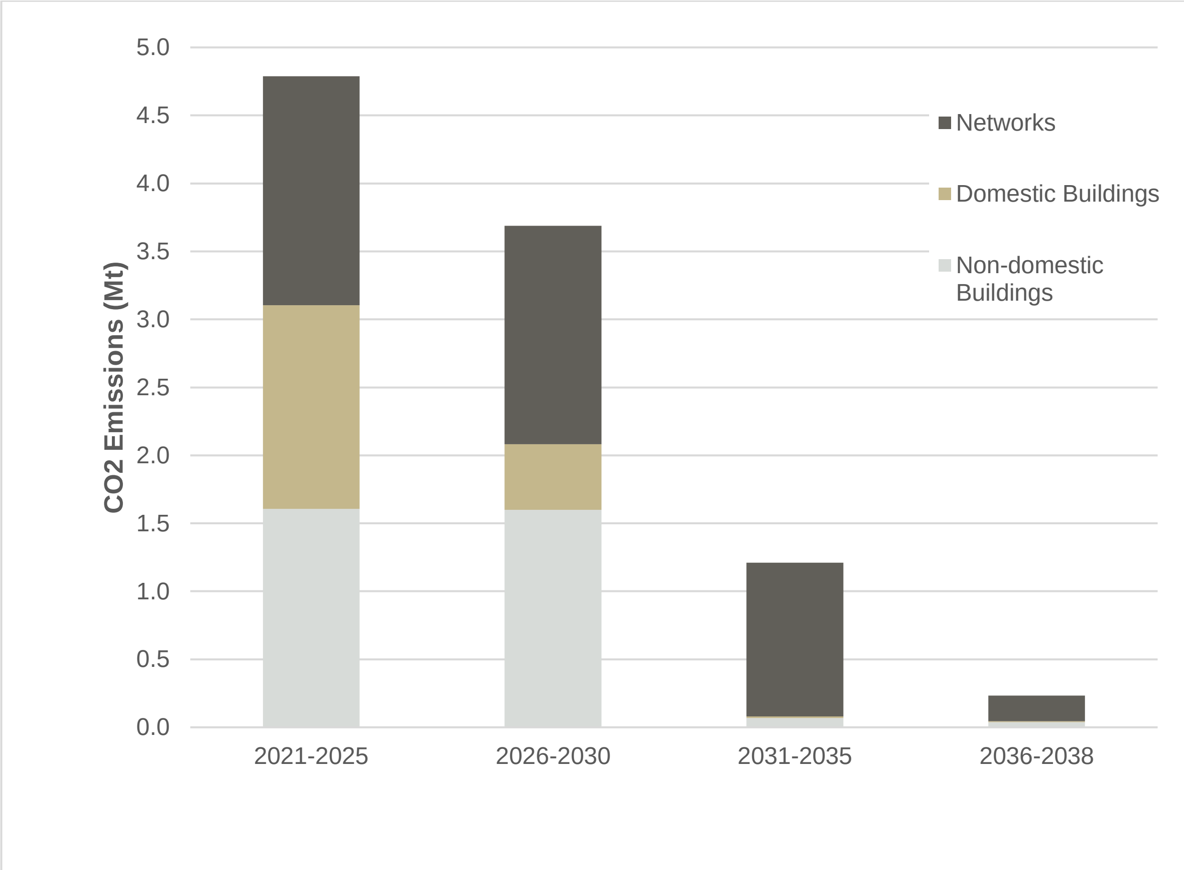


[*] Overall total costs are discounted using standard treasury green book assumptions

[†] In-scope emissions are those resulting from domestic, industrial, and commercial consumption of electricity, gas & other fuels, electric vehicle charging and process emissions from large industrial installations. Out-of-scope are emissions from agriculture and existing liquid fuels for transportation

[‡] Based on current forecasts for electricity grid decarbonisation. If the rate of grid decarbonisation accelerates in line with the UK's recent commitment to reduce emissions by 78% by 2035, grid intensity could reach nearly zero emissions by 2035, eliminating most of the remaining emissions by the end of this plan

Cumulative CO_2 emissions over time (primary scenario)



How to Interpret this Vision

This transition will involve the greatest infrastructure change across Manchester and Greater Manchester for decades; key chapters of this LAEP illustrate the scale of change and investment needed, based on a primary scenario. An alternative scenario (secondary), incorporating the use of hydrogen for heat, is also presented on page 21 (along with other variations within the appendix), where the supporting analysis indicates that hydrogen could have an important role in decarbonising Manchester. Given the significance of backing one view of the future (or scenario) now, the LAEP promotes a demonstration and scale-up approach over the coming years to 2025, before moving to full scale implementation. Therefore, this LAEP identifies several ‘priority areas’ to build capacity and test approaches, across different components, for working with Manchester’s citizens and stakeholders. Insights from the alternative scenarios have been used to produce these priority areas. It is expected that this LAEP may need to be updated as lessons are learnt and uncertainties (such as UK policy regarding the decarbonisation of heat) become clearer.

Fabric Retrofit

At least a third of Manchester’s **dwellings receive insulation retrofit in the plan: 101,500 in the primary scenario and 135,700 in the hydrogen focused secondary scenario**. The greater number of retrofitted dwellings, which involves more extensive (or deep) measures, required in the hydrogen scenario is included to help meet the carbon budget. Fabric retrofit and solar PV are low regret measures to progress in the short-term.

Heat Decarbonisation

Three heating options are explored to decarbonise buildings: electric heating (primarily heat pumps), hydrogen to replace natural gas, and district heat networks. For hydrogen to play a significant heat decarbonisation role, certainty would be required that hydrogen will be available to supply Manchester in a timeframe that supports the delivery of the GM carbon budget. Alternatively, over **180,000 heat pumps** are deployed, serving most dwellings, except in North 2 and Central 1 where district heat supplies a large share of buildings due to the higher density of buildings. The combined cost of fabric retrofit and heating system replacement is £3bn for homes, and 5.7bn for non-domestic buildings. It is recognised that delivery of any option presents comparable challenges and risks, resulting in the need to focus on the demonstration and scale-up approach advocated.

Energy Generation & Networks

To reduce emissions in line with the GM carbon budget, local energy generation could increase significantly, consisting predominantly of the installation of solar PV on much of the available roof space across all parts of Manchester (under all scenarios considered), providing up to 1,230 MWp of installed capacity, at a cost of £3.1bn. Electricity networks could expand to accommodate electrification at a cost of £375m, and £835m could be invested in district heat networks.

EV Infrastructure

The transition to electric vehicles (EVs), with uptake increasing from <2,000 EVs today to over 140,000 by 2038, drives a demand for EV chargers to be installed across all areas. Around **72,000*** **domestic chargers** would be installed (one for every home with potential for off-street parking) at a cost of £40m, along with multiple public charging stations (or hubs). Central 1 requirements differ from the surrounding areas in having a lower number of domestic EV chargers due to its central location.

* Based on ESC in-house analysis of EV uptake. Quantities will need to be aligned with local planning policies as it relates to provision of chargers in new developments and existing dwellings

Consumer Uptake

By the early 2030s all new cars and vans, and all boiler replacements in dwellings and other buildings in Manchester are low carbon[*]; the vast majority of heating systems are either electrified or use hydrogen. Either 181,000 of Manchester's dwellings are fitted with a form of heat pump, or up to 225,000 boilers could be using hydrogen (leaving 66,000 homes using heat pumps). By 2038, nearly 90% of cars are electric vehicles or plug-in hybrids, requiring the provision of >72,000 electric vehicle charging points – one for every home with potential for off-street parking – as well as electric vehicle charging hubs for areas of terraced homes and destinations such as offices and shopping centres. By 2035 commercial and industrial activities in Manchester largely shift to using renewable electricity, district heating or hydrogen instead of fossil fuels; carbon capture may be required to reduce remaining emissions.

Low-carbon energy supplied to and generated in Manchester

The emissions intensity of UK electricity production is expected to fall to around 35% of today's levels by 2035[†]. Offshore wind forms a backbone of electricity generation nationally. Renewable electricity production in Manchester increases to contribute to the GM carbon budget, in the form of up to 1,230 MWp of rooftop solar PV. This generation provides up to 921 GWh of energy annually (19%), with 4,010 GWh (81%) of electricity supplied from the grid. There is limited opportunity for wind and ground mounted solar PV generation across Manchester.

This low carbon electricity is used in heating, industry and vehicle charging, more than doubling electricity demand over the next 15 years. Total electricity consumption is expected to increase by nearly 74% by 2038 in the primary scenario and by nearly 45% by 2038 in the secondary scenario.

Low-carbon hydrogen may be prioritised nationally for the hardest-to-decarbonise sectors such as shipping, heavy transport fuel and energy intensive industry, and therefore the quantity that will be available for building heating is uncertain. However, HyNet is a project which aims to pioneer low carbon hydrogen production, potentially making it available to buildings in the region by 2030. Should Hynet be delivered on time, then it could have a significant role in decarbonising Manchester; Greater Manchester has a carbon budget that requires immediate action to stay within, and so any delay to HyNet may mean it arrives too late to keep within the carbon budget. The similarities across scenarios point to low regret opportunities in each area of Manchester and identify potential priority areas for using hydrogen.

[*] This LAEP considers the energy and emissions associated with current and projected personal car use and ownership only, providing an important understanding of the impact on Manchester's future energy system from electrified cars. This LAEP does not provide a fully integrated energy and transport plan where it is recognised that further work will be required to consider and integrate broader transport decarbonisation and net zero plans. This LAEP does not also account for aspects such as modal shift or behaviour change, acknowledging that other measures such as these will be needed to achieve net zero
[†] Based on current forecasts for electricity grid decarbonisation. If the rate of grid decarbonisation accelerates in line with the UK's recent commitment to reduce emissions by 78% by 2035, grid intensity could reach nearly zero emissions by 2035, eliminating most of the remaining emissions in this plan

Reducing demand for carbon-intensive fuels

Buildings will lose less energy thanks to a series of targeted fabric retrofit programmes, improving insulation and efficiency across Manchester. Fabric retrofit will prepare buildings for zero carbon heating, whilst also making a notable contribution to staying within the carbon budget. By 2038, over 100,000 of Manchester's 295,000 dwellings are retrofitted in the plan (circa 35%), primarily with basic retrofit packages – measures with modest costs and attractive payback times. The option of deeper fabric retrofit has the potential to increase headroom in the carbon budget to give some flexibility for deferring decisions on heating systems.

Energy Networks

The creation of district heating networks in targeted areas could see up to 32,000 homes connected to a heat network in 2038. Central 1 and North 2 zones see the greatest concentration of heat network opportunities. Energy centres using predominantly large-scale heat pump systems to produce heat, though local opportunities for other forms of heat supply such as waste heat should be considered, where available.

Annual electricity demand is forecasted to increase from 2,480 GWh per year to 4,930 GWh per year by 2038, due to electrified heat and electric vehicle charging. This requires an increase in electricity network capacity, with the greatest network reinforcement requirement in the areas of North 1 and South 2, though opportunities to use flexibility and storage in place of reinforcements are explored.

Depending on the conversion and roll-out of hydrogen for heat, gas networks remain in place in some areas to support some hard-to-decarbonise nondomestic buildings that may not be of the scale to have a dedicated hydrogen connection. However, should Hynet phase 3 be available, up to 225,000 homes could be supplied by hydrogen by 2038, meaning much of today's network is retained and repurposed.

Investment

Manchester's transition requires a total energy system and building level investment of £13.2bn (excluding energy costs). This unprecedented level of investment provides a once in a lifetime opportunity for Manchester. Urgent focus will be needed to determine how to maximise the local benefit from this opportunity, considering how to develop the local supply chains and skills needed to enable the transition and provide new, green, local jobs.

Local Opportunities

This LAEP provides a vision for a carbon neutral Manchester. How it is delivered will influence the local benefit to Manchester, in addition to job creation. For example, there will be opportunities for local/community initiatives to provide the future energy system.

Smart local energy systems could be used to provide EV charging hubs, renewable energy generation, communal or locally owned heat networks, energy storage systems, smart/flexible energy systems to avoid electricity network reinforcement or any combination of these or other measures. Greater Manchester is working with partners in developing a Local Energy Market to support the implementation of such solutions through new business models, customer propositions and a trading platform.

Local Impact and Risks

Without changes to national policy wider energy market reforms or the introduction of new support mechanisms, household energy bills are forecasted to increase, predominantly as heating homes through either electricity or hydrogen is assumed to be more expensive than using gas. However, the proposed investments in building works will help to mitigate this and consideration will be needed to target measures at homes with the most need. Consideration is also needed to determine how to fund an average household investment of £18,000 for the associated measures (based on installing insulation, solar PV and a new heating system).

An electric focused heat transition, involving changes to building fabric and internal heating systems (e.g., changes to doors, windows, larger radiators, and improved controls) could be more disruptive to residents and it is not clear how this might compare with disruption associated with using hydrogen for home heating, where more extensive fabric retrofit would be required to provide emission reduction aligned to the carbon budget. In either case, compelling consumer propositions would be needed to facilitate it. With extremely challenging rates of deployment, there is an urgent need to scale up and develop skills and supply chains. Moving to an electrified heating future also presents a risk of backing a technology 'winner' before national decisions are made on heat strategy. Targeting specific areas and housing types most likely to be suited to electric heating and demonstrating effectively clustered transitions in Manchester and GM more widely can build knowledge and evidence for policy decisions as well as industry supply chains, making meaningful progress on emissions reduction. Finally, there is a risk that the economic and social benefit may not be captured locally, therefore consideration of how to maximise the opportunity is essential.

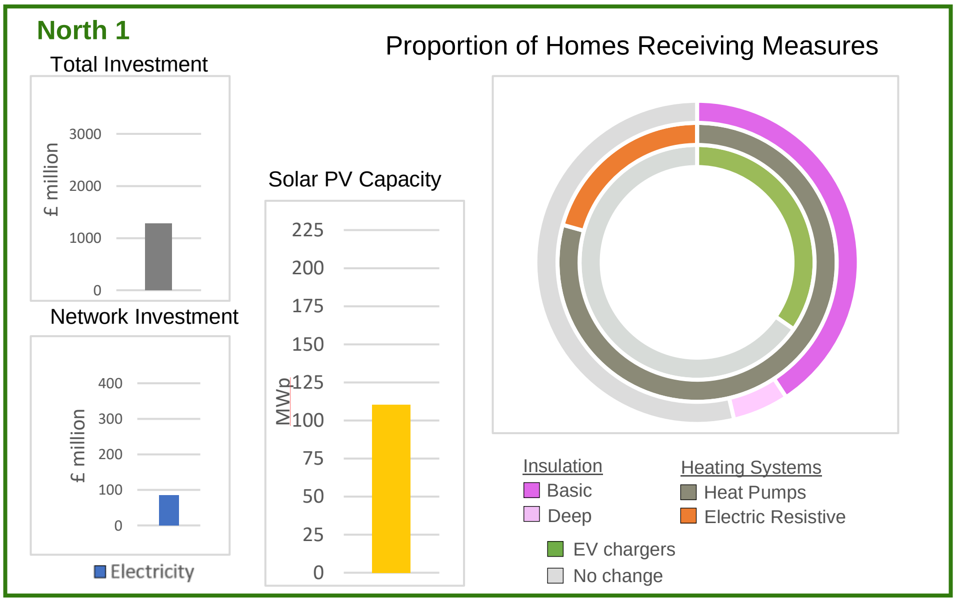
What Manchester's transition to carbon neutral could look like

Recognising that predicting what Manchester's actual transition to carbon neutral will look like is not possible; the following charts illustrate the scale of change needed to decarbonise Manchester, based on the primary scenario (see page 21 for the secondary scenario). This is intended to illustrate to the stakeholders who will support and deliver Manchester's transition, the scale of measures and investment needed by specific area/zone.

This scenario to 2038 is most suitable if uncertainty remains around converting the gas grid to zero carbon hydrogen (provided at an acceptable cost) by the mid to late 2020's. It is around this time that it would be deemed too late to rely on hydrogen for heat to meet the Greater Manchester science-based carbon budget; recognising the timescales needed to carry out widescale infrastructure and building investment and adaptation.

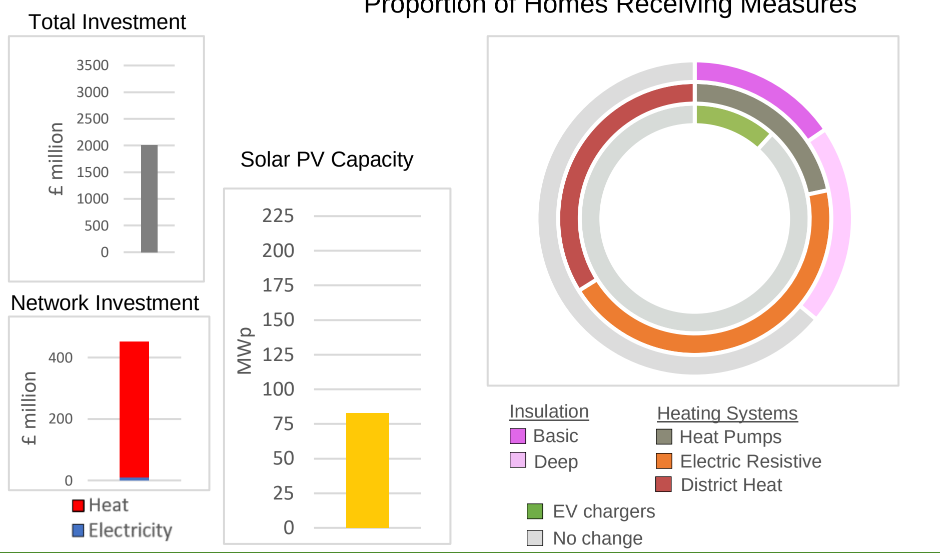
The following charts illustrate total energy system investment*, the component of investment focused on energy networks, installed solar PV capacity, and the proportion of Manchester's dwellings which receive installations of insulation and heating systems. Total investment comprises roof-mounted solar PV, heating systems and insulation for both domestic and non-domestic buildings, energy networks and district heat energy centres.

This LAEP is based on using geographical zones to highlight and illustrate Manchester's carbon neutrality plan. This includes identifying priority activities and proposals by zone. Manchester has been divided into 8 zones: North 1, North 2, Central 1, Central 2, Central 3, South 1, South 2 and South 3. Page 22 illustrates the areas covered by each zone.

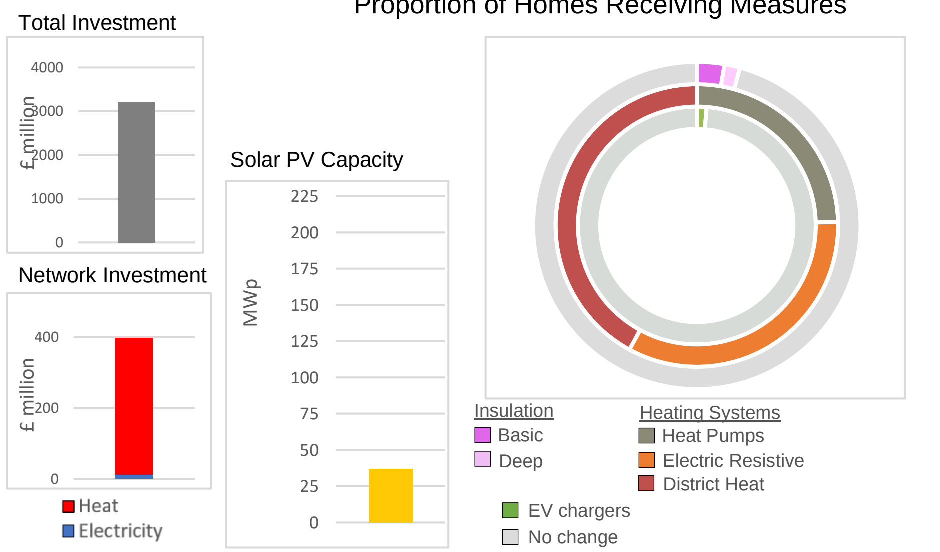


* This is money spent on energy system components and therefore excludes money spent on energy consumed

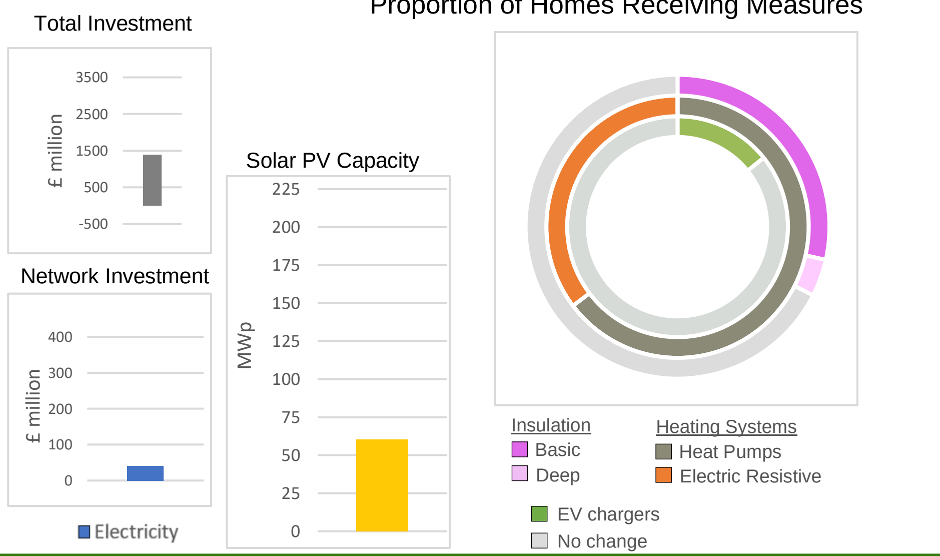
North 2



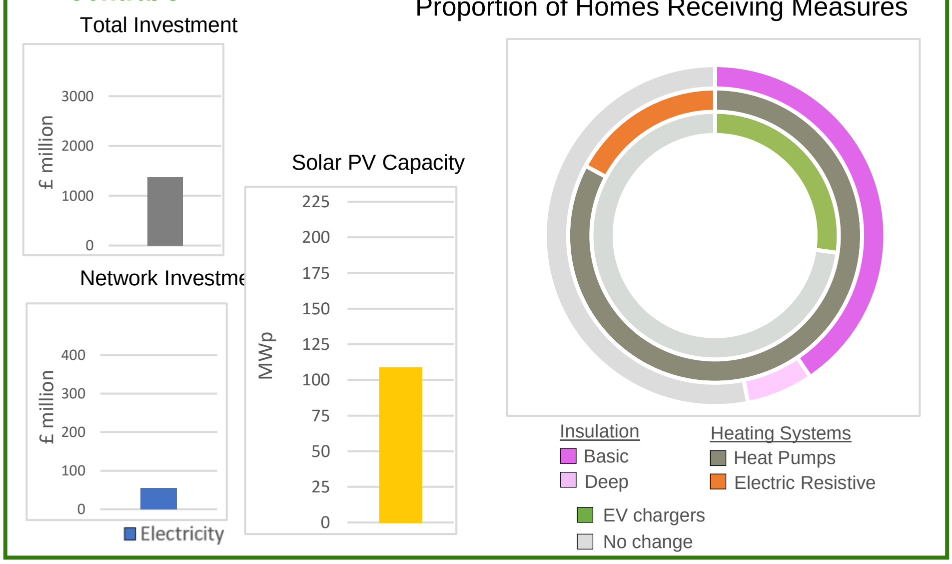
Central 1



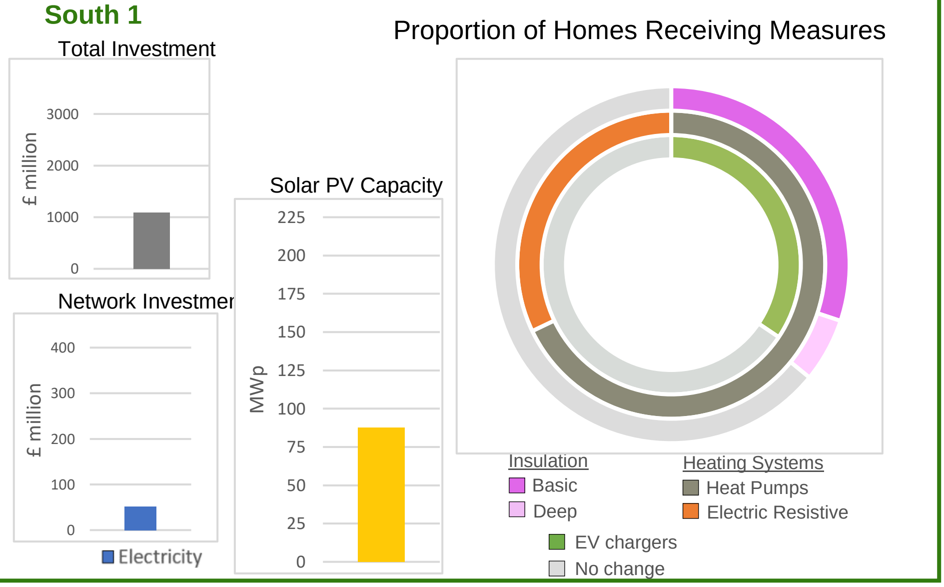
Central 2



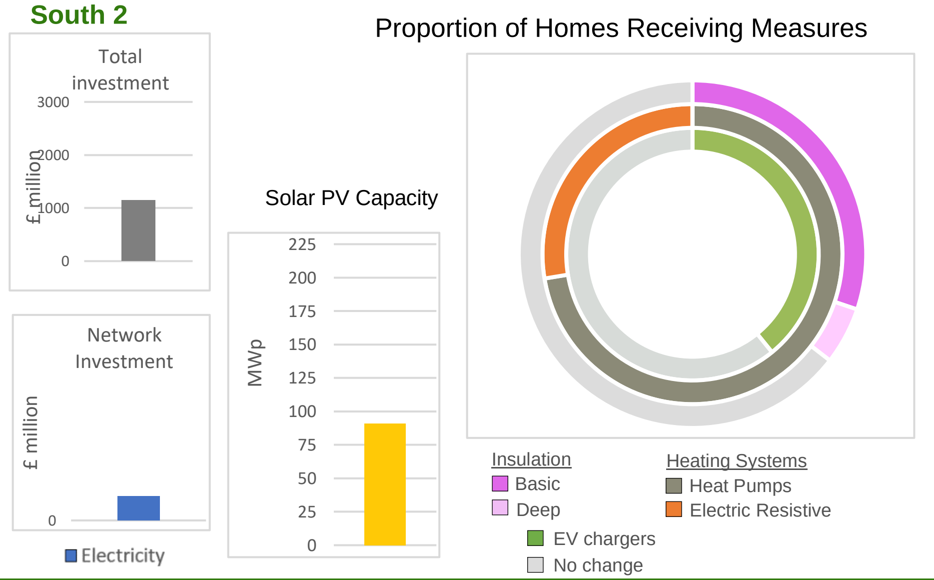
Central 3



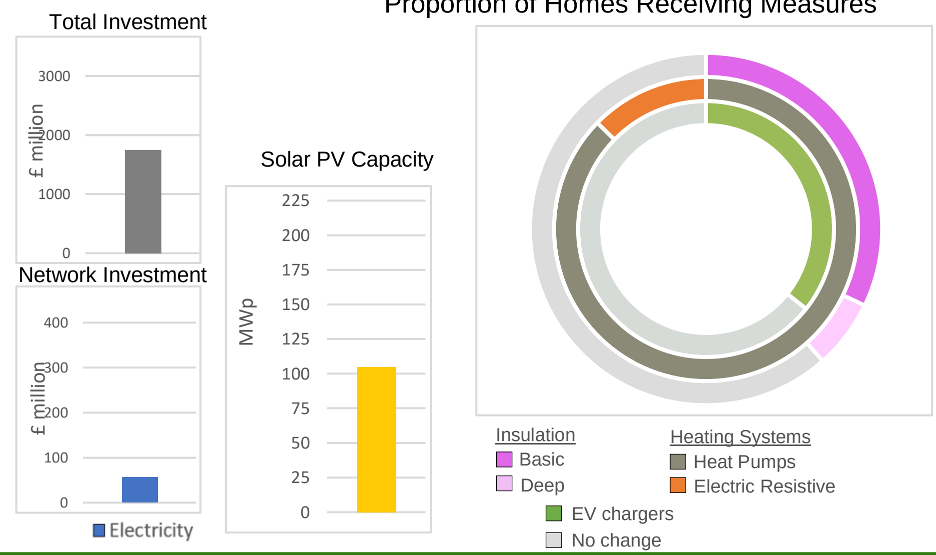
South 1



South 2



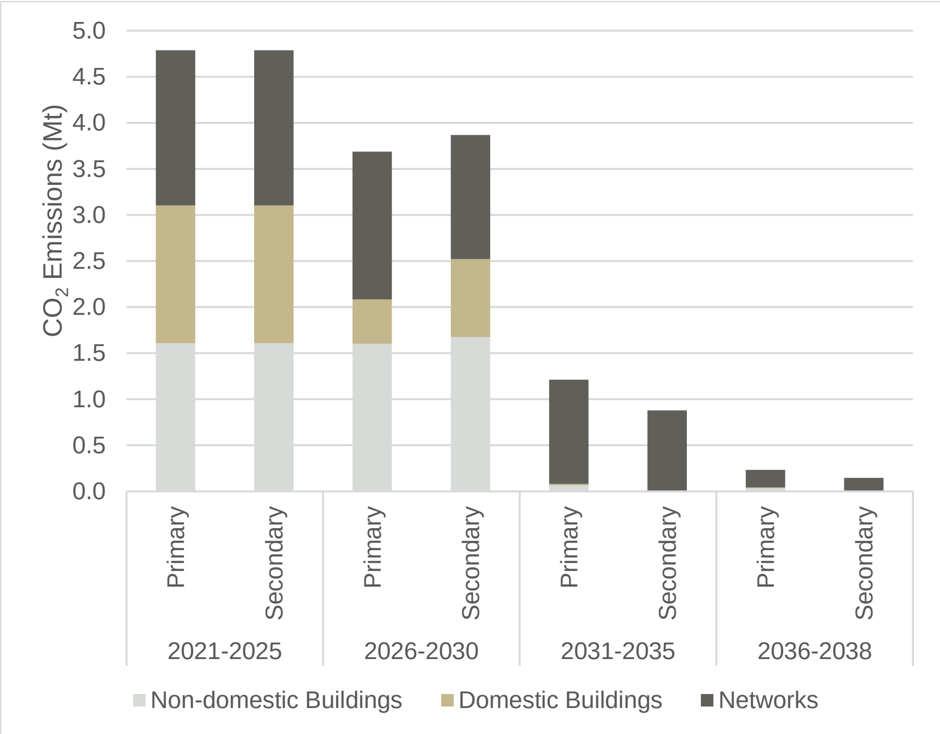
South 3


Total Investment
3000
2000
1000
0
£ million
Network Investment
400
300
200
100
0
£ million
Electricity
Solar PV Capacity
225
200
175
150
125
100
75
50
25
0
MWp
Proportion of Homes Receiving Measures
Insulation
Basic
Deep
Heating Systems
Heat Pumps
Electric Resistive
EV chargers
No change

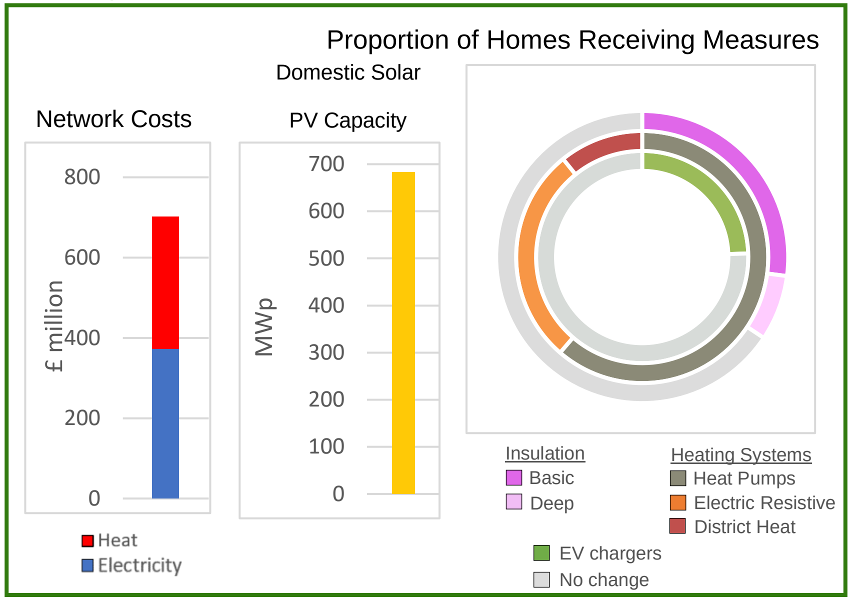
This secondary scenario illustrates an alternative future where hydrogen becomes widely available for heating and hot water in buildings from 2030, in accordance with the aspirations of HyNet phase 3. These graphs show some of the key differences in investment and installation between the primary and secondary scenarios.

The availability of hydrogen for home heating in scenario 2 avoids investment in both electricity and heat networks, although investment for repurposing the gas network to handle hydrogen is needed instead. The need to invest in building retrofit is also increased, as the later availability of hydrogen requires greater savings to be made elsewhere earlier on to meet the carbon budget.

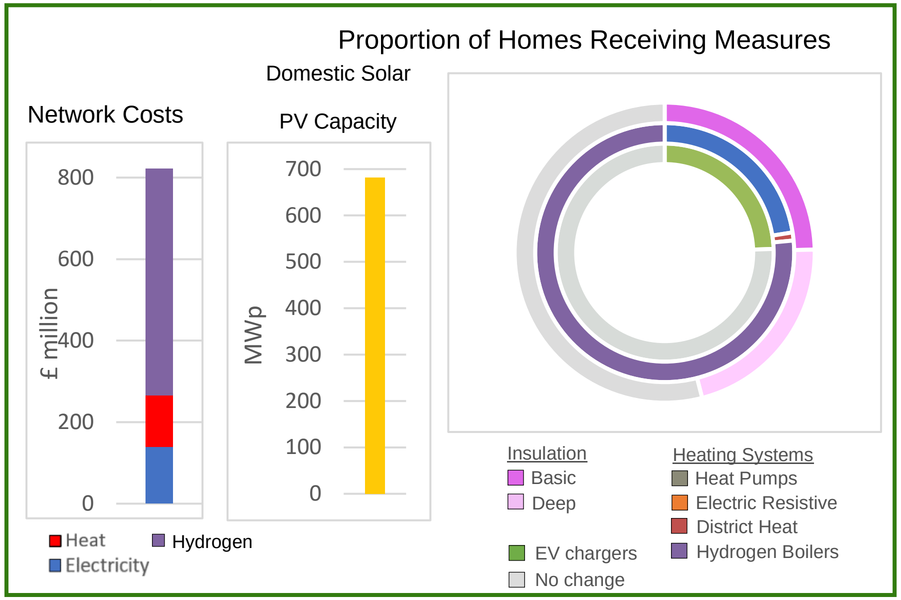
Both scenarios include a similar amount of roof mounted solar PV, required in both cases to provide early emissions reduction to support the carbon budget. EV related aspects are consistent across both scenarios.



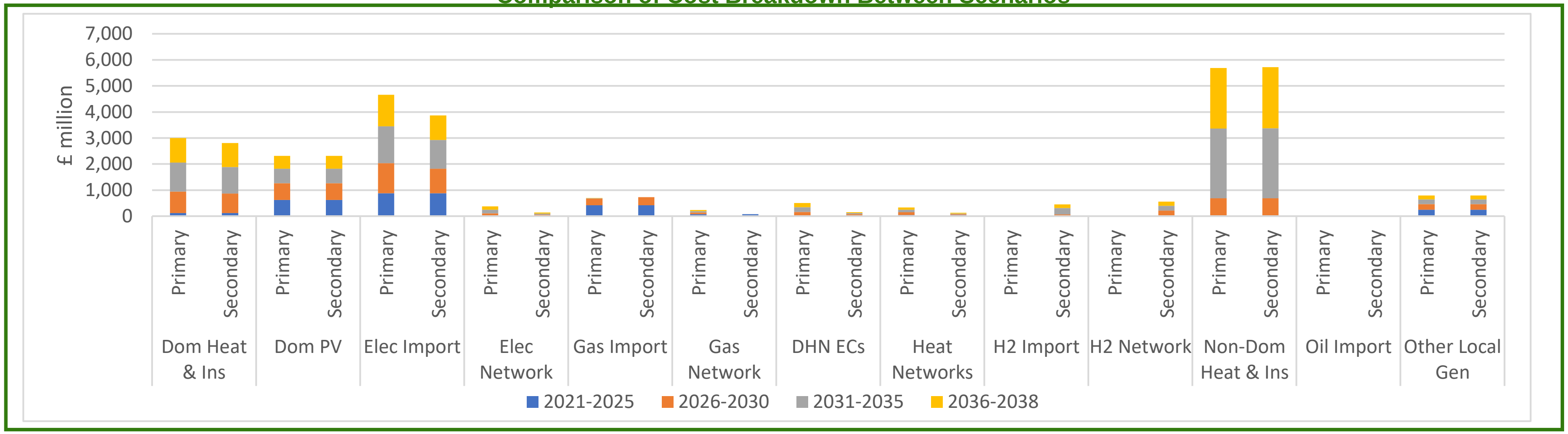
Primary Scenario



Secondary Scenario



Comparison of Cost Breakdown Between Scenarios



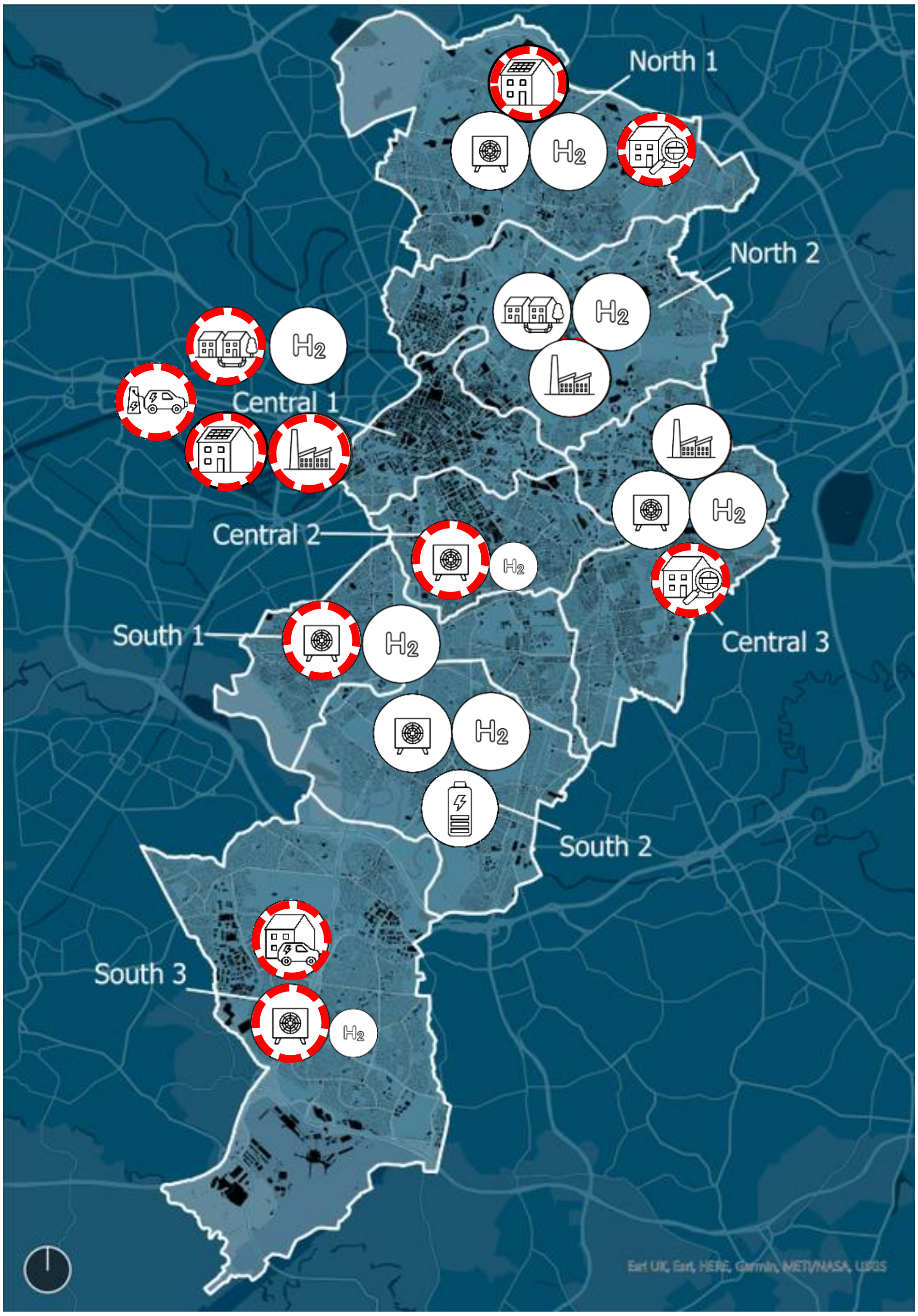
How to use this LAEP

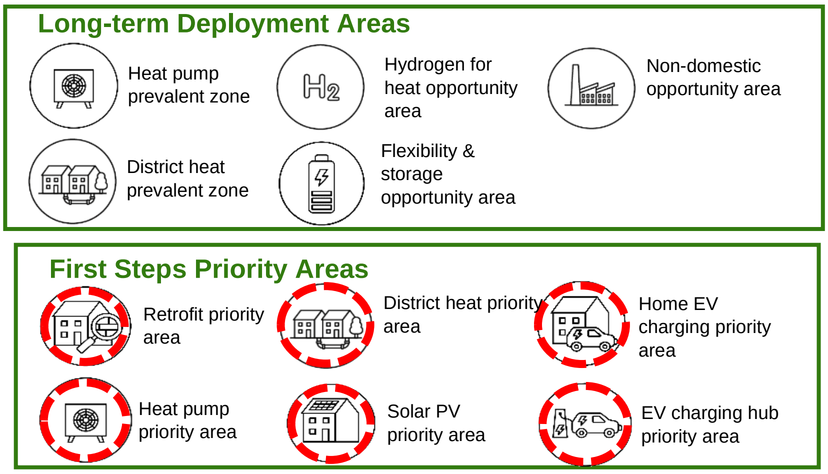
The plan opposite illustrates the proposed activities to progress this LAEP in the near-term, based on a demonstration and scale-up approach, as well as focus areas for changes in the longer term. The red rings highlight priorities to test how to roll out Manchester's transition to carbon neutral and work with Manchester's citizens. Insight from these activities- is expected to be evaluated, for example through demonstrating where proposed components of the LAEP are still the cost-effective option, before moving to widescale rollout. For example:

- How to roll out heating system and fabric retrofit change alongside renewable energy generation and EV charging infrastructure. Testing how best to combine these components and understand where a whole house retrofit approach may be beneficial
- How should additional electricity demand be provided in an area e.g. through network reinforcement or through providing alternative strategies
- How to engage with stakeholders and provide appealing customer propositions. Should activity be deployed at a neighbourhood level or dispersed across a wider area
- Taking account of evolving UK energy and heat policy

It is expected that Manchester Council will work with other key stakeholders, including GMCA, Cadent, ENWL and delivery partners to develop a detailed demonstration and delivery programme.

Demonstration and scale-up priority areas





The following priority areas highlight suggested areas to test specific components of this LAEP in the near term:

- Central 2, South 1 and South 3 have been highlighted as areas where, even if hydrogen becomes widely available for building heating, there would still be significant deployment of heat pumps, meaning that prioritising heat pumps early in this area is a low-regrets action. In the other zones, heat pumps would also be a low-regrets option for housing far from any industrial areas (which might be served by hydrogen) or potential heat network coverage.
- North 1 and Central 3 are prioritised for fabric retrofit deployment, predominantly due to high proportions of inter-war dwellings (1914 to 1944) that would benefit from thermal improvement.
- Space capacity in the electricity distribution system makes North 1 a good candidate for large scale roll out of rooftop PV, and South 3 for home EV chargers.
- Central 1 is an area where demand for public EV chargers is likely to be substantial.

Long term Deployment

- Hydrogen could be used for heating across all areas if it became widely available. North 2, Central 3 and South 3 have industry which could benefit from hydrogen availability, and this might increase the likelihood of hydrogen becoming available to domestic buildings near these areas of industry. The same is true for homes near the airport in South 3.
- Flexibility and storage (combined with other components including heat pumps, solar PV and EV charge points) can be tested in South 2, including a focus on evaluating if alternative approaches to electricity network reinforcement provide benefit.
- North 2, Central 1 and Central 2 present opportunities for the demonstration of solutions for Manchester's non-domestic buildings, although Central 1 can make take steps in the near term.

To summarise, aspects of this LAEP present a Vision (from many possible options), rather than a design, of how Manchester could move towards GM's goal of carbon neutrality by 2038. This is not meant to provide a forecast or recommendation on what Manchester's actual decarbonisation will be, where it is accepted that an entirely different future will evolve.

The following themes set out both how the rationale for how this Vision has been produced, identifying several key considerations that will need to be thought about and integrated alongside demonstration and scale-up activity, as plans to take forward this LAEP are developed. It is expected that insights from the demonstration activity and considerations of these themes will influence Manchester's actual transition.

Modelling Approach and GM Carbon Budget

The GM carbon budget and the modelling approach to develop this LAEP are the primary drivers for setting out this Vision. The GM carbon budget requires an approximate year on year 15% emissions reduction. This stringent target drives the need for early decisions and significant action in early years rather than adoption of a 'wait and see' approach with more change in later years. Therefore, the cost-optimised modelling approach used has to identify measures from a wide range of options to provide the required short term carbon savings. This results in the identification of measures, such as local generation and deep fabric retrofit, which can provide early emission savings. If there wasn't a carbon budget, or there were a later carbon neutrality target, different options would be identified, some of these alternatives may provide a more cost effective (from a whole system perspective) transition or one that would be easier to roll out and less disruptive to building occupants.

There are risks and benefits associated with each of the options discussed and either of the scenarios presented. Because of these, Manchester's actual transition may result in a combination of the primary and secondary scenario. Before making any widescale and significant commitment to one option or technology over another, evaluation of multiple factors will be needed.

Evaluation

Demonstration of low-regrets and priority actions in the short term (3-5 years) feeds into key decisions in the plan. These decisions also require further evaluation of the following aspects, so that trade-offs between different options and their impacts on consumers are taken into account before moving from demonstration to large scale implementation, considering associated risks and benefits.

- Local generation is deployed rapidly and early in the plan, as it is most effective at reducing carbon while grid emissions are higher in the earlier years. If such rapid deployment cannot be achieved in practice, the optimal mix of measures may look different, and total emissions may be higher (see slide 30 for more details)
- The timing of Hynet compared to the rate of electricity grid decarbonisation

- The ability to scale-up and install options rapidly aligned to the carbon budget
- The practicality and cost of installing measures in dwellings and non-domestic buildings
- The disruption associated with options – both within homes and at community level (e.g. traffic disruption from street works)
- Maintaining the gas network to supply sites (e.g. industrial) in areas that are expected to be heat pump or district heat prevalent
- How an electrified heat future would be paid for, recognising the greater in building investment required to move off-gas
- Coordination with other Greater Manchester local authorities in relation to energy network options
- Social and community benefits
- How to fund options and the preferences of investors

Consultation

Further consultation will be needed with key stakeholders, including GMCA, Cadent, ENWL and delivery partners to consider these considerations when developing demonstration and scale-up activity.

In addition, consultation with Manchester's citizens is essential to help understand attitudes towards Manchester's carbon neutrality transition; whilst also forming part of the evaluation process. This will help Manchester communicate with its citizens so that they both understand the transition and can help to inform plans to take forward this LAEP.

Citizen consultation will:

- Help to communicate Manchester's intentions
- Understand what people want and what options they are supportive of
- Help to identify areas to focus demonstration and then wider roll-out activity
- Help to provide confidence to organisations that will be involved in the delivery of Manchester's transition that there is a demand for solutions, products and services

Vision to 2038

A significant portion of existing homes and buildings in Manchester will require retrofit, carrying out insulation in **at least 33% of dwellings** (around 100,000). This is true even in areas where there is less certainty on the choice of future low carbon heating systems, so early focus and investment in fabric retrofit would be a low regret step in these areas. In fact, **more homes receive deeper retrofit in the secondary (hydrogen) scenario**. This is because heating system replacement occurs at a later date in the secondary scenario (once hydrogen is available), so emissions reductions must be achieved by other means to stay within the carbon budget in the early years. In contrast, heat pump deployment can begin straightaway in the primary scenario, delivering early emissions reductions. Furthermore, the likely higher cost of hydrogen against gas raises affordability issues which fabric retrofit can help address.

Fabric retrofit could be combined with other measures such as heating system replacement, PV installation and EV chargers to minimise number of visits required to homes, as in the "cost effective retrofit" option on page 35.

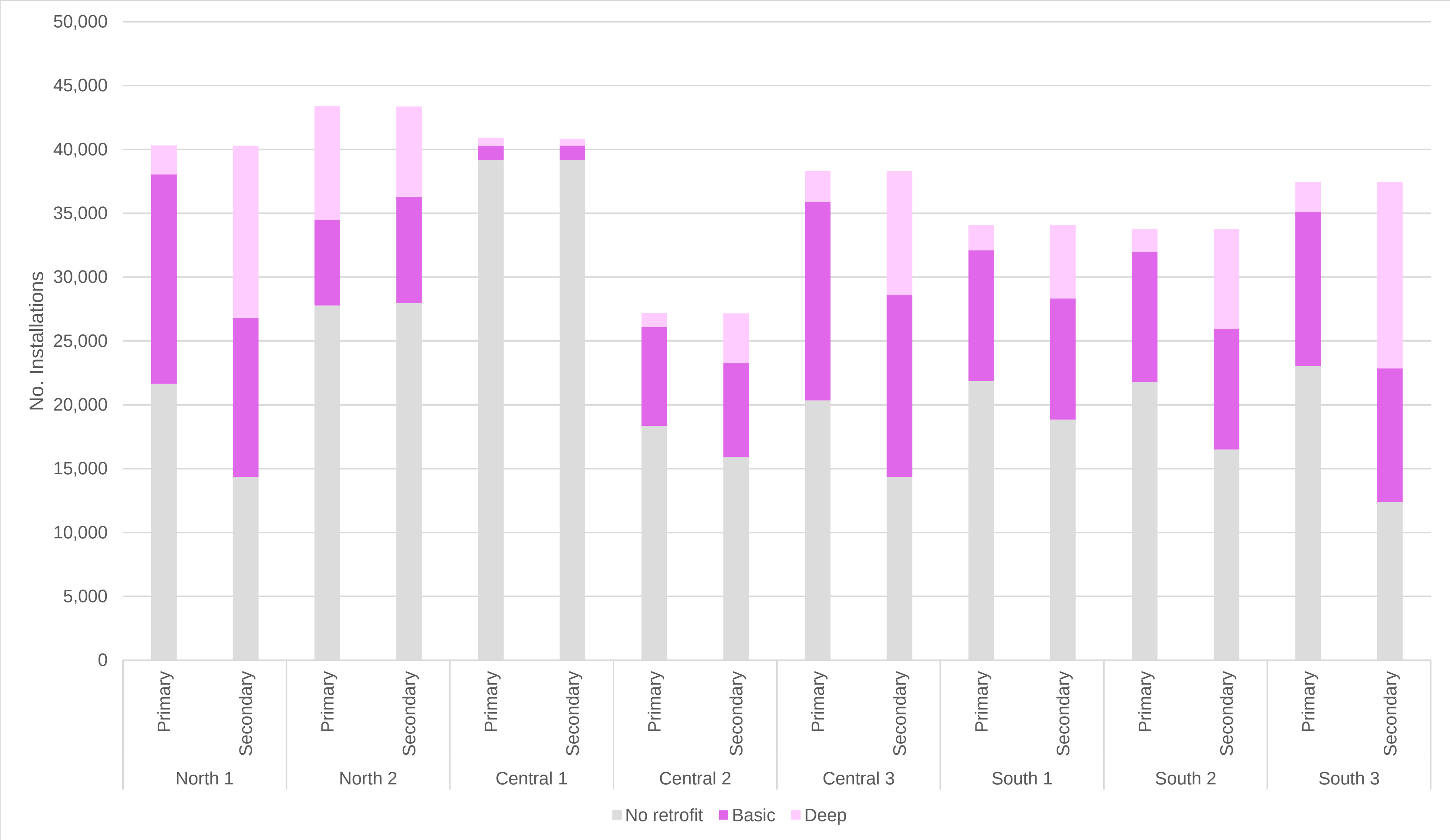
The dwellings that are most consistently identified as needing fabric retrofit to support decarbonisation are inter-war (1914-44) houses. **Over 60% of these properties will need fabric retrofit across all parts of Manchester** (in all scenarios). Newer houses often already have better standards of insulation and fabric energy efficiency, but many will still need some treatment, unless built to the most recent building standards.

Flats, which tend to have lower heat loss, show lower benefits from fabric retrofit, so are less of a focus area. However, further specific consideration will be needed at a building level to determine buildings that would benefit. For example, if a block of flats were to pursue a communal heating system, then the optimum balance between fabric improvement (to reduce heat loss and demand) and internal heating distribution systems would need to be specified, dependent on the heating system design strategy; recognising that a whole energy system approach will always be needed at a building level.

Hard-to-treat pre-1914 houses can often be more cost-effectively decarbonised[*] through heating system change without extensive fabric retrofit. This could include use of high temperature or hybrid heat pumps or, where appropriate, connection to district heating. Again, more detailed consideration will be needed when considering implementation as other factors may influence actual requirements. For example, additional investment could be targeted at dwellings most in need of support in managing energy usage costs.

[*] From a whole life cycle and total whole energy system cost perspective. i.e. it is cheaper overall to provide zero carbon heat than it is to both provide zero carbon heat and install more extensive fabric retrofit measures. This perspective has been taken on the basis that there will be finite resource available to decarbonise Manchester.

Retrofit across Manchester by 2038 (Primary and Secondary Scenarios)



First Steps – Priority Areas

Whilst large numbers of dwellings will need to be retrofitted to improve energy efficiency across all areas of Manchester, a number of priority zones have been identified.

The purpose of identifying these priority zones is to highlight areas where demonstration and scale-up could be prioritised over the near-term (<5 years)*. These areas are regarded as low regret, as they contain large numbers of similar housing stock considered to be cost effective to receive fabric retrofit measures, regardless of the type of heating system (e.g. hydrogen or a heat pump) that is used to replace natural gas boilers. These are predominantly inter-war-built homes (1914-1944). Two priority retrofit zones have been identified for Manchester:

- **Central 3**
- **North 1**

Conversely, Central 1 is less likely to be a focus for fabric retrofit, as it has the lowest overall levels of required retrofit, driven by a high proportion of flats (over 85%) that are generally of modern construction.

Whether or not a priority area based retrofit approach is pursued, it is essential that any delivery programme considers how to best integrate implementation with other changes to homes (heating systems, solar panels and EV chargers) to consider where a whole house retrofit approach would be required.

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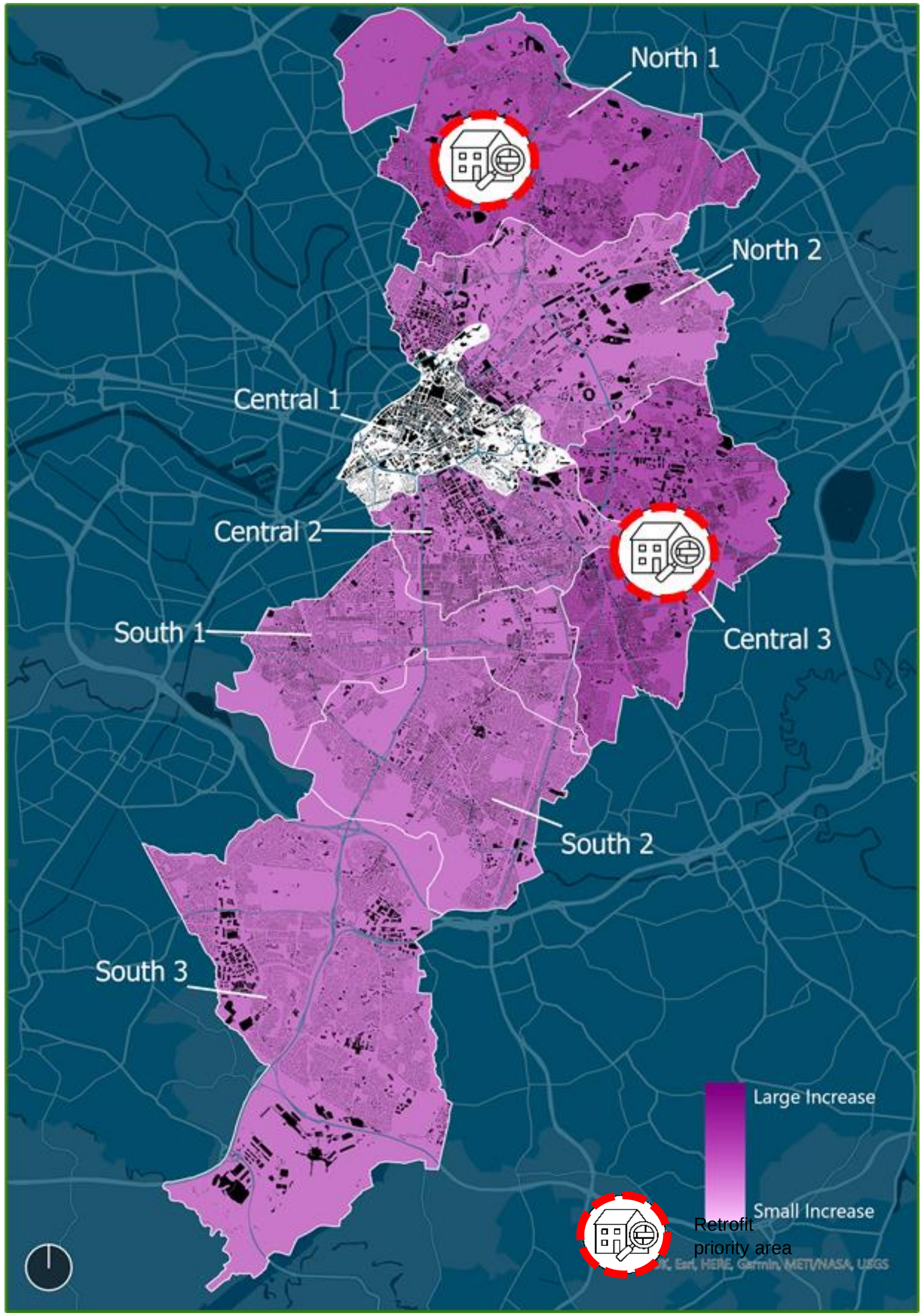
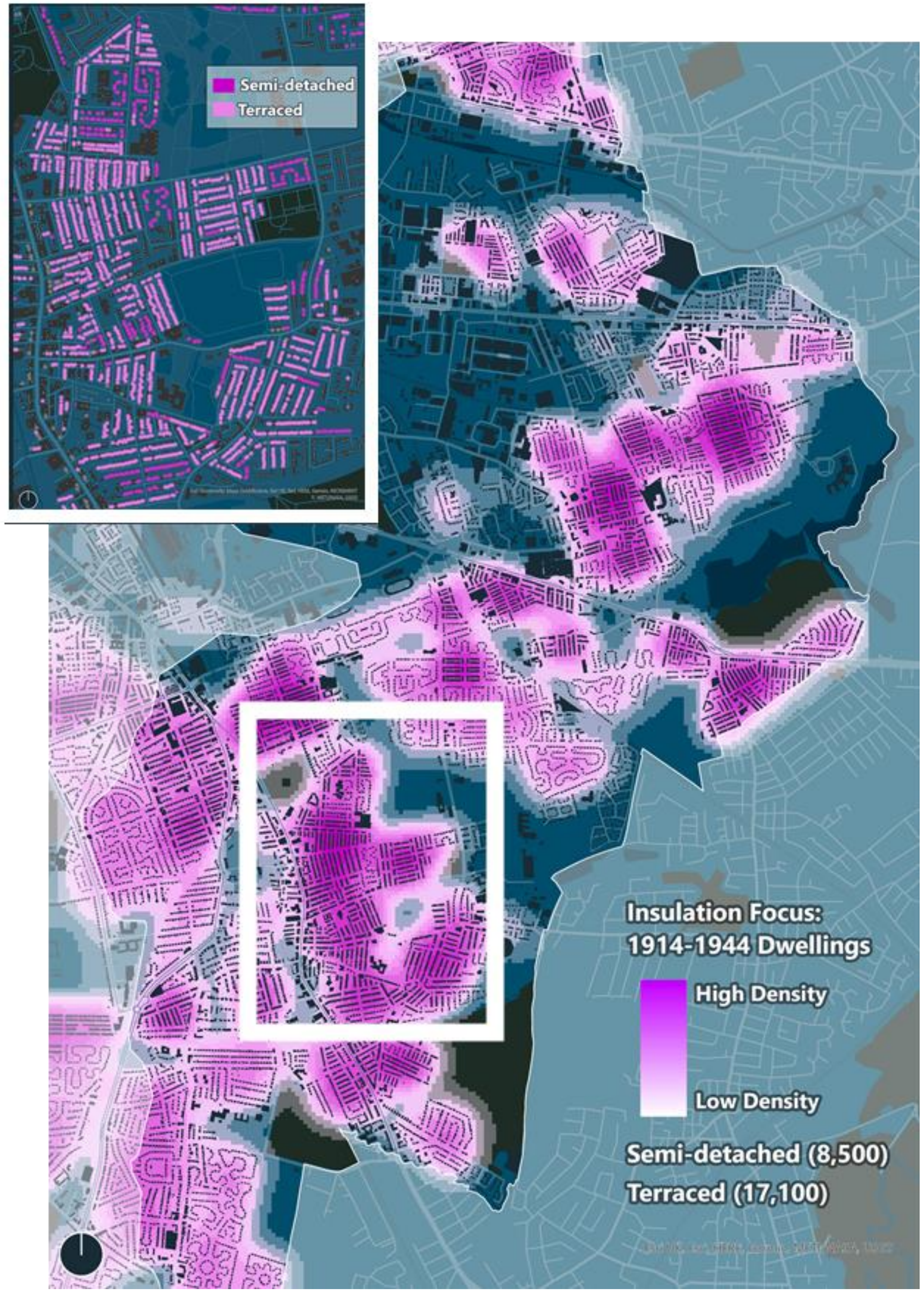
* Fabric retrofit measures have been identified following a whole energy system approach, considering the cost-effectiveness of fabric retrofit measures alongside other options to achieve carbon neutrality in Manchester. This does not mean that individual dwellings or buildings would not benefit from additional retrofit measures when considered on a case-by-case basis, particularly as part of a package of wider measures that could include heating system change and PV installation. During the development of any activity or plans to progress this LAEP, consideration will be needed to determine the optimum approach for deployment, when appraised alongside the approach for taking forward any of the other components of this LAEP. For example, in some cases a whole house retrofit may be beneficial, taking account of other GMCA activity, such as the Pathways to Healthy Net Zero Housing for Greater Manchester report and recommendations: https://democracy.greatermanchester-ca.gov.uk/documents/s13523/07%20Pathways%20to%20Healthy%20Net%20Zero%20Housing%20GM_Report.pdf

Fabric Retrofit Zones in Manchester by 2038


North 1
North 2
Central 1
Central 2
Central 3
South 1
South 2
South 3
Large Increase
Small Increase
Retrofit priority area

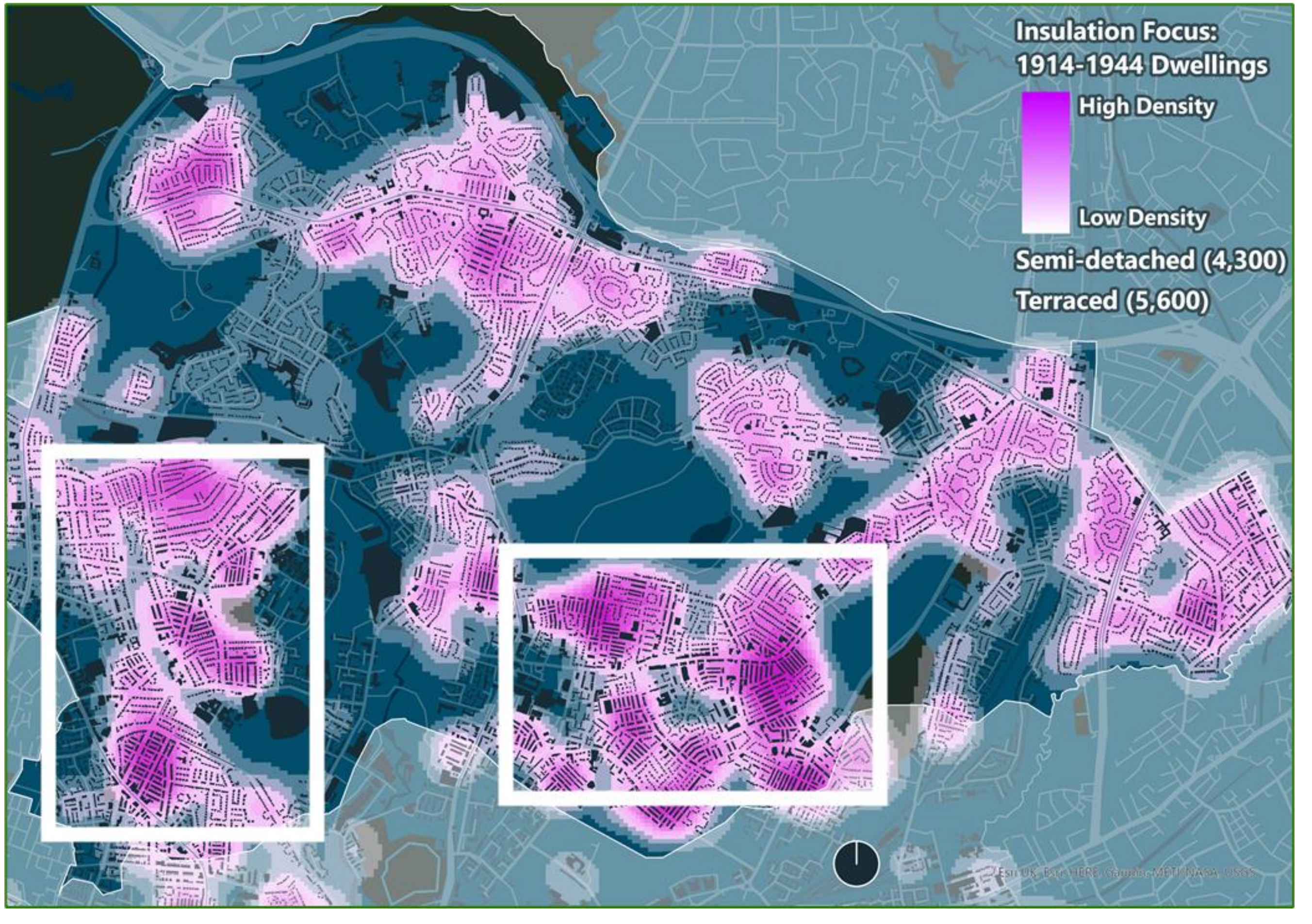
Current Fabric Retrofit Zone Opportunity in Central 3

Central 3: A low regret area for fabric retrofit measures as significant numbers (>12,000) of terraced and semi-detached inter-war dwellings are considered as cost effective to receive basic insulation measures in both the primary and secondary scenarios. If a hydrogen heating system is used, the same type of housing stock can go on to receive triple glazing as part of a deep retrofit approach.


Semi-detached
Terraced
Insulation Focus:
1914-1944 Dwellings
High Density
Low Density
Semi-detached (8,500)
Terraced (17,100)

Current Fabric Retrofit Zone Opportunity in North 1

North 1: Contains the greatest number of dwellings (>16,000) that are considered cost effective for fabric retrofit in both scenarios.




Semi-detached
Terraced


Semi-detached
Terraced

Fabric Retrofit Approach

Retrofit measures should be tailored for the individual dwelling, taking account of its type, age, construction, existing insulation and likely future heating system. For example, cavity wall insulation will only be applicable to dwellings that have suitable* cavities (usually post-1920 properties) that are not already filled. Narrow cavities, common in interwar houses, are likely to be unfilled, having been considered "hard to treat" during previous rounds of cavity treatment; targeting these dwelling types is a key focus for this LAEP.

The retrofit zones identified on the previous pages are designed to allow the coordinated targeting of interventions across Manchester in such a way that supports and aligns with Manchester's wider local energy system transformation.

There is uncertainty in the specific measures needed and most suitable for individual homes as exact details of the existing fabric efficiency of any given dwelling are not known. Survey work will be needed before any works are undertaken.

The distribution of the dwellings in Manchester expected to need retrofit measures by dwelling type is shown below. This represents around a third of the projected domestic building stock in Manchester of approximately 295,373 dwellings in 2038; increasing to 46% in the secondary scenario.

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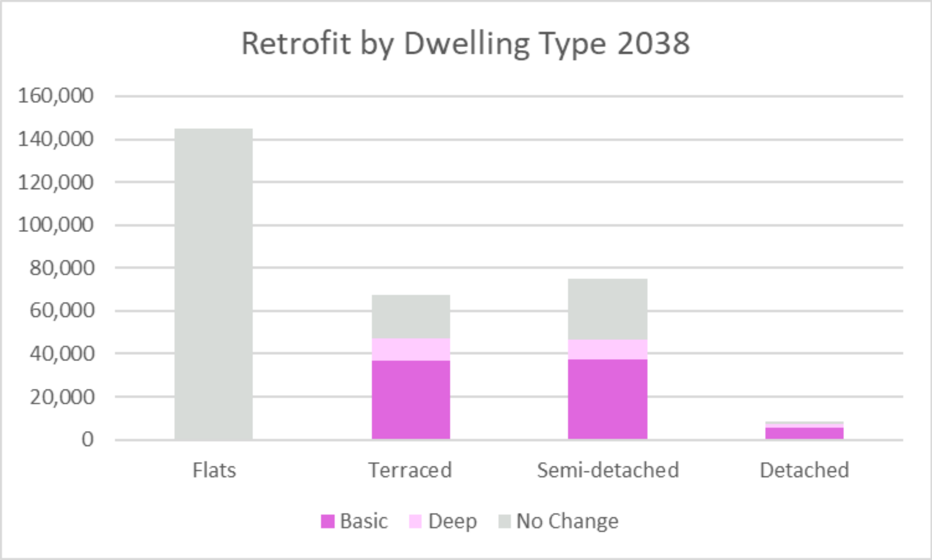
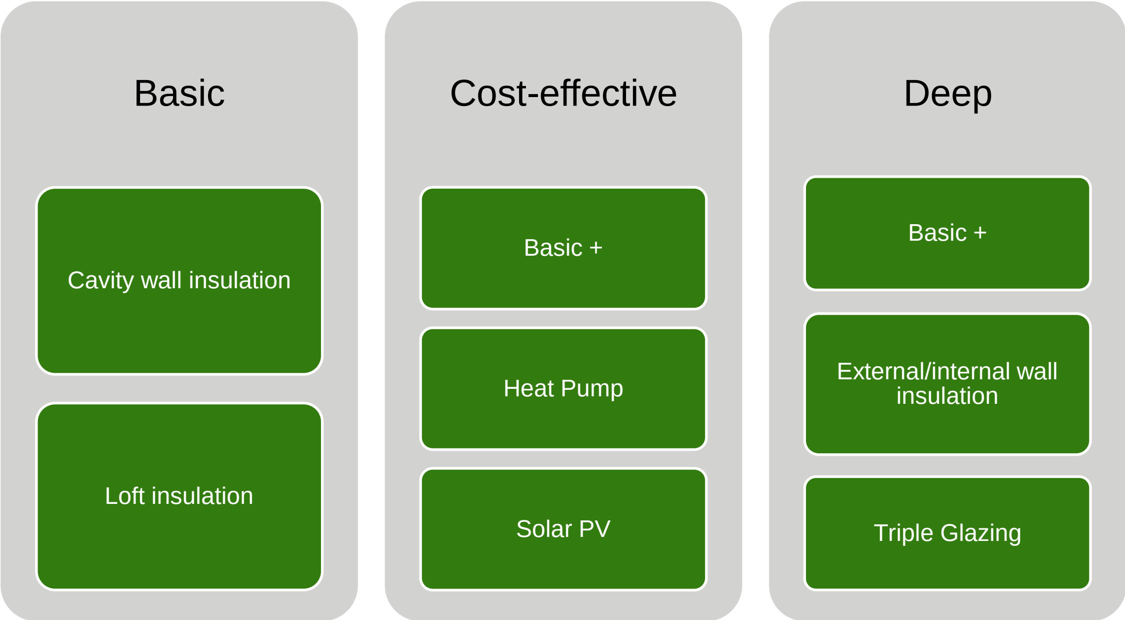
* Consideration will be needed to identify a suitable approach for insulating inter-war cavity walls, noting cavity widths are generally smaller than more modern dwellings; considering aspects such as insulation type and damp prevention, where external wall insulation may be needed on some dwellings with cavity walls



Over 70,000 homes receive basic measures in both scenarios. However, around 34,000 additional dwellings receive fabric retrofit measures in the secondary scenario, where the additional measures are predominantly of the 'deep' type. Carrying out basic measures in earlier years would not therefore preclude deeper measures being installed in homes in later years. Hence basic measures are considered low regret across all scenarios and heating system selections. Due to the housing type targeted, a significant proportion of the cost-effective deep measures are based on adding triple glazing to dwellings with basic measures applied, rather than large volumes of external/internal wall insulation to pre-war period dwellings.

Cost-Effective Deployment

The proposed approach centres on ensuring basic fabric retrofit measures are implemented in the vast majority of suitable homes in Manchester, which is found to be the most cost-effective approach for the whole system. The deployment of more advanced measures is much more limited due to the additional cost and disruption to install. However, deployment of measures should not be considered in isolation; integration with other components (such as heating system changes, PV installation and EV charging) can help minimise disruption and offer cost savings, and so opportunities to develop cost-effective whole-house approaches will need to be considered during the development of any activity to take forward this LAEP. The range of different potential packages is illustrated in the diagram below*.



Rapid deployment of retrofit measures could be a relatively easy intervention in the near term, which is especially beneficial for staying within the carbon budget. The rate of deployment that is possible will depend on the development of a supply chain and business models; developing this in the next few years could allow for higher deployment rates in the medium term to support progress with decarbonisation where there may not yet be clarity on heating systems across all parts of Manchester.

* The modelled packages align loosely with packages in the Pathways to Healthy Net Zero Housing for Greater Manchester, with some differences due to the modelling approach. The 'deep' package here is similar to the fabric measures in the 'deep' package in Pathways. The 'basic' package in this report is loosely comparable to the fabric measures in the 'cost-effective' package in the Pathways report, but generally does not include external/internal wall insulation. The cost-effective package illustrated here was not part of the modelling but may be a useful 'real life' approach for individual houses under the primary scenario when wider factors are taken into account

In a hydrogen scenario, the number of dwellings expected to need retrofit would be even greater than in an electrified scenario. This is due to the timing of the introduction of hydrogen and a greater heat saving being required earlier to stay within carbon budgets.

Deeper Retrofit

The approach described is based on finding the most cost-effective route for decarbonising Manchester overall, in line with the carbon budget.

However, there may be strong reasons for additional retrofit work and so deeper and more extensive retrofit for individual dwellings is expected, with the potential to bring benefits including:

- Increased comfort and reduced running costs for individual households. This could also be important for some households to reduce fuel poverty and improve health and general quality of life
- Potential to reduce energy consumption and associated carbon emissions across Manchester more quickly. This would give greater headroom in the carbon budget, especially if carried out early in the plan, to wait for more certainty on important options such as that related to the future of the gas grid.

Supporting Low Carbon Heat

The improvement of building insulation supports the roll out of low carbon heat in several ways. By reducing the heat demand, less powerful heating systems can be installed, reducing capital costs. The reduced demand for heat will also compensate for a shift to a more expensive energy source (gas to electricity or hydrogen). Finally, reduced heat losses enable heat pumps and district heat networks to run at lower temperatures, improving their efficiency and running costs, and may also reduce the need for radiator upgrades in homes.

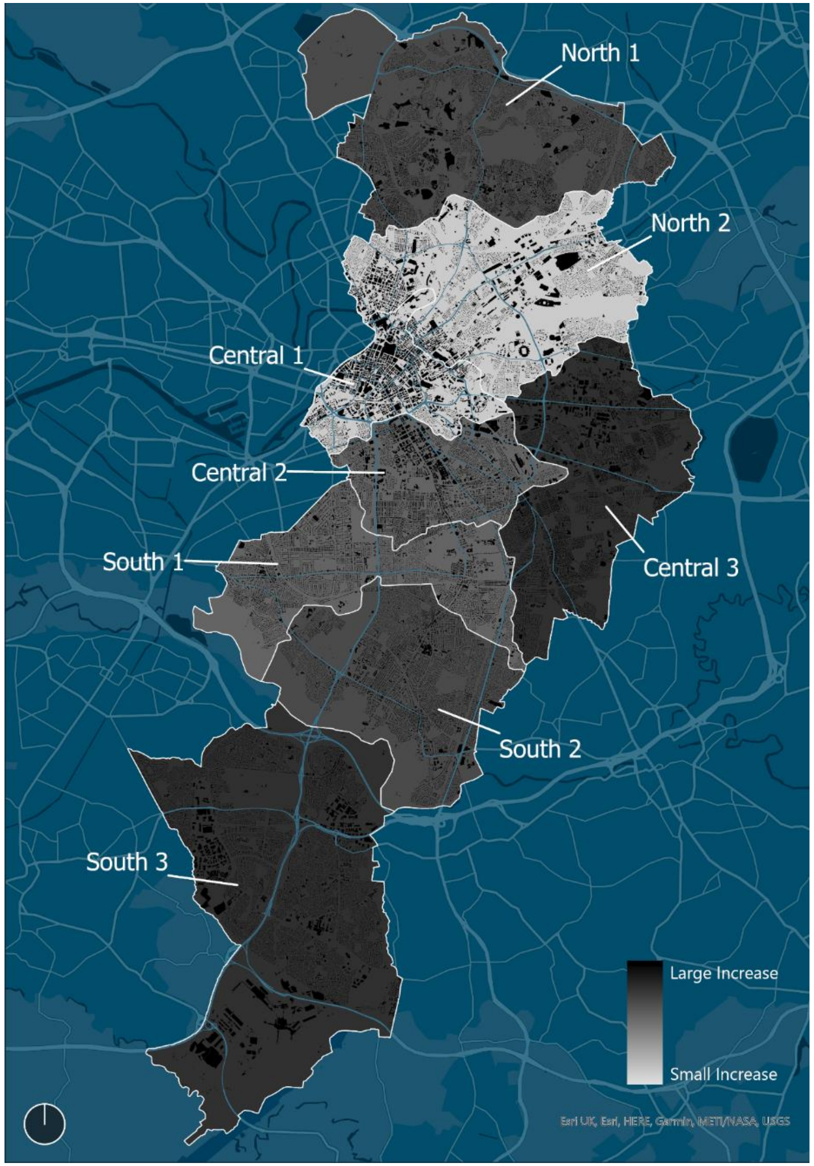
It therefore makes sense to carry out retrofit either before or at the same time as heating system replacements to capture these benefits. Carrying out both activities at the same time would minimise the number of disruptions experienced by households, while insulating earlier would provide further emissions reductions compared to the modelled scenarios.

Vision to 2038

Building characteristics, costs to install heating systems and costs to build or upgrade networks inform the low carbon heating system best suited to each building, and this causes patterns to emerge between the zones across Manchester. The approach taken to decarbonise heating is very much dependant on the assumptions made around the availability of affordable, very low carbon hydrogen.

The primary scenario, which aims to reach the carbon targets using proven technology, achieves this mainly through installation of electric heat pumps in existing and new homes, resulting in more than 180,000 domestic heat pump installations. These are the predominant heating system in all areas besides North 2 and Central 1, although other electric systems are also present in less significant numbers.

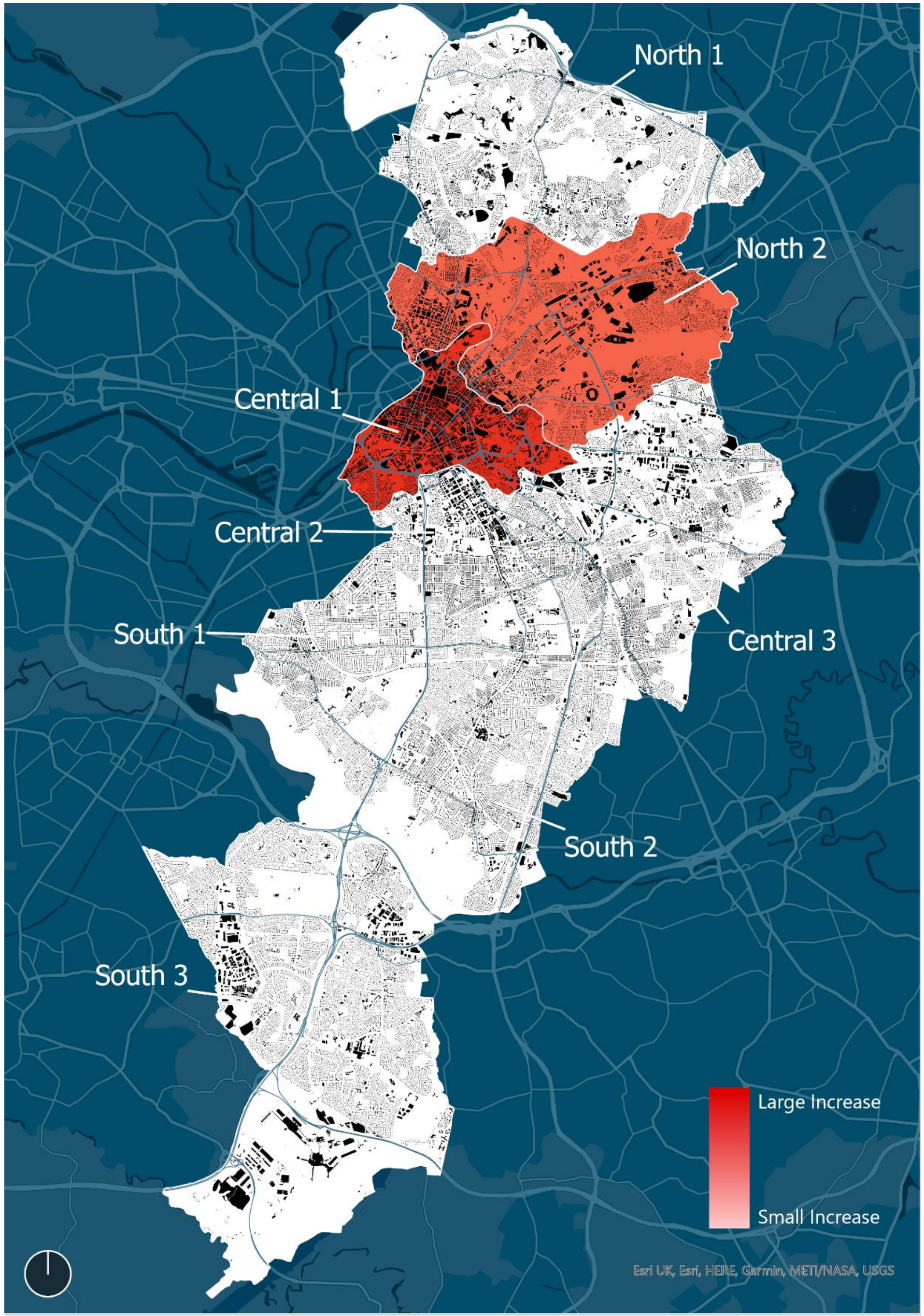
Heat Zones for electric heating in Manchester by 2038 (Primary Scenario)


North 1
North 2
Central 1
Central 2
Central 3
South 1
South 2
South 3
Large Increase
Small Increase
Esri UK, Esri, HERE, Garmin, METI/NASA, USGS

A significant proportion of dwellings (32,000) were found to cost effectively transition to a district heating system, with this serving a major share of homes in North 2 and Central 3, alongside electric resistive and some heat pumps.

In contrast, the availability of affordable, low carbon hydrogen to buildings by 2030 results in hydrogen boilers being chosen as the predominant heating system, serving over 225,000 homes. In this scenario, hydrogen takes the place of most of the district heating network, as well as providing a way for industry to decarbonise. Heat pumps do, however, retain a significant share of the heating duty in this case (see next page).

Heat Zones for District Heating in Manchester by 2038 (Primary Scenario)

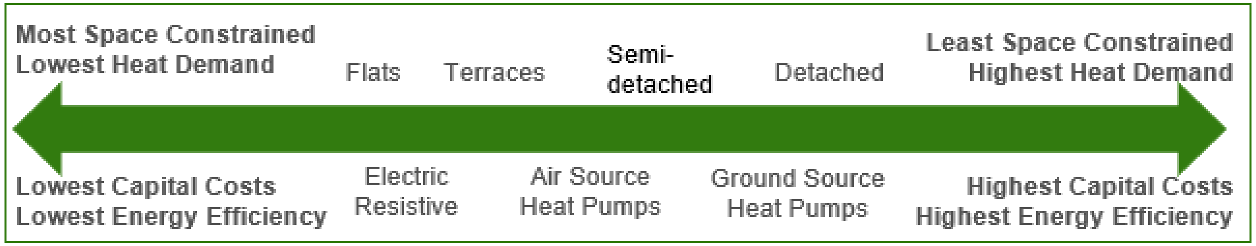

North 1
North 2
Central 1
Central 2
Central 3
South 1
South 2
South 3
Large Increase
Small Increase
Esri UK, Esri, HERE, Garmin, METI/NASA, USGS

Even where hydrogen is widely available, least-regret effort in the near term is focussed on retrofit, priority electrification areas, and monitoring the development of hydrogen (at national and regional levels). The installation of hydrogen-ready boilers could provide optionality given the uncertainty, at minimal additional cost.

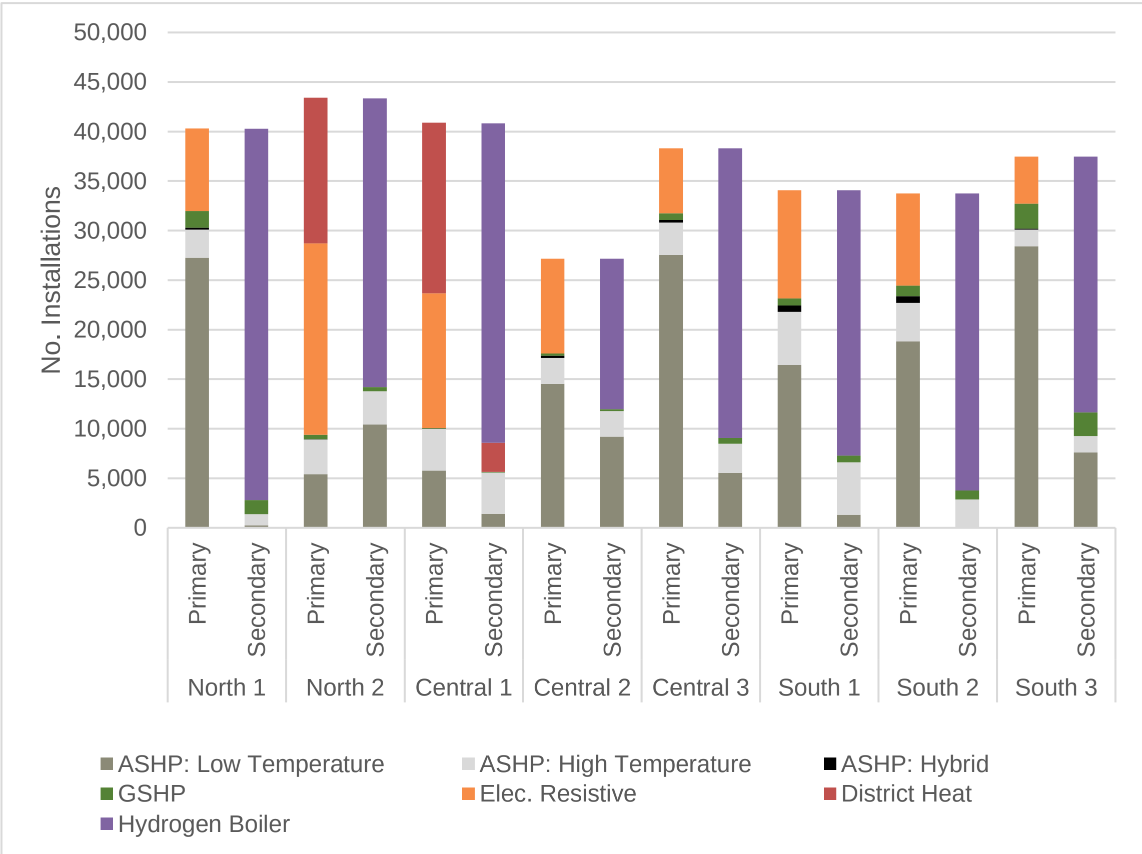
These forecasts are not definitive and represent a view of the future for each zone, to illustrate the scale of change required, it is expected that alternative solutions will be specified when exploring at a more detailed level, for example, there may be opportunities for communal / shared heating systems over the use of individual heat pumps.

Heating System Selection

Standalone electric heating systems are selected according to building characteristics as shown in the diagram below, while district heating is chosen in dense urban areas. In the secondary scenario, hydrogen boilers are selected instead of electric or district heat options for many homes, as shown in the chart on the right



Deployment of Heating Systems by 2038 in the Primary and Secondary Scenarios



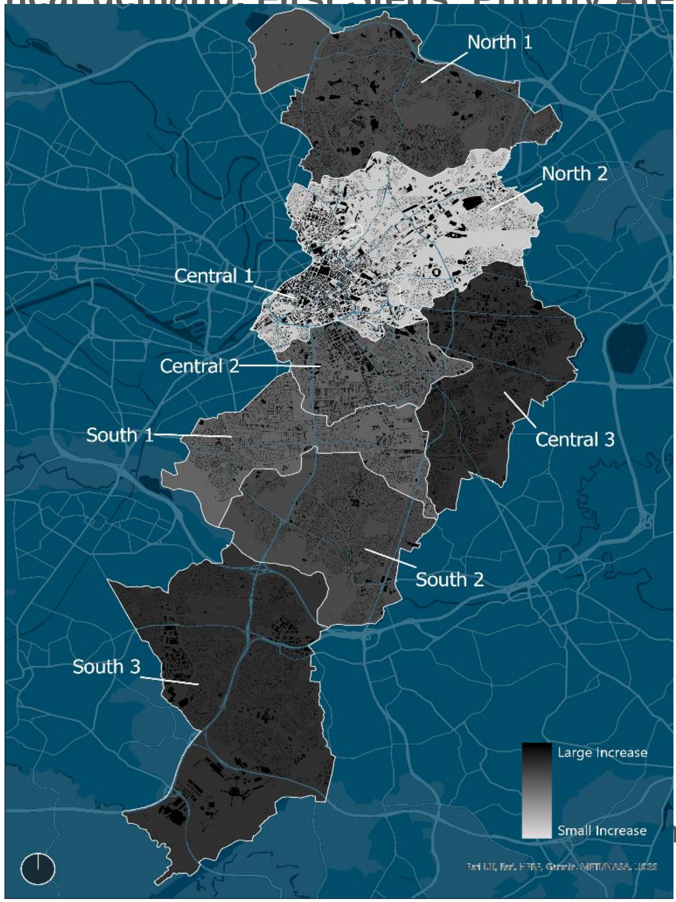
Air source heat pumps are the most widely suited electric heating technology, though a small proportion of homes in most areas was found to be suitable for ground source heat pumps, where greater outdoor space permits the installation of a ground collector, and larger properties can justify the higher upfront cost with greater savings in running costs. These properties would also be suitable for air source if preferred. Electric resistive (conventional heaters) can be used in space-constrained buildings with low heat loads, such as modern flats.

Heat pumps are a proven and mature renewable heating technology, capable of delivering deep emissions reductions today. They can be rolled out to individual households gradually, without the requirement for large scale area transitions and buy-in from multiple households that district heating and hydrogen require. Some disruption within the home is typically required for radiator replacements and the installation of a hot water cylinder in homes which do not have one already. These indoor space requirements, together with the need to manage disruption to the household and site an outdoor unit where it will not cause noise issues for neighbouring properties, must be considered in the design, and can make heat pumps unsuitable for some properties. These issues would be avoided with hydrogen boilers, which would be a like-for-like replacement for natural gas boilers.

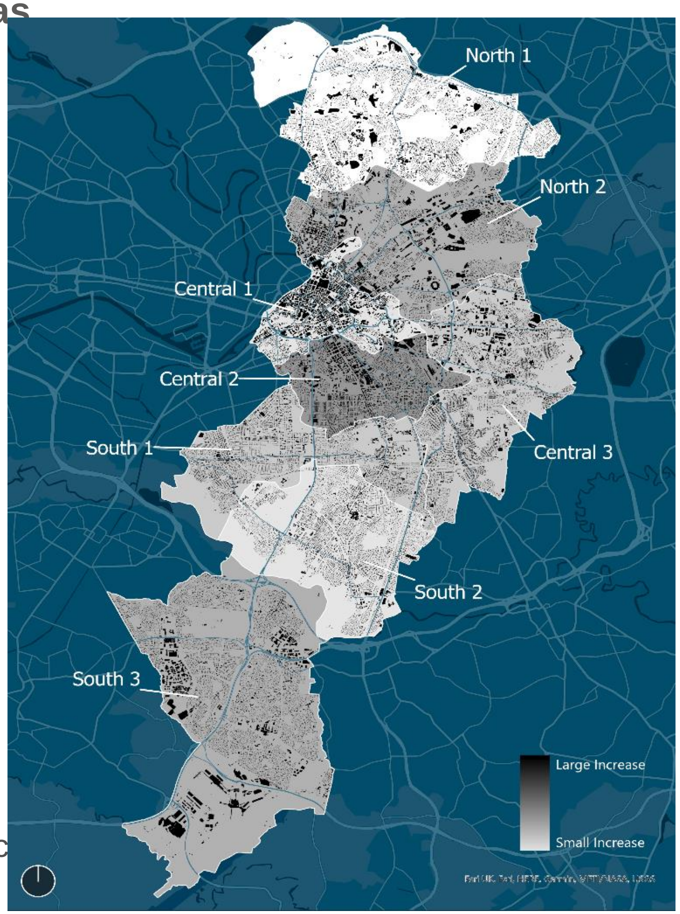
Heat pumps perform best in homes with good levels of insulation, so building retrofit should be considered alongside heat pump installations to minimise disruption to dwelling occupants. This would also reduce overall cost by allowing smaller heat pumps to be used and fewer radiators to be upgraded due to reduced heat demand.

First Steps: Priority Areas

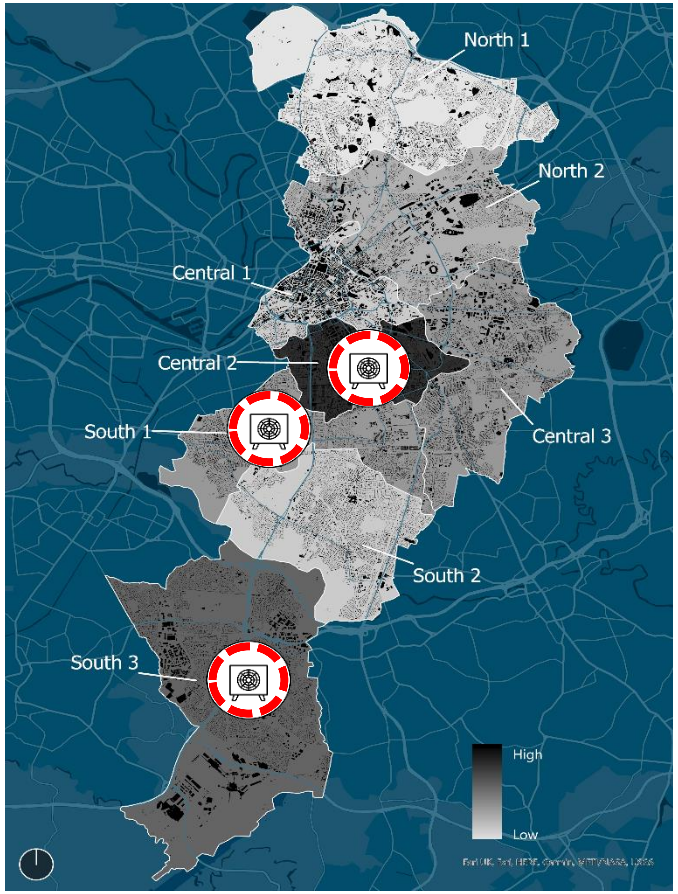
Primary Scenario



Secondary Scenario



Dwellings with heat pumps in both scenarios



Certain geographic zones within Manchester have been highlighted as having a large number of buildings well-suited to a particular heating technology, independent of scenarios. Early progress can be made in deploying systems in these zones, with low risk of regret even before the UK's heat strategy becomes more certain. Prioritising these zones for early deployment as existing heating systems approach end-of-life (while avoiding the distress replacement of a stranded asset, which can constrain options) can help establish supply chains, delivery approach and capacity. This strikes a balance between flexibility and early progress, leaving the plan open to developments around the future of the gas network, conversion to hydrogen and UK heat strategy, ahead of a mass programme of transition in places where the best option is less clear.

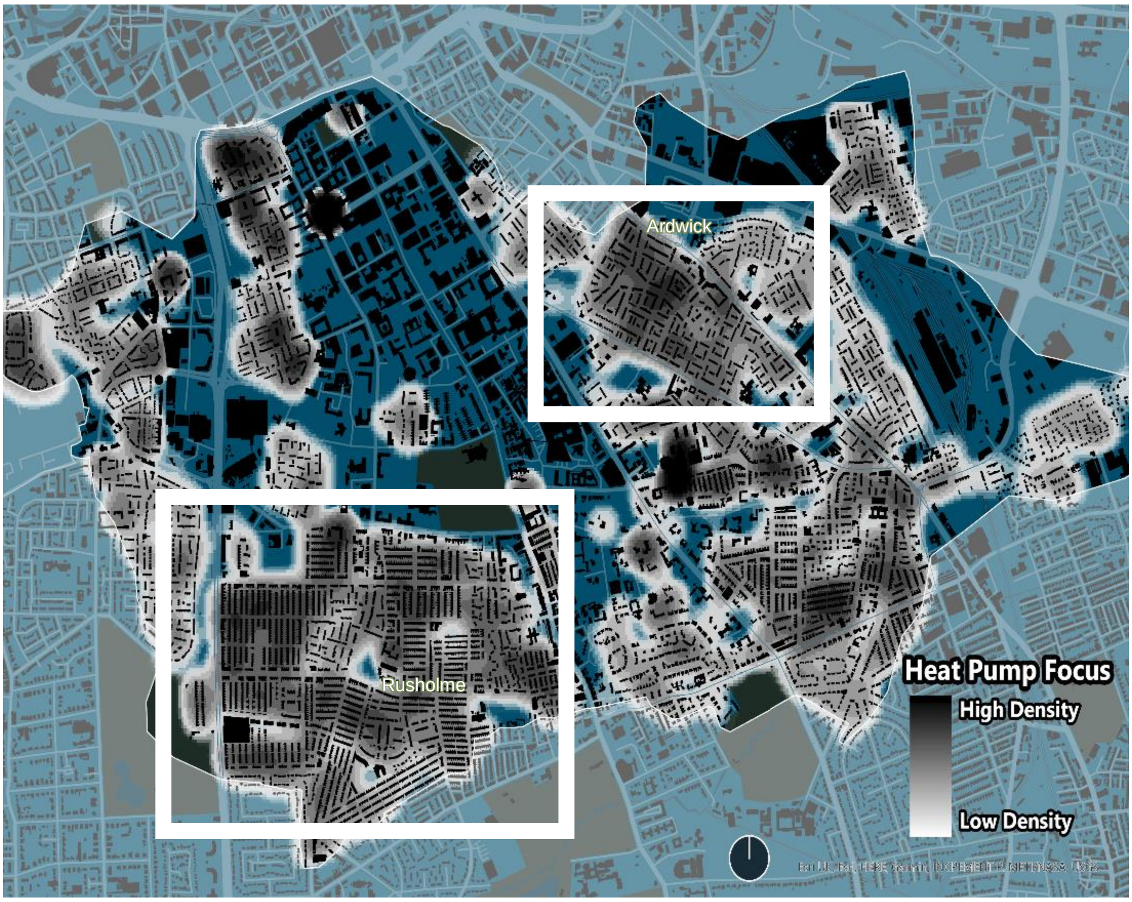
The following maps to the and on the following pages illustrate suggested priority areas for demonstration and scale-up activity. Consideration will be needed to develop a programme of works that aligns with other interventions to maximise delivery efficiency and minimise disruption to residents.

Heat Pump Priority Areas

- **Central 2 (primarily terraced housing)**
- **South 3 (primarily flats and highest quantity of detached housing)**
- **South 1 (primarily semi-detached housing)**

Central 2

Central 2 is an area in which, even in a high hydrogen scenario, heat pumps are still a predominant technology, suggesting they are a low regrets opportunity for early deployment here. This area has a high number of terraced houses transitioning to air source heat pumps in both scenarios. Central 2 has a high number of flats, of which around a third transition to air source heat pumps, with the remaining staying on electric resistive.

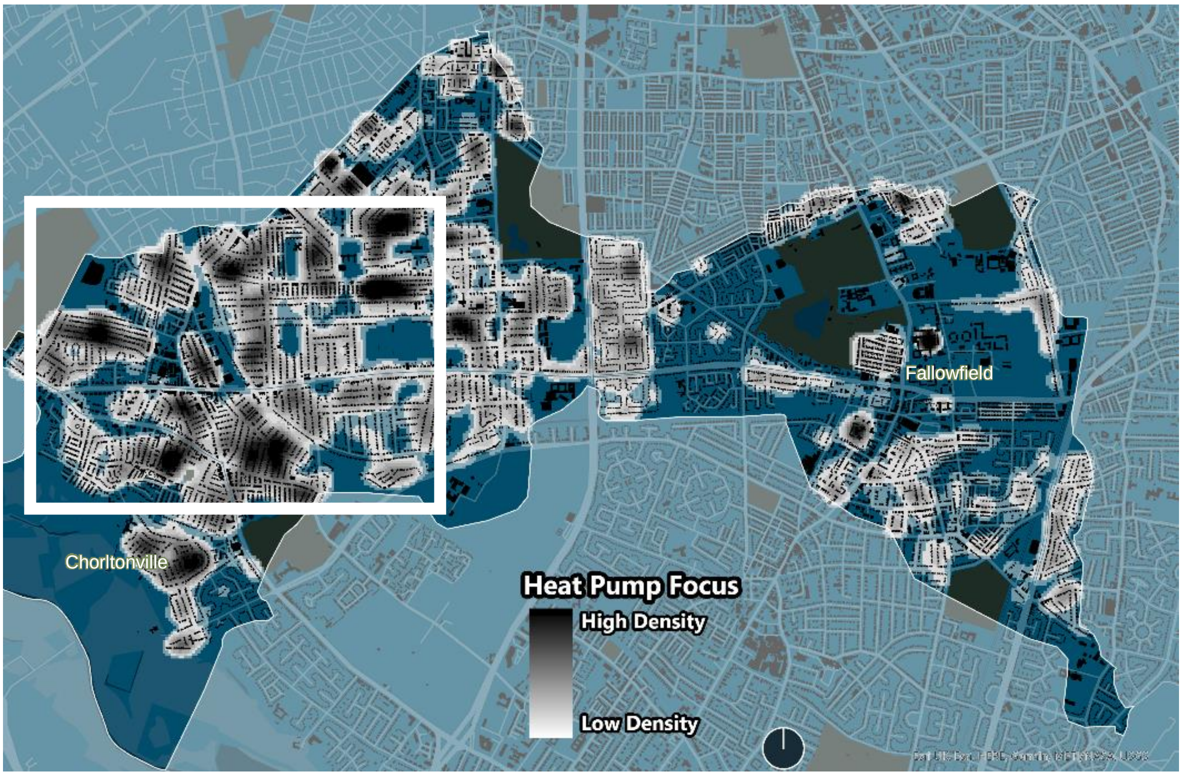


South 3

Similar to Central 2, South 3 sees a significant uptake of heat pumps even in the hydrogen scenario. In this area, the balance is weighted more towards air source heat pumps serving semi-detached homes, with fewer flats, being a lower density zone. It also sees a high number of ground source heat pumps given the number of detached houses.

South 1

South 1 is also suggested as a heat pump priority zone because very little industrial use of gas has been identified here, suggesting this area would be less likely to be prioritised to connect to a hydrogen network. Since homes near specific industrial areas could be considered more likely to be connected to a hydrogen supply (e.g. were hydrogen supply to be limited), South 1 can be considered a low regrets zone to make early progress on heat pump deployment. South 1 is more similar to Central 2 than South 3, with a significant share of electric resistive heating in flats, and a majority of homes heated by air source heat pumps.

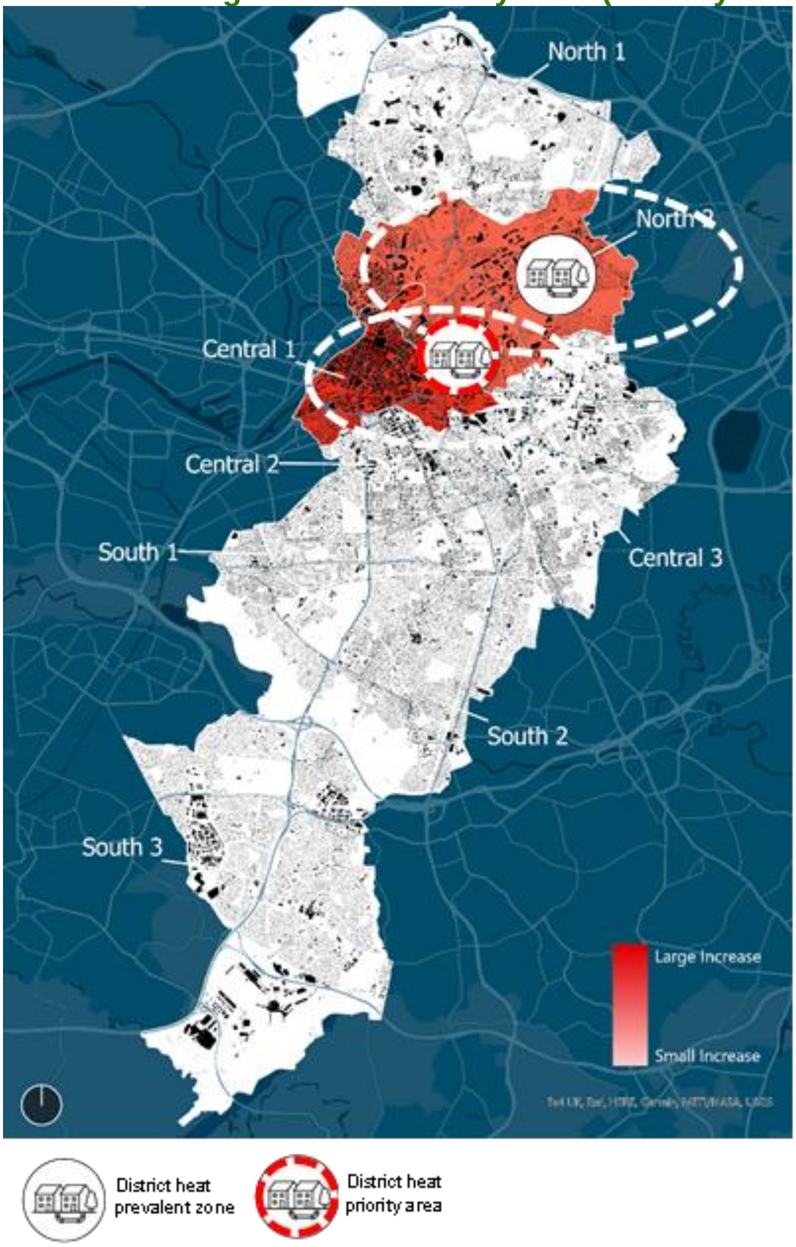


District Heat Networks

Heat supplied through underground pipes from a centralised energy centre tends to be most suitable for dense urban areas, particularly where it is either too expensive (e.g. to reinforce the electrical network) or impractical (e.g. due to space limitations) to make suitable for heat pumps or to supply with hydrogen

Heat networks can have the advantage of causing less disruption in dwellings during installation compared to some other options, though there are wider considerations such as disruption to roads during pipe laying, and space restrictions in city centres. Two zones of lowest regret for district heating have been identified for Manchester: North 2 and Central 1*.

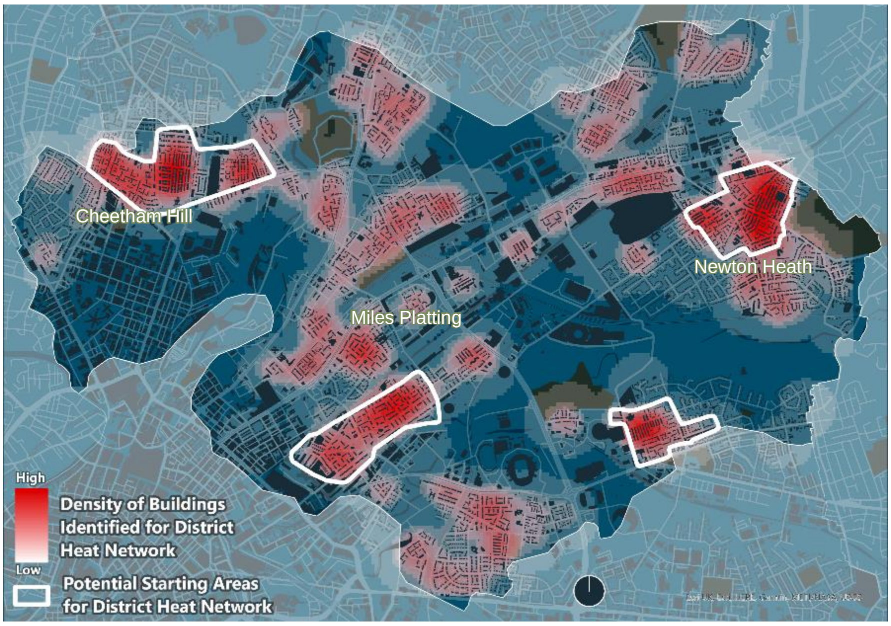
Heat Zones for District Heating in Manchester by 2038 (Primary Scenario)



* These ‘low regret’ areas highlight where it has been identified that district heating could provide the most cost-effective dwelling heat decarbonisation system. They should be regarded as initial opportunity areas for further consideration, where more detailed feasibility assessment would be required, as would be the case with any heat decarbonisation option

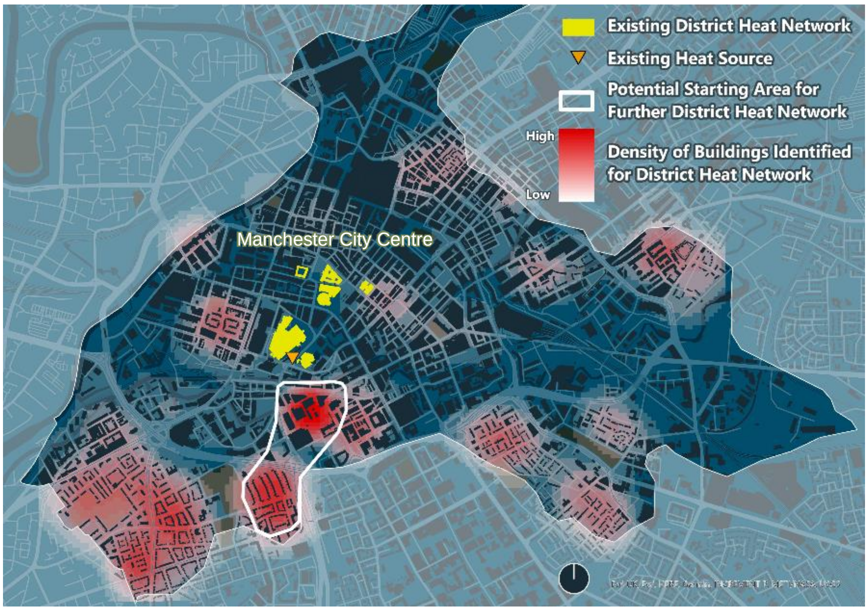
North 2

The high concentrations of tightly packed terraced dwellings provide a good opportunity for heat networks, avoiding the noise and planning constraints, as well as additional electricity network reinforcement often required for heat pump deployment. These dwellings, along with nearby flats, provide an ideal opportunity for the rollout of a scheme. With 13,000 flats also due to be built in this area between now and 2038, early consideration of a heat network in this area would maximise the number of new flats which could benefit from a potential district heat network.



Central 1

Central 1 contains a pre-existing heat network, which could be expanded to serve more buildings (mostly flats) in the dense city centre. Even in the secondary scenario, it is still cost effective to supply approximately 3,000 dwellings from the district heating network, meaning that Central 1 is considered a least regret area to target as a district heat priority area. Initial focus can centre on how to develop appealing propositions to transition and retrofit existing mixed tenure housing stock to a district heating network.



Hydrogen for Heating

The representation of hydrogen in the analysis for this plan has been aligned with the proposals for HyNet in the North West of England, and the associated opportunities for the GMCA area.

The primary scenario reflects phases 1 and 2 of HyNet, where low carbon hydrogen may be available from 2025 onwards for the largest industrial sites in the region. It is not believed that any of these are likely to be in Manchester. The secondary scenario includes the possibility of HyNet phase 3, where low carbon hydrogen becomes available for the homes and the full range of non-domestic buildings from the early 2030s onwards. This would require the repurposing of areas of gas grid to serve the hydrogen to the users. Under this scenario it is seen as cost effective to provide hydrogen to domestic and non-domestic buildings in significant areas of Manchester, although heat pumps are still found to provide a cost-effective solution to a notable proportion of buildings. Analysis showed that the total carbon emitted was very sensitive to the exact year that low carbon hydrogen became available in suitable quantities. Further detail is provided in Energy Networks chapter.

In the secondary scenario, hydrogen heating displaces much of the electric and district heating across all clusters. This would retain the use of boilers in homes, providing familiarity to dwelling/building occupiers. However, in areas highlighted as potential district heating zones, over-time, energy centres could be served by hydrogen boilers, making district heating a low regrets option where there is any hydrogen uncertainty; for example, district heating networks could initially be served by heat-pump systems that are replaced or supplemented by hydrogen boilers in the 2030's.

Opportunity areas

Several zones could focus on hydrogen deployment (if available) for different reasons.

- The shading on the map shows the intensity for uptake of hydrogen for domestic heating, according to the cost optimal modelling in scenario 2.
- The industry icons highlight zones where it is thought a larger quantity of gas may be needed for high temperature industrial purposes, representing a non-domestic opportunity for hydrogen.
- When hydrogen availability is constrained, modelling found that hydrogen was deployed preferentially in North 2 and Central 1, where it was of most value when scarce.
- Finally, the planned route of the hydrogen pipeline for phase 2 of the HyNet project is indicated on the map.

These factors combined to recommending North 2 as an opportunity area for hydrogen heating, although as outlined above there are opportunities in multiple zones.

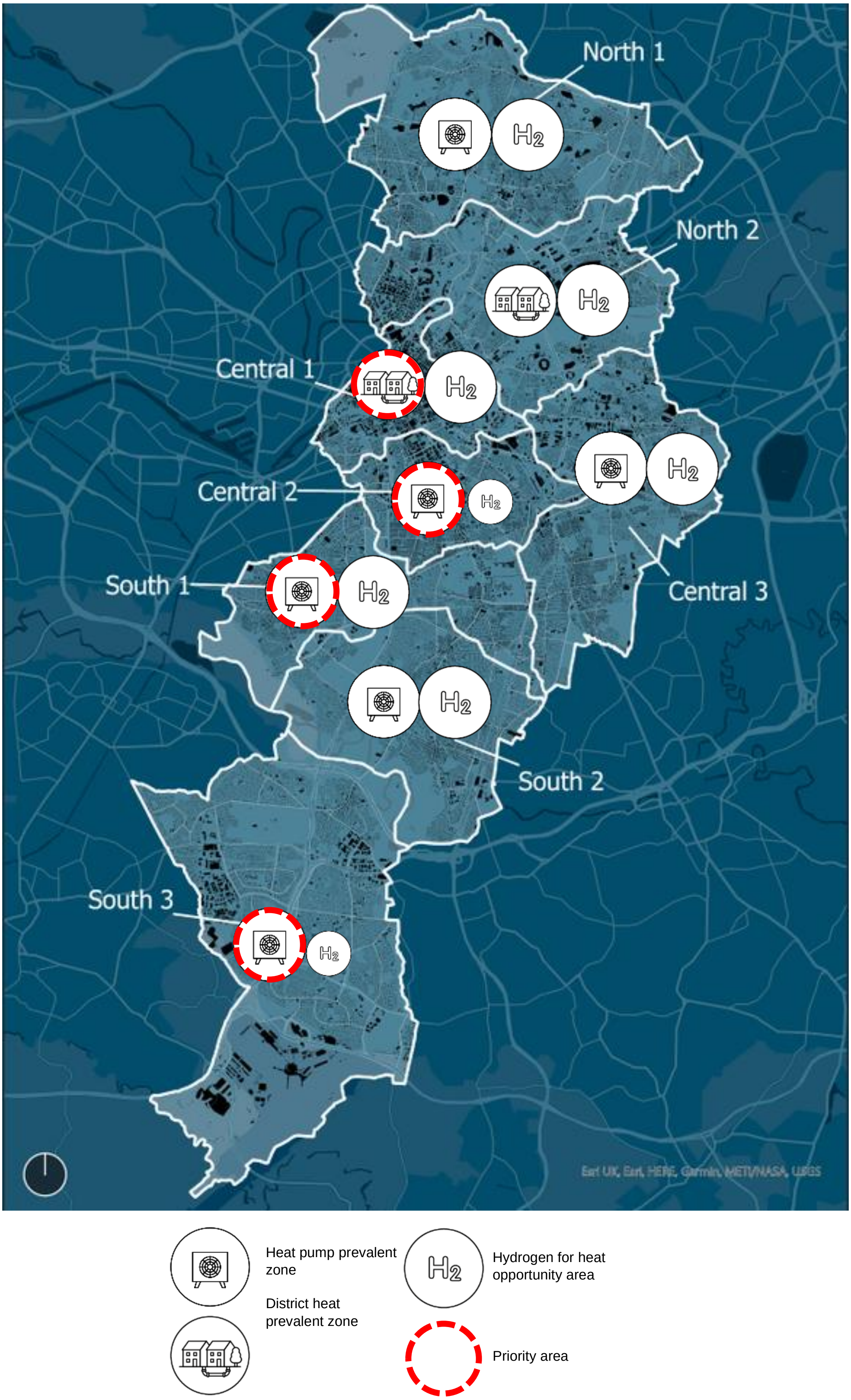
Hydrogen for heat opportunity area

Areas of high gas use by industry which may be difficult to electrify

4. HEATING SYSTEM ZONES - SUMMARY

Most zones swing between being dominated by air source heat pumps or by hydrogen boilers, depending on assumptions about the availability, cost and carbon content of hydrogen. In the hydrogen scenario, heat pumps still play a supporting role in every zone, and a significant role in Central 2 and South 3 zones. The zones North 2 and Central 1 swing between heat networks and hydrogen, with a supporting role from heat pumps in both cases.

Zone	Primary scenario – Prevalent heating system	Secondary scenario – Prevalent heating system	Priority area
North 1	Heat Pump 80%, electric resistive 20%	Hydrogen 95%	No
North 2	Electric resistive 50%, district heat 30%, heat pump 20%	Hydrogen 70%, heat pump 30%	Hydrogen priority area
Central 1	District heat 40%, electric resistive 35%, 25% heat pump	Hydrogen 80%, heat pump 15%, district heat 5%	District heat priority area
Central 2	Heat pump 65%, electric resistive 25%	Hydrogen 55%, heat pump 45%	Heat pump priority area
Central 3	Heat pump 85%, electric resistive 15%	Hydrogen 75%, heat pump 25%	No
South 1	Heat pump 65%, electric resistive 35%	Hydrogen 80%, heat pump 20%	Heat pump priority area
South 2	Heat pump 70%, electric resistive 30%	Hydrogen 90%, heat pump 10%	No
South 3	Heat pump 85%, electric resistive 15%	Hydrogen 70%, heat pump 30%	Heat pump priority area


North 1
North 2
Central 1
Central 2
Central 3
South 1
South 2
South 3
Esri UK, Esri, HERE, Garmin, METI/NASA, USGS
Heat pump prevalent zone
District heat prevalent zone
Hydrogen for heat opportunity area
Priority area

4. NON-DOMESTIC BUILDINGS - SUMMARY

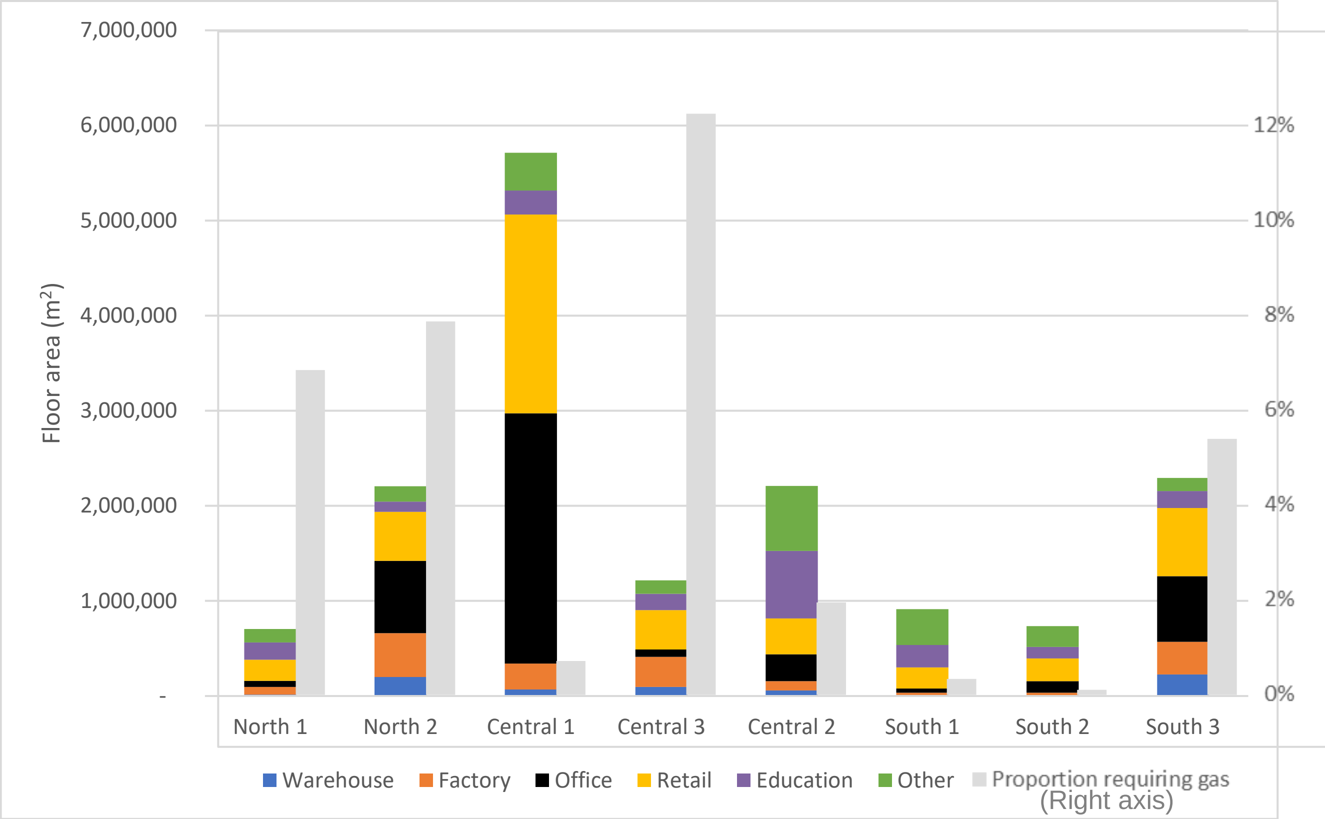
With the requirement to rapidly reduce CO_2 emissions in line with the GM carbon budget, the primary scenario is based on an individual heat pump transition for the majority of Manchester's non-domestic buildings. The estimated combined investment (for improving the energy efficiency and installing heat pumps) is in the region of £5.7b. Key associated points include:

- The majority of Manchester's non-domestic buildings (95% by floor area) have been deemed able to transition to a heat pump option. However, in the scenario where hydrogen becomes widely available for building heating in time to meet carbon targets, it could be used in a majority of non-domestic buildings as an alternative to electrification, similar to domestic buildings.
- Around 5% of non-domestic buildings by floor area are deemed to be reliant on either natural gas or hydrogen for use in industrial processes.
- The practicality of providing zero carbon heat to distributed sites (as per the map on the following page which illustrates an area within Central 1) will need consideration and solutions developed. For example, if zero carbon gas is needed, then consideration is required of whether surrounding buildings should also be served by the same network / infrastructure[*]
- Further area-specific and detailed consideration is required to identify the most appropriate non-domestic solutions. For example, whilst the primary scenario is based on individual heat pump options, Central 1 and North 2 have been identified as the zones of least regret for potential heat network development[†]. With a wide range of building usage types (see chart), solutions will be dependent on building type and aspects such as density of non-domestic buildings

[*] Acknowledging that the primary scenario is based on identifying the solution to decarbonise aligned to the GM carbon budget. Further area and building specific consideration will be needed to determine specific, cost-optimal, logical and practical solutions, considering both district heating and hydrogen options. However, delaying the transition of non-domestic buildings will result in a greater amount of CO_2 emissions that would need to be reduced through other means. Plans and timing for heat network development and HyNet will need to be considered in any decision making

[†] More detailed consideration is expected to identify non-domestic buildings where it would be beneficial to connect to a heat network, particularly when considering opportunities to develop district heat networks to supply dwellings in the surrounding areas; specific district heating network master planning, heat mapping, feasibility and subsequent detailed design assessment will be required

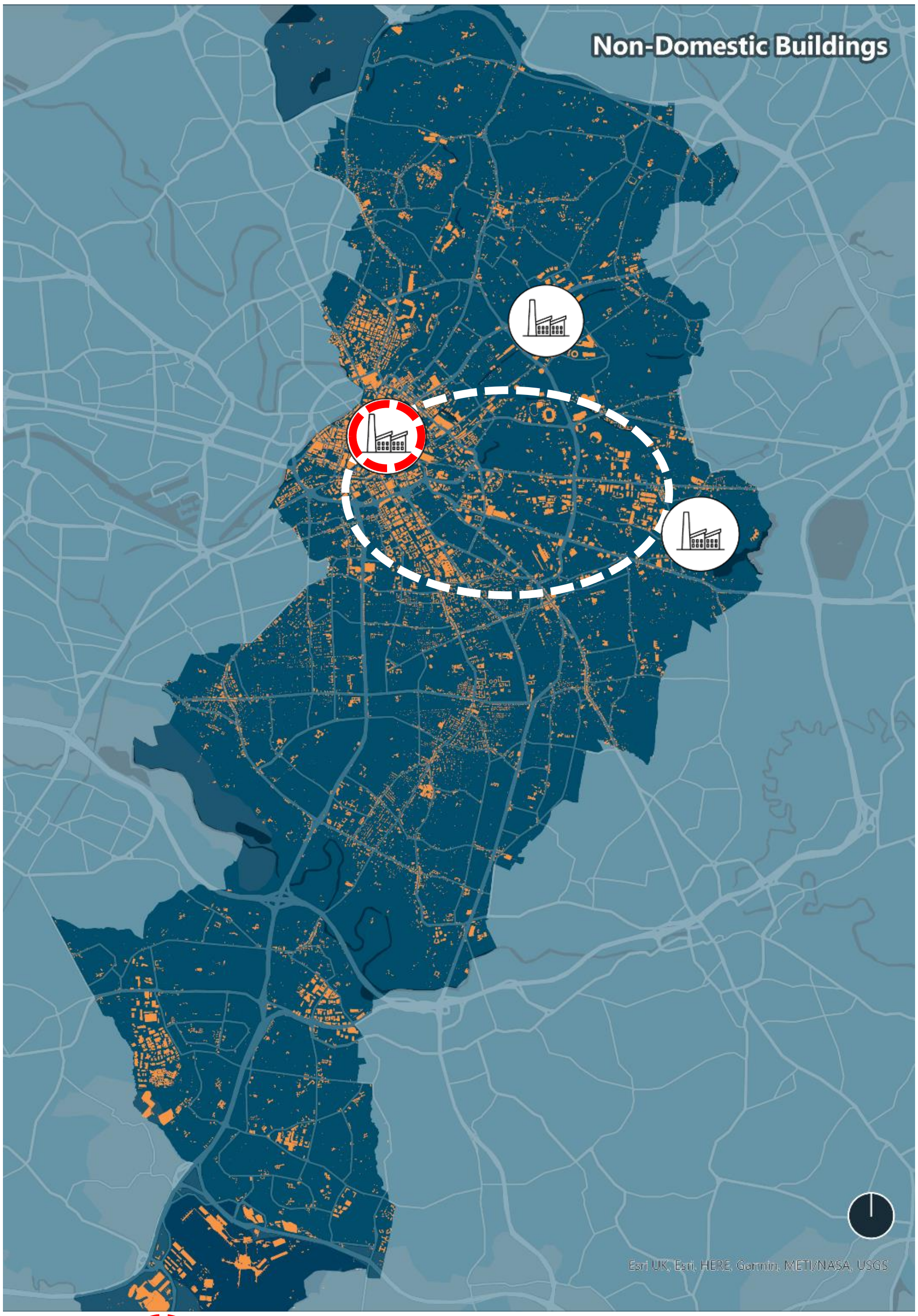
Non-domestic Building Usage by Floor Area (m^2)



Non-domestic buildings opportunity area selection

North 2, Central 1 and Central 3 have been identified as opportunity areas to demonstrate how to decarbonise Manchester's non-domestic buildings before considering wider scale-up. While Central 1 has the greatest proportion of non-domestic buildings in Manchester, it contains a large amount of retail and office space that makes it well suited to be served by heat pumps or district heating, which can be prioritised for near-term development. Central 3 has a cluster of industrial buildings that may be hard to decarbonise without gas, and North 2 has been flagged as a hydrogen opportunity area, while also having a significant portion of buildings which may be hard to decarbonise without gas. All of these characteristics provide a good basis for determining an approach that could later be applied to non-domestic buildings across Manchester.

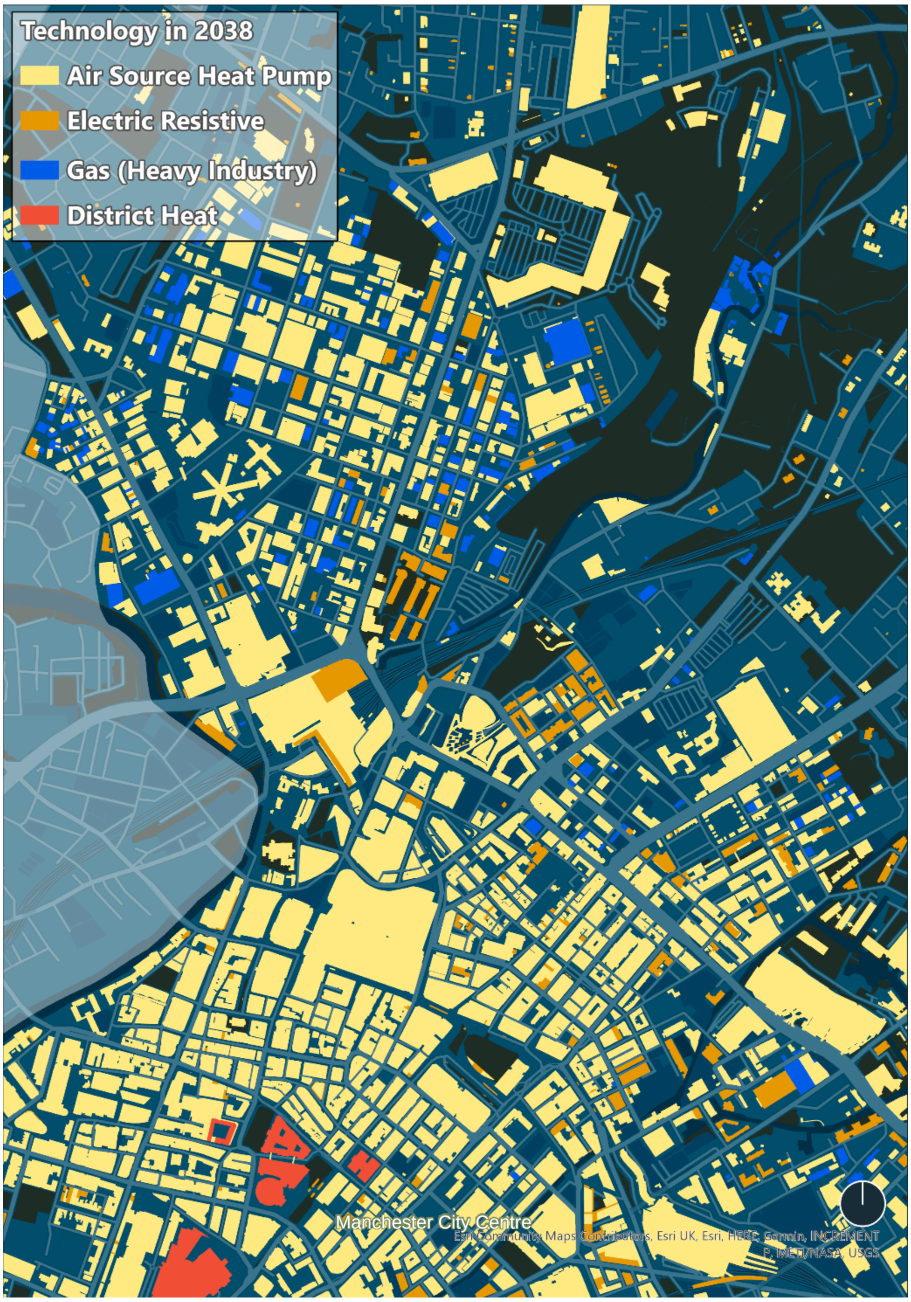
Non-domestic decarbonisation priority areas



Non-domestic opportunity area

Non-domestic priority area

Illustrative deployment of heating system in non-domestic buildings



Vision to 2038

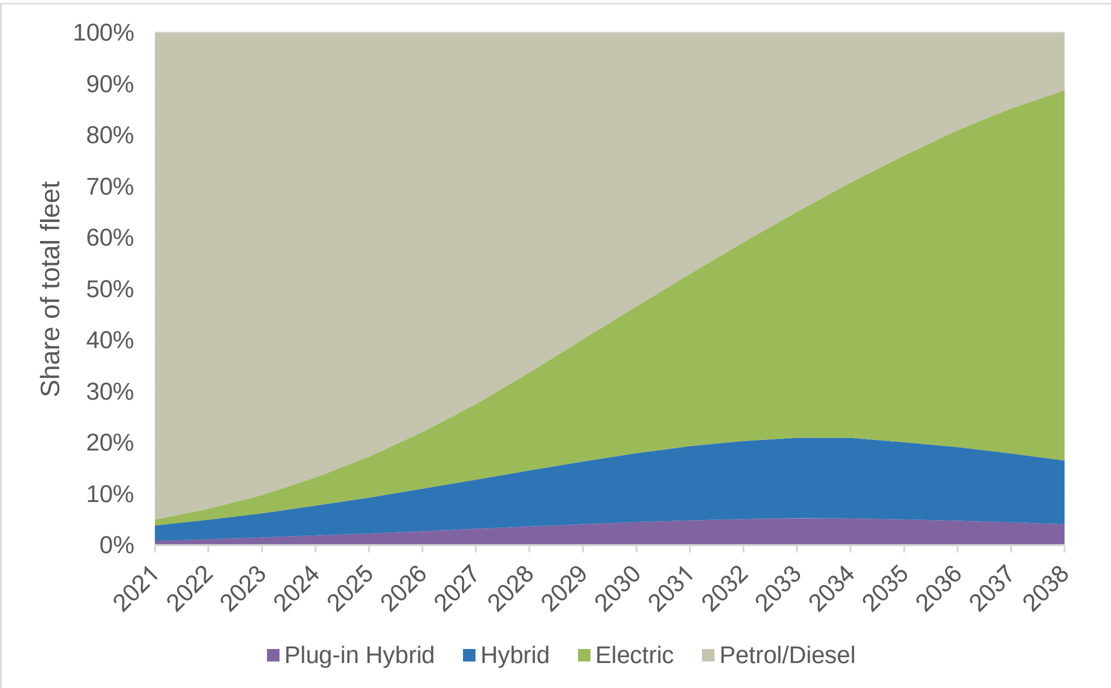
Electric Vehicle (EV) ownership is expected to grow significantly to support local decarbonisation targets and in alignment with national policy, which will see the phasing out of internal combustion engine vehicle sales by 2030 and hybrids by 2035.

Fully electric and plug-in hybrid vehicles in Manchester are expected to grow from around 3,000 today to over 150,000 cars by 2038 – over 75% of the total fleet. Charging infrastructure will need to be installed to encourage this transition and keep up with this demand, providing confidence that owners will be able to recharge when needed. A mixture of publicly accessible and private residential chargers will be required to provide this amenity.

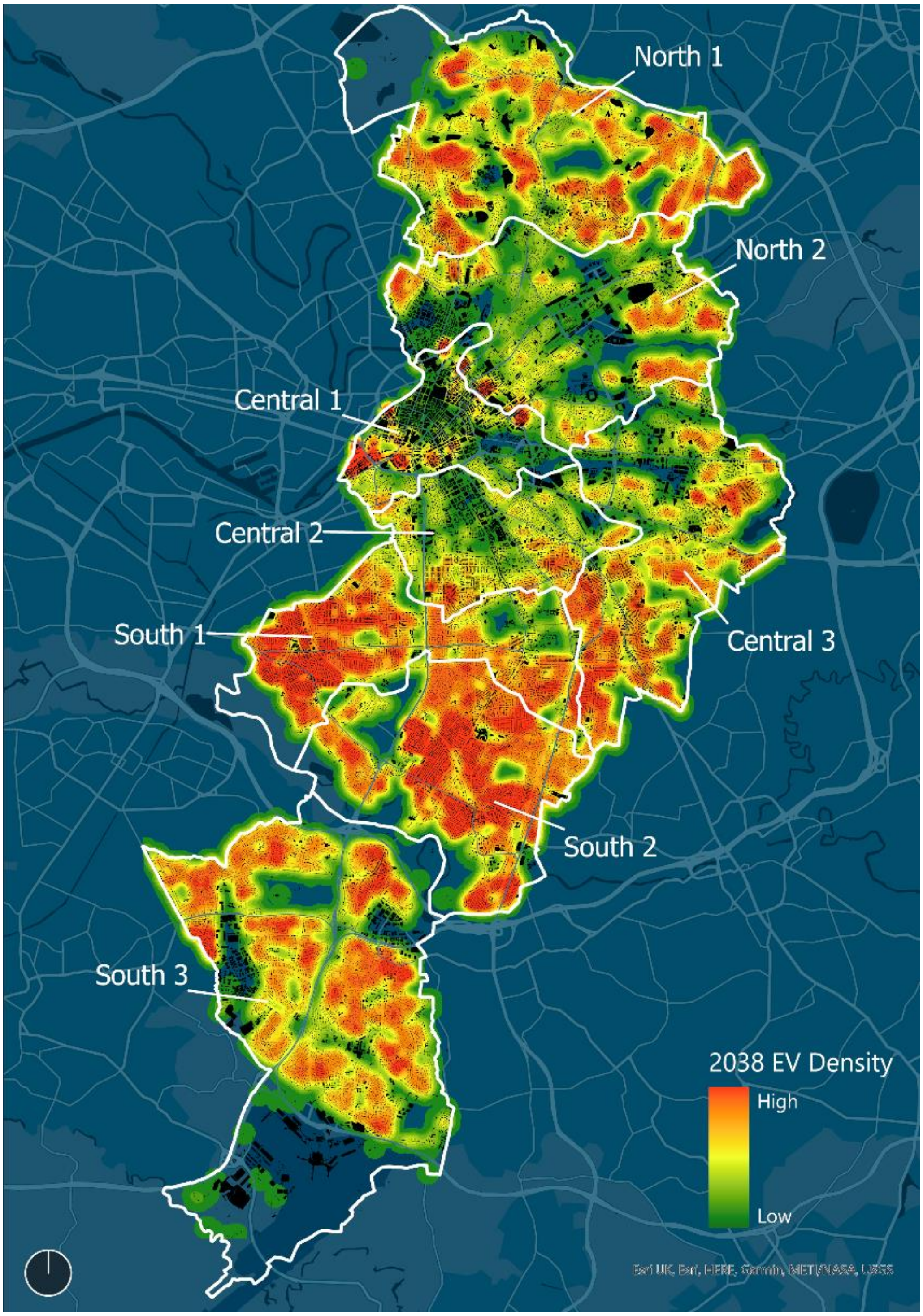
Greater Manchester's Transport Strategy 2040 sets out an ambition that no more than 50% of daily trips (across all modes) will be made by car in 2040, down from 61% today. In light of an expected overall growth in trips, the strategy sets out that meeting this target would mean a reduction of car trips from the current 3.7m per day to 3.4m. However, this still represents a significant demand for EV charging, estimated to increase to 512 GWh per year in Manchester by 2038.

Since EV transition, supported by publicly accessible and home chargers, is a consistent result across all scenarios, all moves to make first steps in charger deployment can be considered low regret.

Projected Vehicle Mix Over Time



"Heat map" showing density of EV uptake by 2038 across Manchester



Publicly Accessible EV Charge Points

Charge points will be a mixture of at-home and at-destination (such as workplaces and shopping centres). Transport for Greater Manchester (TFGM) is developing plans for the expansion of the existing network of publicly accessible charge points, to help overcome the inability to charge an EV at home, as experienced by many GM residents, to aid an accelerated transition to EV; aspects of this have been incorporated in this plan.

At-home charging for dwellings that have off-street parking is a solution which is well developed, but for dwellings without, other solutions will be needed. One solution may be public charging hubs located in residential areas with limited off-street parking. Other alternatives include developing an EV car club offer and expanding levels of workplace and destination charging provision.

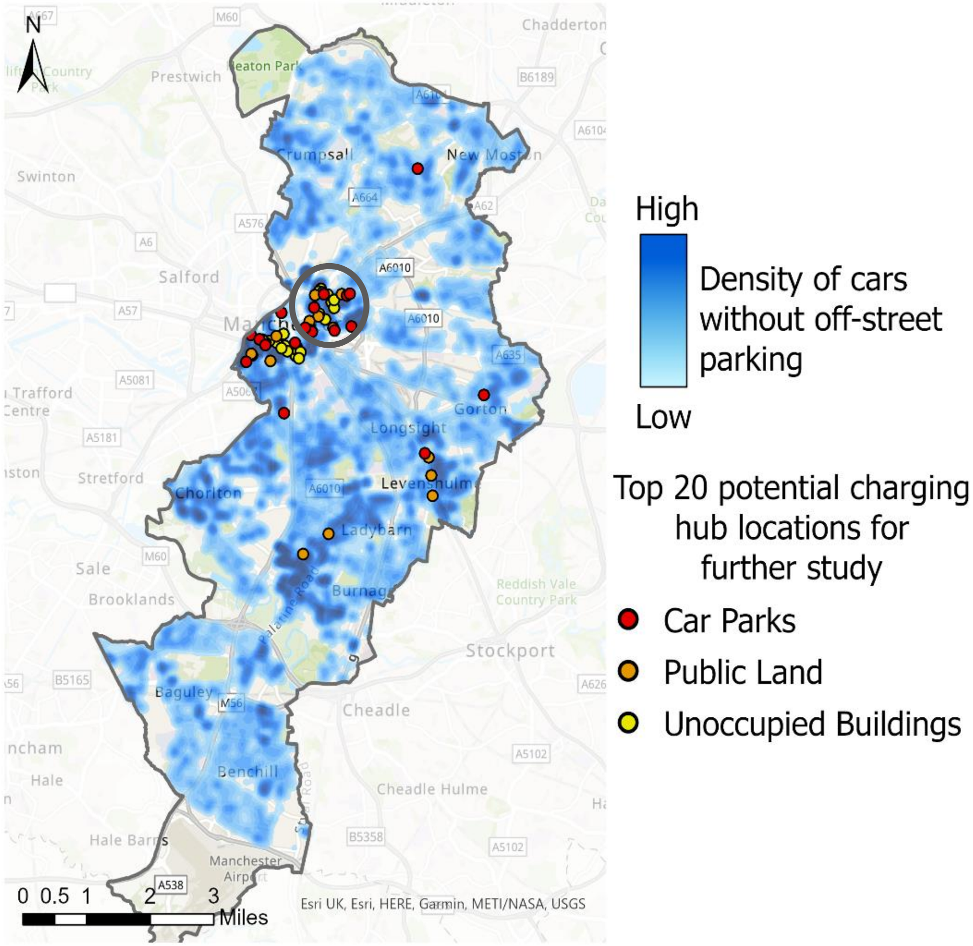
The maps shown identify potential prioritised charging hub locations, based on dwellings without off-street parking and projected EV use. Further consideration will be needed, working with TFGM to identify and develop public/hub charge points across Manchester[*].

Home Charge Points

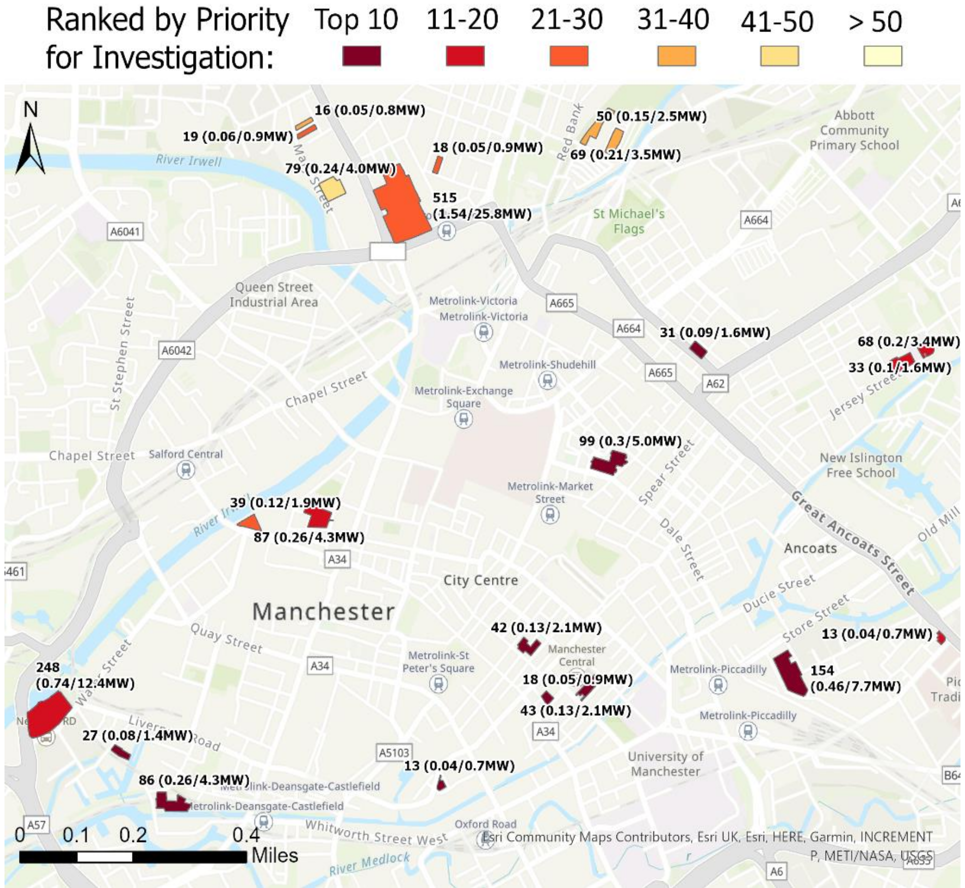
Homes with off-street parking are considered able to install private chargers. EV ownership is projected to significantly outstrip the number of homes with off-street parking, and every home with off-street parking sees a charger installed, amounting to **72,000 home chargers**. This could be coordinated with other home interventions, such as PV installation, heating system replacement and insulation, to minimise disruption experienced by households, and avoid multiple changes to wiring. Opportunities should also be explored for smart system integration between these different technologies

[*] It is also recognised that EV charging provision should not be considered in isolation from other transport related decarbonisation plans. Manchester will need to work with GMCA, TFGM and other relevant stakeholders to ensure a joined-up transport decarbonisation approach is developed and implemented. As well as aligning with local planning policies as it relates to provision of chargers in new developments and existing dwellings

Potential Charging Hub Locations



Potential Charging Hub Locations at Existing Car Parks. With Estimated Spaces (and Slow/Rapid Charge Demand).



As discussed, these maps highlight areas by proposed density/priority. These locations have been taken forward as the proposed 'EV charging hub priority areas in the Demonstration and Scale up Priority Areas aspect of this LAEP. Other public/hub charge points will be needed in other areas across Manchester; supporting data will be provided in the accompanying detailed and granular data set.

Vision to 2038

The shift to electricity for heating and transport increases the importance of using low carbon electricity sources. Although the UK intends to achieve a zero carbon electricity grid by 2050, with very low levels of emissions as early as 2035, Manchester will need to shift to zero carbon electricity earlier than the nation as a whole in order to stay within its carbon budget. This will mean generating much more zero carbon energy locally. All modelled scenarios found increases in locally generated renewable energy, primarily through solar PV.

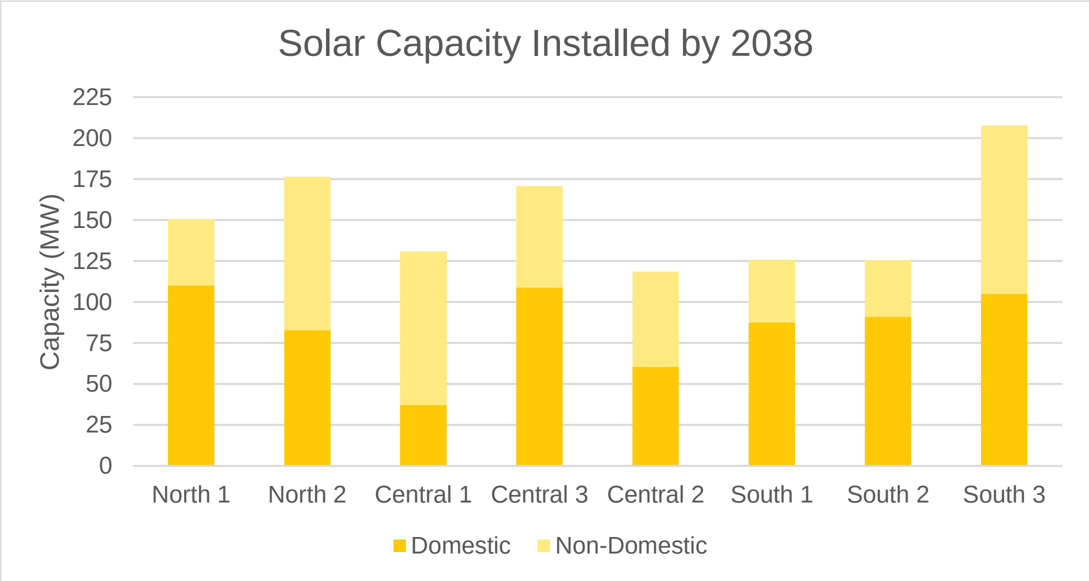
Domestic Solar and Batteries

Building rooftops are used to meet a portion of energy requirements. Every modelled scenario utilised all suitable rooftop space (generally South East to South West), resulting in approximately 680 MWp domestic and 523 MWp non-domestic rooftop PV capacity installed by 2038, yielding 901 GWh of energy annually. Alongside rooftop PV, there is an opportunity to install batteries to help flatten the load profile and reduce network reinforcement demands, and installations can be co-ordinated with other home interventions such as the installations of EV chargers, new heating systems and insulation. New market incentives which value flexibility may boost the economic case for batteries going forward. Further work will be required to ascertain what proportion of this identified best case amount of PV is feasible.

Density of dwellings with multiple interventions, including rooftop PV, by 2038 in South 1

Large Scale Solar PV and Wind

A study to determine the areas of land in Manchester suitable for ground mounted solar and wind turbines (including land not owned by the council) was carried out, accounting for factors such as flood zones, protected natural spaces and habitats, infrastructure, agricultural quality of land and future developments. This study did not find any suitable areas for these technologies, which is not unusual for a dense urban area. Since sites were screened for their suitability to host 5MW solar PV installations or larger, and 50 or 100m hub height wind turbines, it is possible that smaller projects could be developed.



Hydroelectric Power

Two sites were identified as suitable for the development of small-scale hydroelectric power – one at Deansgate and one at Northenden – totalling 0.2 MW capacity. These would make a very small energy contribution of 0.7 GWh per year.

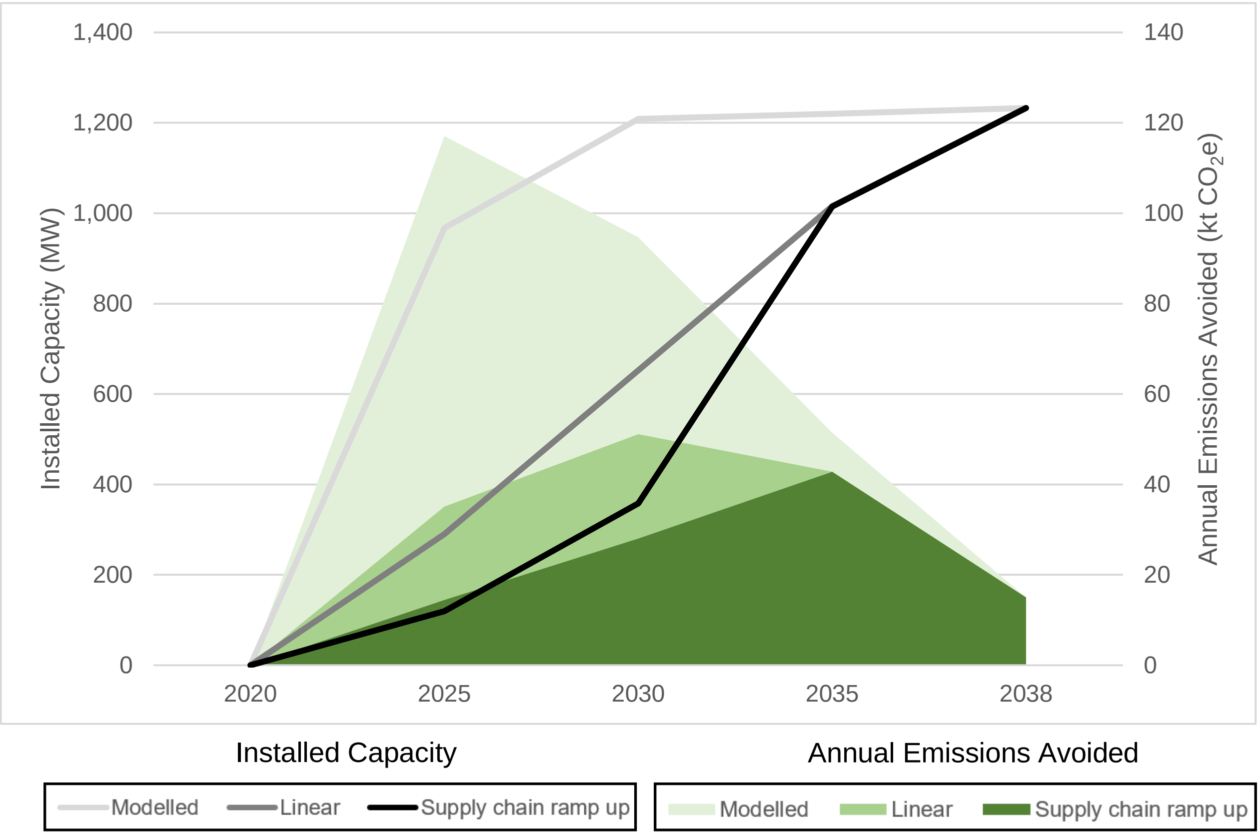
Rooftop PV Deployment Rate

The rate and timing of solar PV deployment has a large influence on the emissions avoidance it can achieve. Since the emissions intensity of the electricity grid reduces rapidly over the period to 2038, local renewable generation has a diminishing carbon benefit in the later years. As the black line of the following graph shows, the modelled scenarios deploy the rooftop PV capacity very rapidly and early, which is unlikely to be achievable in practical terms, and likely to run into grid capacity constraints. The reason for such rapid deployment is to maximise the savings early in the plan (shown as the dark green area), while the grid emissions intensity is still relatively high. This allows the model to stay within the challenging carbon budget in the early years.

Two other deployment rates are shown for illustration. The most conservative rate shown as the light grey line, “supply chain ramp up", would result in the remaining emissions over the period to 2038 reaching 10.8 Mt, compared to the 9.9 Mt in the modelled primary scenario. Some consideration is therefore needed around the speed at which PV can be deployed, and the implications for the carbon budget. Capacity which is not deployed in early years becomes less impactful to install in later years as the grid transitions to renewables (illustrated by the green areas of emissions savings), so may become a less worthwhile focus of resources than other measures.

In addition to carbon benefits, investment in local generation can generate employment opportunities, and may create opportunities to establish local energy markets. On the other hand, care should be taken to balance these benefits with potentially higher energy prices than might be available from the National Grid, particularly since the shift to electric heating will increase sensitivity to electricity prices. Small scale rooftop solar especially can be a significantly more expensive source of electricity than large scale wind and solar farms sited remotely.

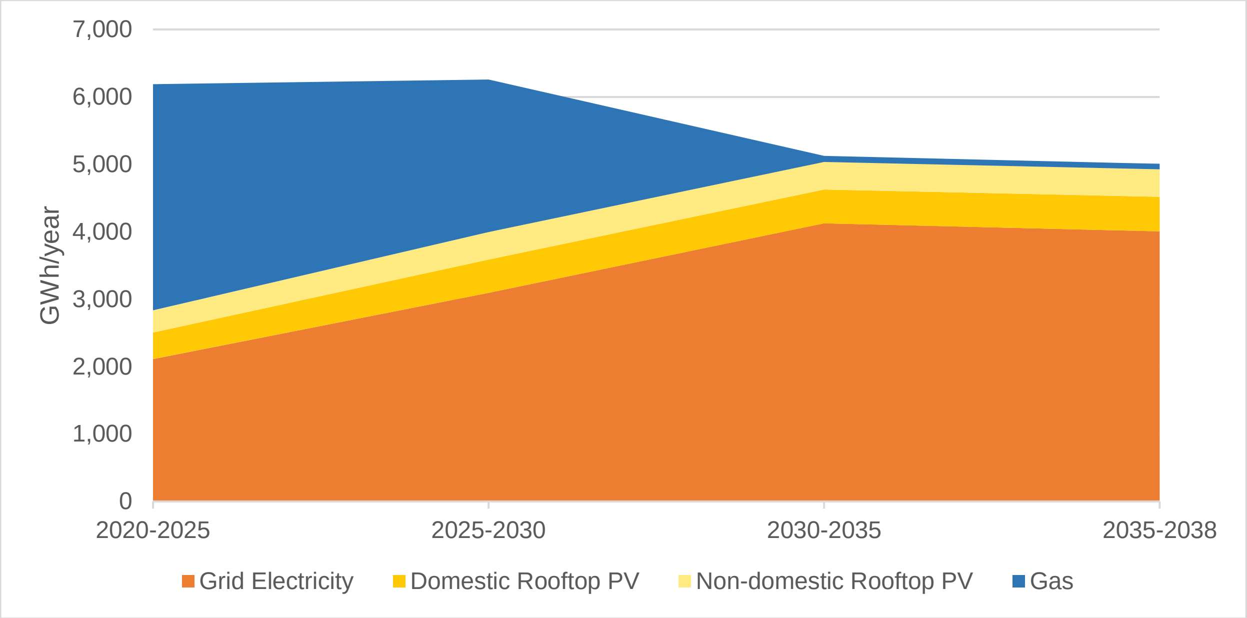
Rooftop PV deployment rate and impact on emissions avoided



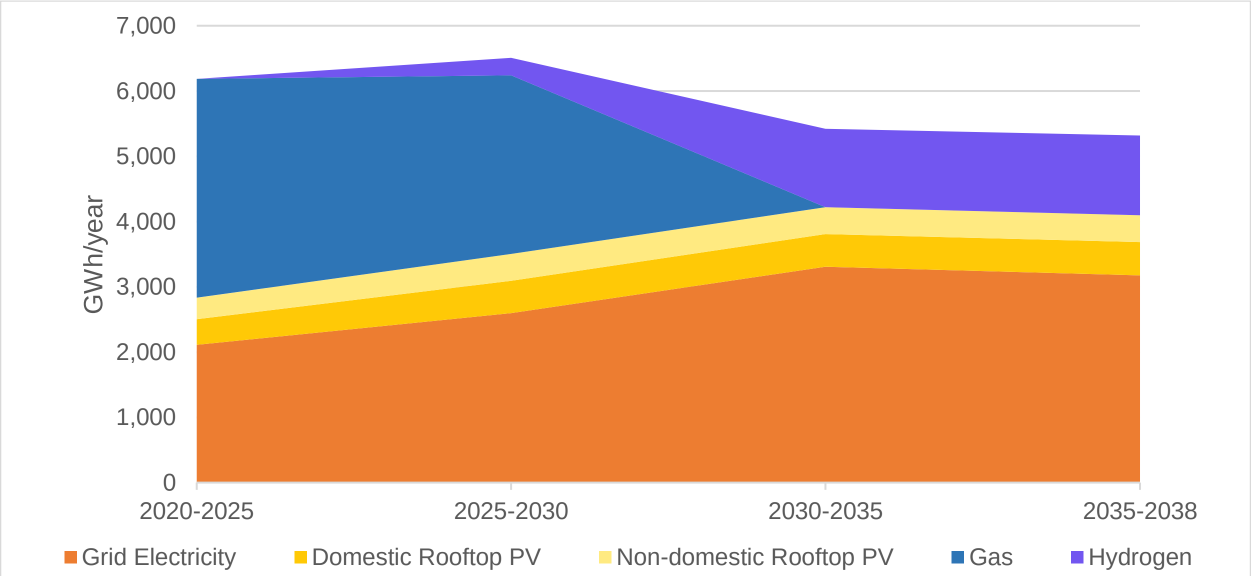
Energy Supply and Demand

The overall trend in the energy balance is an increase in the consumption of electricity to replace fossil fuels, with a shift towards some of that electricity being generated by local renewables. This is a transformation in the way energy is used, meaning the delivery systems must evolve rapidly. This is explored in the next chapter: Energy Networks. The increase in energy produced and consumed locally offers the potential to explore local energy market arrangements.

Changes in Energy Supply in Primary Scenario



Changes in Energy Supply in Secondary Scenario



Figures shown exclude petrol and diesel fuel consumed for transport. The overall reduction in energy consumption due to increased efficiency is therefore greater than shown, due to the reduction in transport fuel consumption.

Vision to 2038

Energy networks are the backbone of Greater Manchester's carbon neutral future; the large-scale changes in the way we use energy described in the previous chapters will require our networks to adapt and evolve in significant ways. For Manchester to reach carbon neutrality, major changes to the existing gas and electricity networks will be required, as well as the development of new networks including district heat and potentially hydrogen networks to meet future demand without the carbon emissions.

The electrification of heat and transport is likely to drive a major shift towards greater dependency on the electricity network, with demand rising from 2,480 GWh per year today to 4,930 GWh per year by 2038. This growing demand for electricity will require investment in generation capacity and storage and distribution network infrastructure upgrades, even in a scenario where all heating is provided by hydrogen, largely due to EV charging.

In the primary scenario to decarbonise Manchester by 2038, gas demand is reduced to a small residual level due to its use in some non-domestic and industrial applications which are more difficult to electrify, whereas the secondary scenario sees much of this natural gas replaced with hydrogen.

This chapter of the report provides an overview of the impact on each of the energy networks of the plan as well as insight from the other modelled scenarios and other key considerations given the uncertainties.

The primary scenario sees natural gas consumption reducing from c. 3,350 GWh per year currently down to around 80GWh in the 2030s, while the hydrogen scenario sees natural gas replaced entirely by 1,225 GWh per year of hydrogen.

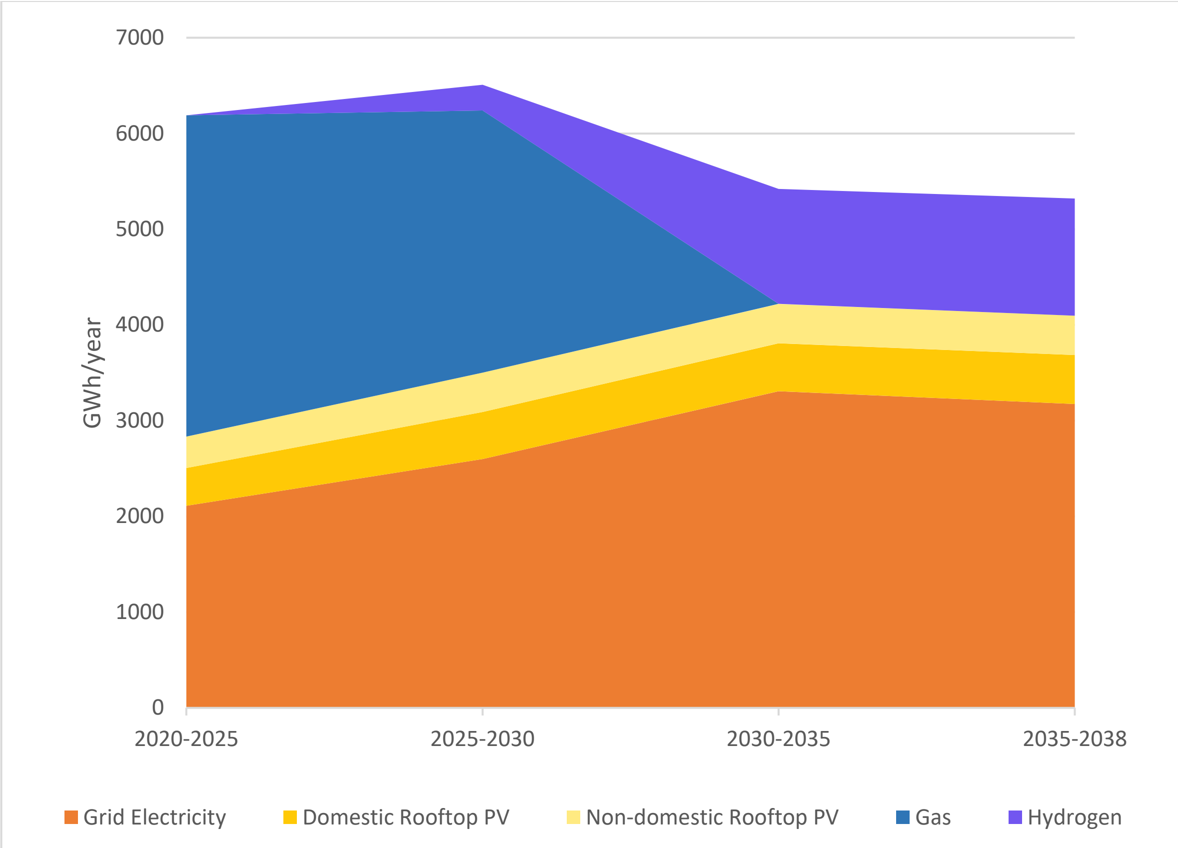
There is uncertainty currently about the role of hydrogen to replace heating, including when and where it may be available, in what quantities, the associated carbon emissions, and the cost compared to other solutions.

The modelled scenarios considered the possible role of hydrogen for heating aligned to the development of Hynet infrastructure (scenario 2), serving businesses and dwellings throughout Manchester.

The variation in total system cost for Manchester's local energy system between high hydrogen and high electrification scenarios was found to be small.

All scenarios show that some gas (either natural gas or hydrogen) remains in use by 2038, largely to support hard-to-decarbonise non-domestic premises, including high-temperature process heat for industry. If hydrogen does not become available to support decarbonisation of these uses, alternatives may need to be considered to achieve the carbon target and budget, such as carbon capture and storage technologies.

Changes in Energy Supply in Secondary Scenario

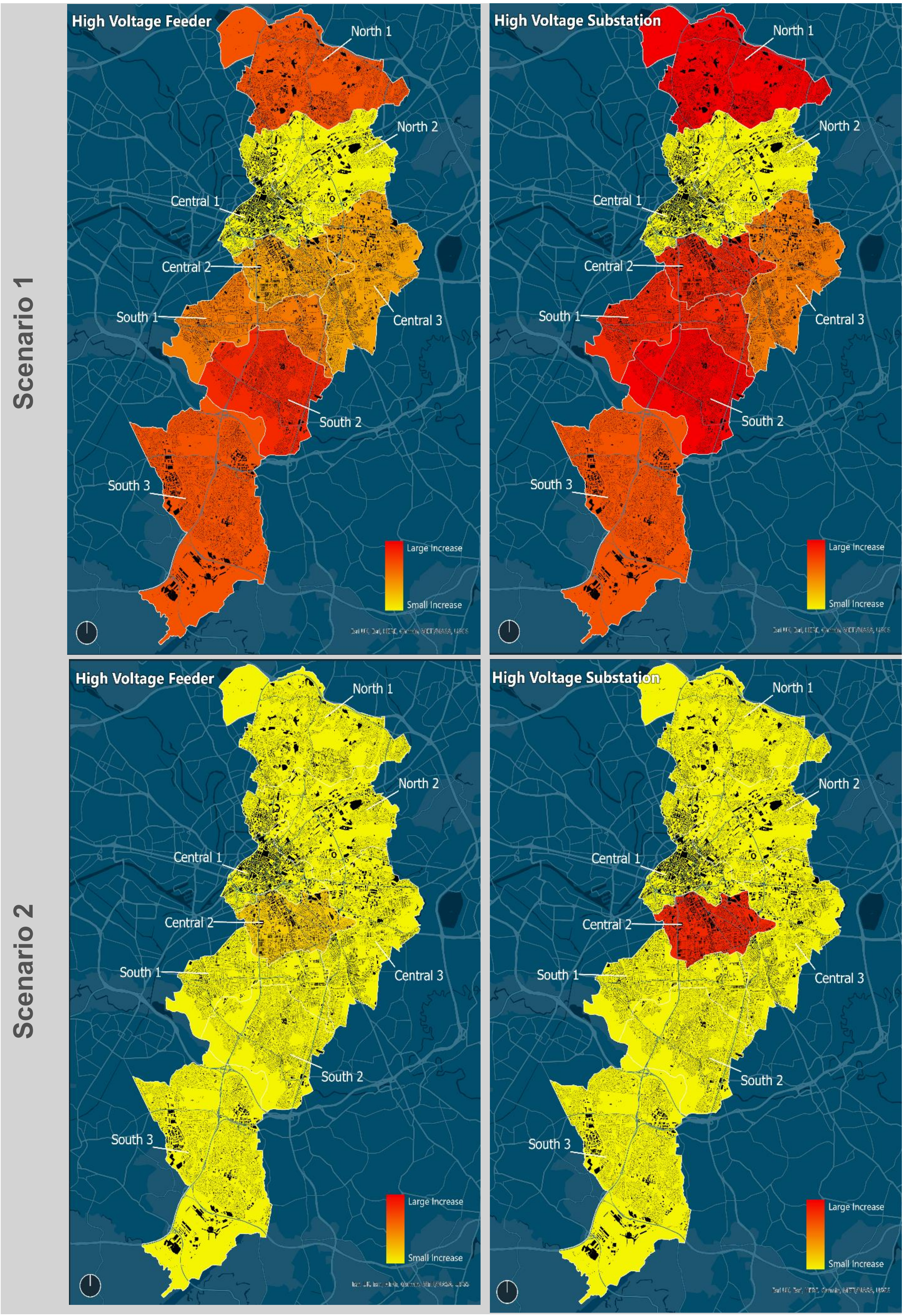


Capacity Requirements for 2038: High Voltage

The local electricity distribution network operated under license by Electricity North West supplies electricity to the majority of dwellings and industry in Manchester today. Modelling indicates the capacity required to meet all projected demand growth through conventional investment, but some of this demand could instead be accommodated through alternative investments, such as flexibility and storage. Hence the physical capacity increase required could be less than shown here. Areas with large increases in required capacity present opportunities for innovation and smart technology. Smart EV chargers and smart heat pump controls could make demand flexible, while storage technologies and vehicle-to-grid could help meet peaks in demand locally and provide other grid services.

The modelled capacity requirements at high voltage and low voltage (see next slide) levels are shown in the maps and tables. The distribution of these impacts is determined by a combination of factors, such as electric vehicle ownership, space for off-street parking and existing spare capacity in the current electricity infrastructure. For example, a zone may see a large increase in demand for home EV chargers, but not require large capacity increase because it currently has significant spare capacity. The difference in capacity requirement increases between scenario 1 where heat is mostly electrified, and scenario 2 where heating is mostly provided by hydrogen, is very pronounced.

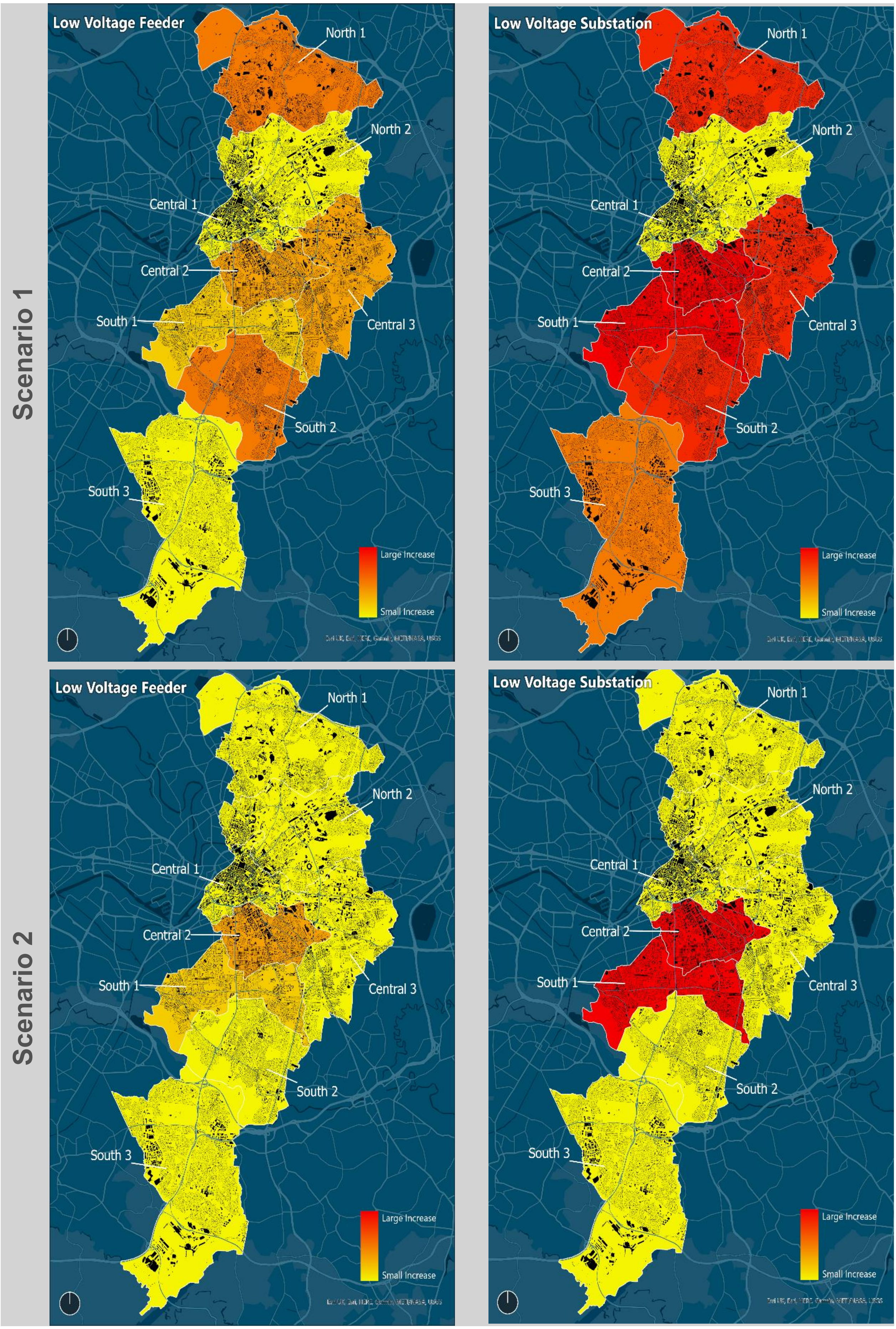
	High Voltage Feeder Capacity (MW)			High Voltage Substation Capacity (MW)		
Zone	2020	2038		2020	2038	
		Scenario 1	Scenario 2		Scenario 1	Scenario 2
North 1	86	267	86	71	360	71
North 2	169	169	169	165	165	165
Central 1	276	276	276	284	284	284
Central 3	94	145	94	107	231	107
Central 2	123	206	206	114	335	335
South 1	95	233	95	95	332	95
South 2	77	281	77	72	345	72
South 3	140	325	140	124	293	124


Scenario 1
High Voltage Feeder
North 1
North 2
Central 1
Central 2
Central 3
South 1
South 2
South 3
Large Increase
Small Increase
High Voltage Substation
North 1
North 2
Central 1
Central 2
Central 3
South 1
South 2
South 3
Large Increase
Small Increase
Scenario 2
High Voltage Feeder
North 1
North 2
Central 1
Central 2
Central 3
South 1
South 2
South 3
Large Increase
Small Increase
High Voltage Substation
North 1
North 2
Central 1
Central 2
Central 3
South 1
South 2
South 3
Large Increase
Small Increase

Capacity Requirements for 2038: Low Voltage

Low voltage feeders are the underground cables serving individual buildings, often located under pavements, so upgrades to these can involve extensive street works. High voltage feeders on the other hand, only run to substations which typically serve multiple streets, so require less extensive works. They are typically laid in ducts under roads. Substations are located on designated plots of land, with exclusive access for the DNO.

	Low Voltage Feeder Capacity (MW)			Low Voltage Substation Capacity (MW)		
Zone	2020	2038		2020	2038	
		Scenario 1	Scenario 2		Scenario 1	Scenario 2
North 1	65	205	65	67	316	67
North 2	97	97	97	122	122	122
Central 1	180	180	180	213	213	213
Central 3	86	183	86	84	286	84
Central 2	78	137	137	83	370	370
South 1	80	123	82	70	355	355
South 2	65	167	65	68	278	68
South 3	251	251	251	101	214	101


Scenario 1
Scenario 2
Low Voltage Feeder
Low Voltage Substation
North 1
North 2
Central 1
Central 2
Central 3
South 1
South 2
South 3
Large Increase
Small Increase
Low Voltage Feeder
Low Voltage Substation
North 1
North 2
Central 1
Central 2
Central 3
South 1
South 2
South 3
Large Increase
Small Increase

Present Day Capacity and First Steps

Examining present network capacity gives some indication of where deployment of low carbon technologies could be prioritised without immediately running into network constraints.

The areas South 1 and 3, for example, have the greatest levels of capacity headroom for demand, suggesting that heat pumps and EV chargers could be installed at scale in these areas before network upgrades are required. In contrast, North 2 and Central 1 show limited spare capacity. Fortunately, heat pump deployment is also lowest in these areas, and they have been flagged for potential hydrogen deployment.

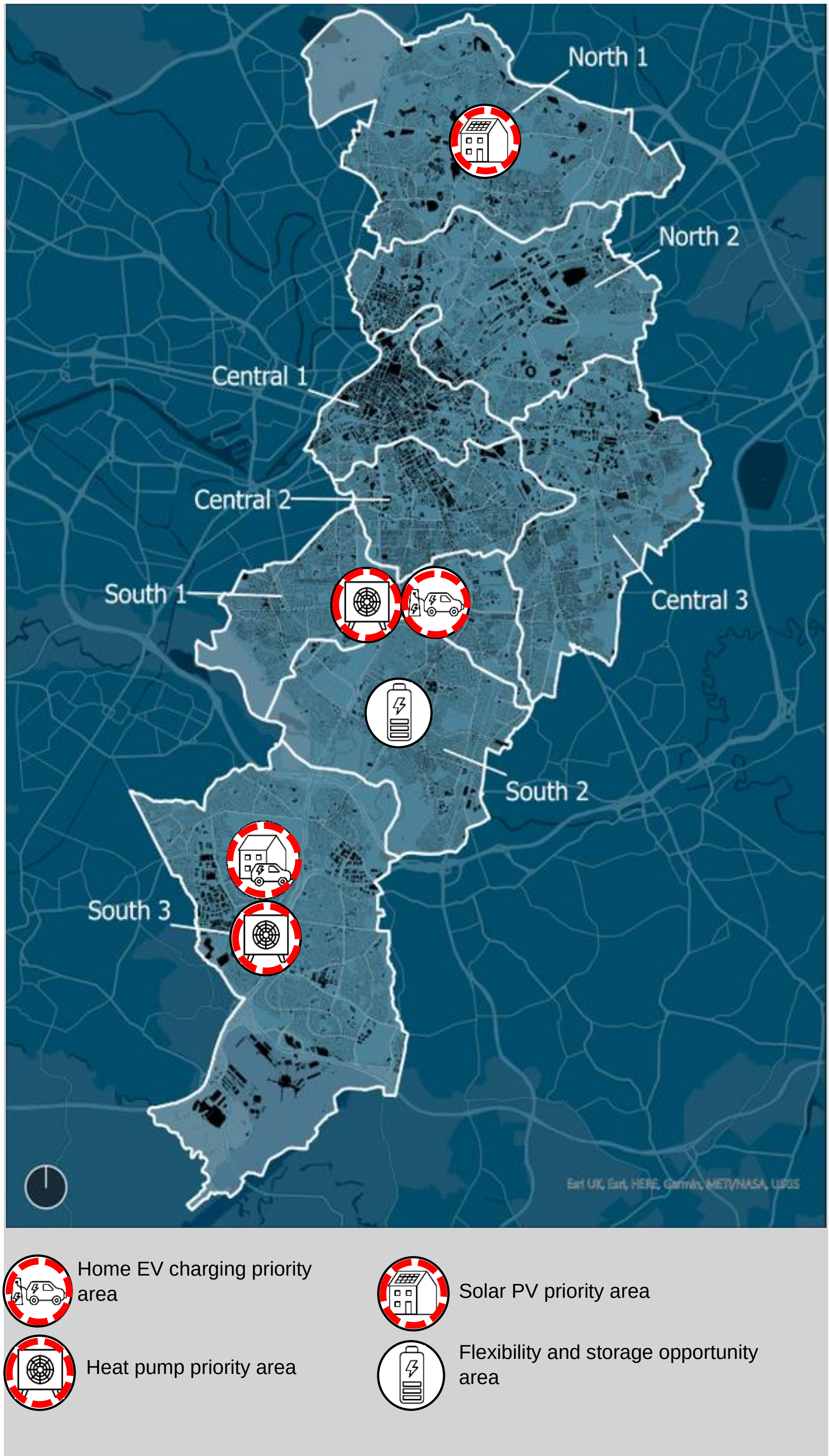
However, if heat networks supplied by heat pumps were chosen instead, this constraint would have to be addressed. This would present the opportunity to study how local generation may facilitate the connection of additional demand even where the network is constrained. It's worth noting however, that peak network demand typically occurs on winter evenings, when solar generation is negligible, and electrification of heat is likely to compound this.

	Demand			Generation	
Zone	**Headroom (MW)**	**Heat pump installs**	**Home EV chargers**	**Headroom (MW)**	**Solar PV (MW)**
North 1	13.2	31,981	13,965	94.1	110
North 2	9.4	94,07	5,108	85	83
Central 1	7.9	10,059	538	190.7	37
Central 3	11.8	31,735	10,432	48.3	109
Central 2	10.6	17,582	3,879	81.8	60
South 1	29.9	23,139	11,733	33.6	87
South 2	10.7	24,441	13,216	22.4	91
South 3	29.1	32,704	13,378	66.6	105

Demand headroom is non-firm headroom at the primary substation for the zone. Generation headroom is the inverter-based headroom at the primary substation for the zone, which is most relevant for considering solar PV. All figures from ENW's heat map tool: https://www.enwl.co.uk/get-connected/network-information/heatmap-tool/

Similarly for solar PV, the zones North 1 and Central 1 especially stand out as likely to be able to absorb large power flows from PV installation, while South 1 and 2 would not be able to proceed as far with installations before network upgrades became necessary. Since the modelled deployment of PV is modest in Central 1, North 1 is suggested as a solar PV priority area. Nevertheless, there appears to be sufficient headroom to begin installations in all areas.

South 2 could be well suited to prioritising storage and flexibility, having less demand and generation headroom relative to the proposed increase of heat pumps, EVs and solar PV. This would be an opportunity to test and demonstrate innovative technologies and business models which enable more demand and generation to be accommodated without conventional capacity upgrades. Examples might include smart EV charging and vehicle-to-grid, smart flexible heat pump operation, batteries, and new technologies.


North 1
North 2
Central 1
Central 2
Central 3
South 1
South 2
South 3
Home EV charging priority area
Solar PV priority area
Heat pump priority area
Flexibility and storage opportunity area

Gas Network Today

The gas network operated under license by Cadent supplies gas to the majority of dwellings in Manchester today, predominantly for heating and hot water but also cooking. It also supports a range of non-domestic and industrial local energy demands. The current total gas consumption across Manchester is around 3,355 GWh.

To deliver Manchester and GM's carbon budget and target, it is expected that the vast majority of dwellings will no longer use natural gas by the early 2030s to avoid the budget being exceeded. Most non-domestic buildings will also transition away from natural gas.

Future of Gas and Hydrogen for Heat

The primary scenario for Manchester sees the majority of dwellings converting their heating systems to either be

- connected to a district heat network or, more commonly,
- converted to electric heating, predominantly in the form of different types of heat pumps depending on different factors such as location, energy efficiency and house type.

This would necessitate phased disconnection of homes from the gas network as they are converted to electric or district heating, which would need coordination.

However, the secondary scenario sees the majority of buildings supplied by hydrogen, meaning they would remain connected to a repurposed gas network. Around £560m of investment would be required for this network conversion. Of Manchester’s approximately 1955 km of gas pipework, around 70% is already of polyethylene, suggesting that much of the network could already by suitable for carrying hydrogen.

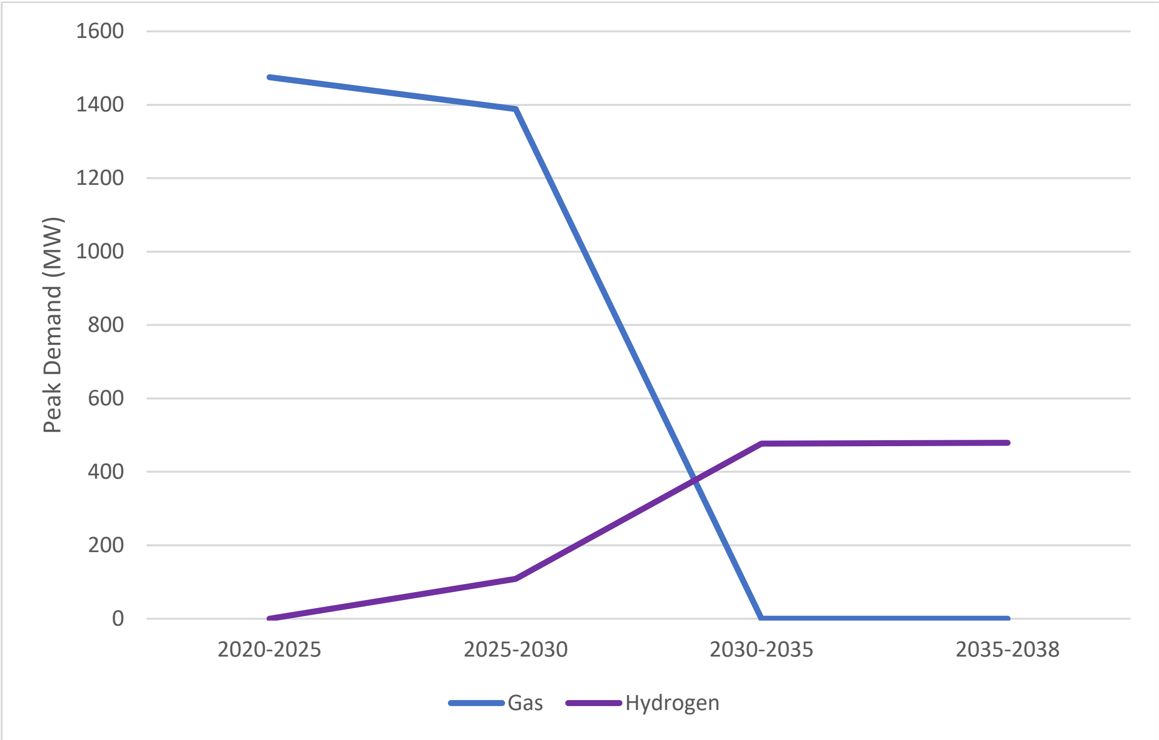
Hybrid heating (air source heat pump/gas boiler hybrid) is an option in certain circumstances and could provide a valuable transition technology to manage uncertainty around the role of the gas network in domestic heating through the 2020s. Around 2000 dwellings may be best suited for this technology: generally larger properties where a hybrid solution may become more cost effective than an air source heat pump alone, but where a ground source heat pump is unsuitable due to exterior space and access requirements.

Even in the electrification scenario, gas networks may need to be retained for longer in areas where hybrids are a useful transition option due to property types, particularly South 1 & 2.

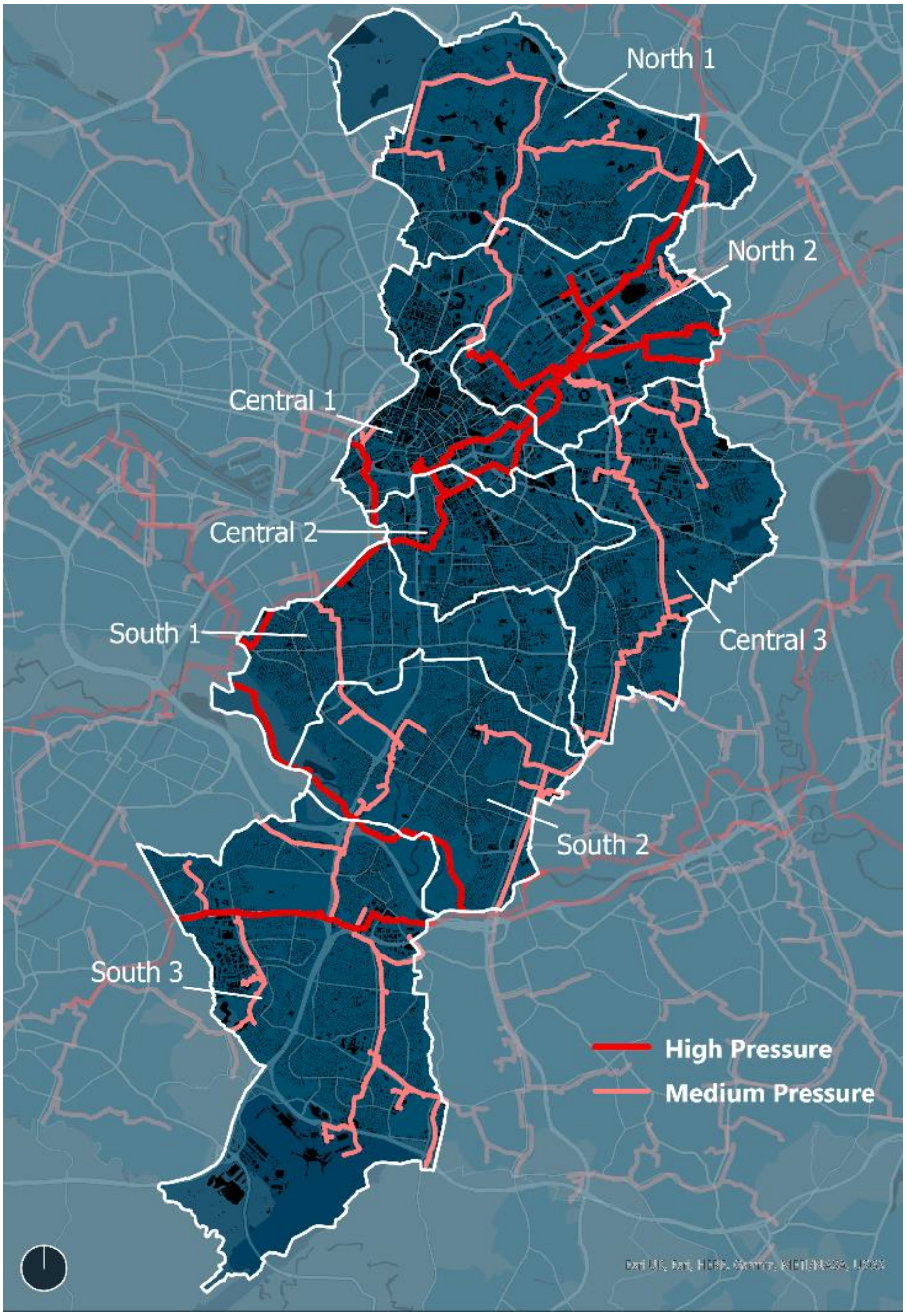
There are a small number of non-domestic properties that are harder to electrify, particularly with industrial uses that require high temperature process heat: these will remain on the gas network under the primary scenario and use hydrogen in the secondary. Most non-domestic gas use can be electrified.

Equitable solutions for dealing with the ongoing gas network maintenance costs for remaining customers will need to be explored for the case where usage falls to very low levels. These properties may also be well suited to using hydrogen for heat under a scenario where hydrogen becomes available.

Usage of Gas Network under HyNet Scenario for Manchester



Current Gas Network in Manchester



District heating could supply in the region of 11% (32,000) of Manchester's dwellings. The role of district heating is diminished in scenario 2 where hydrogen meets much of the demand, although in practice district heating could be supplied by hydrogen boilers in the energy centres, meaning that investment in the heat networks would remain a relatively low regrets option if hydrogen for heating materialised. By centralising the hydrogen boilers, the need to replace gas pipework in streets and buildings to make them compatible with hydrogen would be reduced.

In Central 1, an existing heat network (pictured bottom) can provide the starting point to grow the coverage of district heating to reach more of the buildings identified as suitable. Areas with a high density of buildings suitable for district heat connections are also highlighted for North 2 (pictured top) which could be starting points for a new heat network in that area, though if the Central 1 network were to grow substantially it could expand into North 2.

There are five main opportunity areas for district heating zones providing opportunities to develop in the region of 40 km of heat network for an investment of £328m*, in the clusters highlighted opposite and around suitable non-domestic buildings and areas of proposed new development.

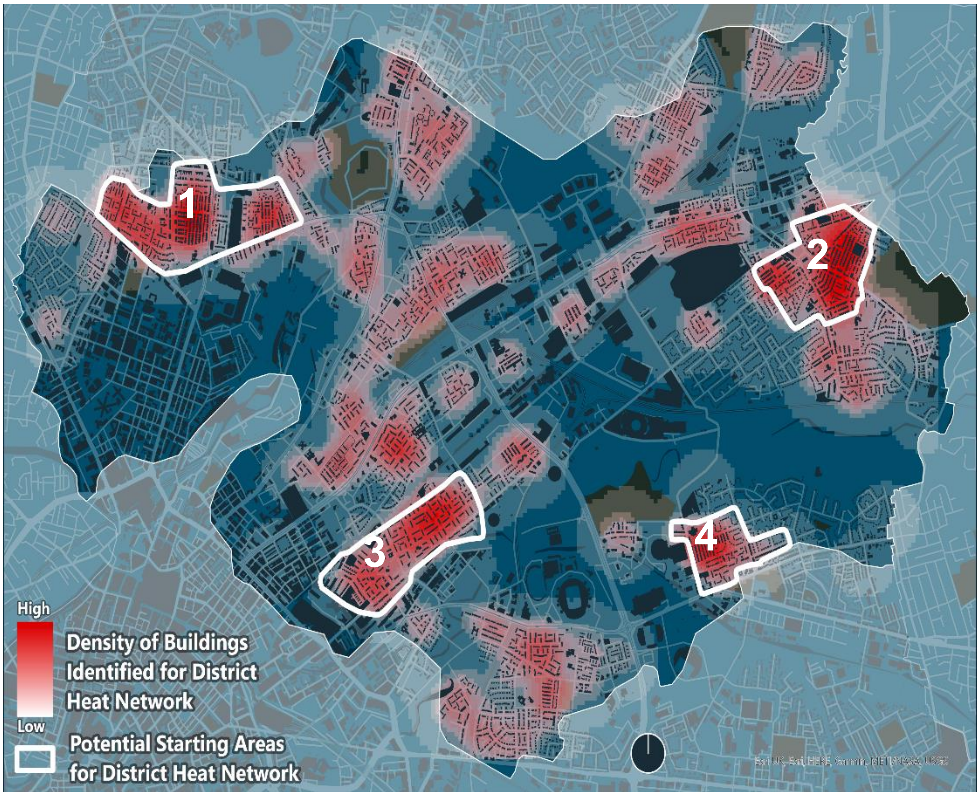
There are limited opportunities for utilising local heat supplies (such as waste heat), therefore heat generation is primarily based on large scale heat pumps, consisting of 37 MWp of heat delivered from heat pumps.

The specific feasibility and configuration of any district heating networks, including energy centre locations, plant design etc. will require appropriate assessment to take forward, providing opportunities for the consideration of smart local energy systems or community schemes to support network development.

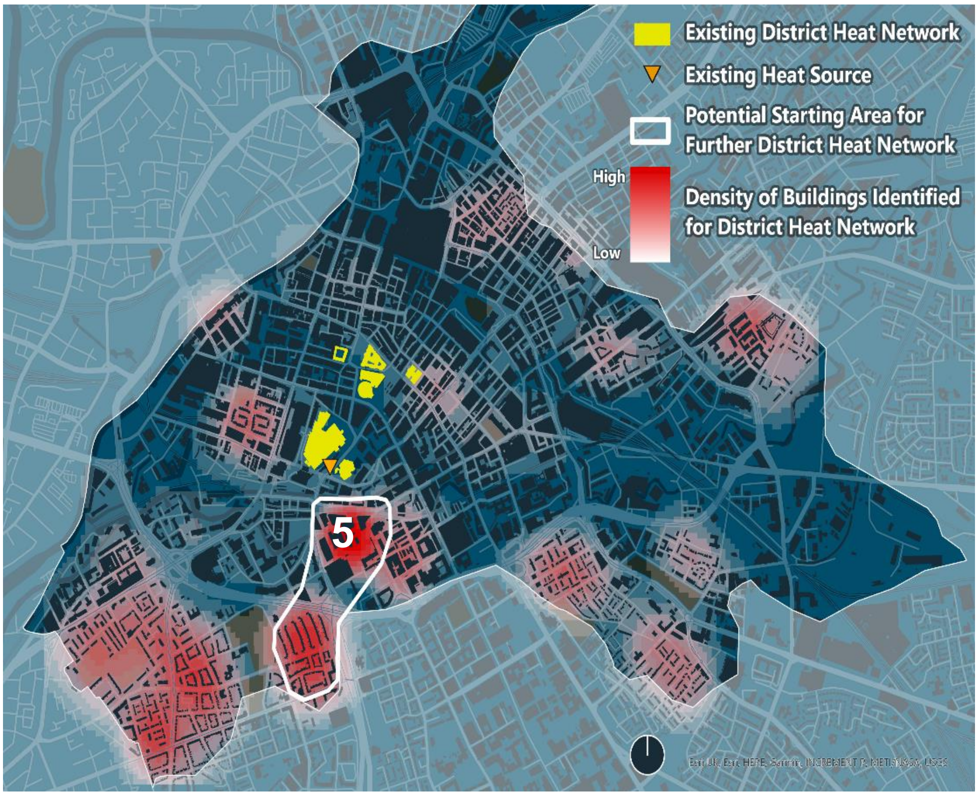
Heat Network Opportunity Area	Approximate Peak Heat Generation Capacity (MWp)	Approximate Network length (km)
1 – North 2 – North Western cluster	1.6	5
2 – North 2 – North Eastern cluster	1.5	11
3 – North 2 – South Western cluster	1.1	10
4 – North 2 – South Eastern cluster	0.7	9
5 – Central 1 – Southern cluster	1.0	5

* District heating network (I.e. pipework) cost only

North 2



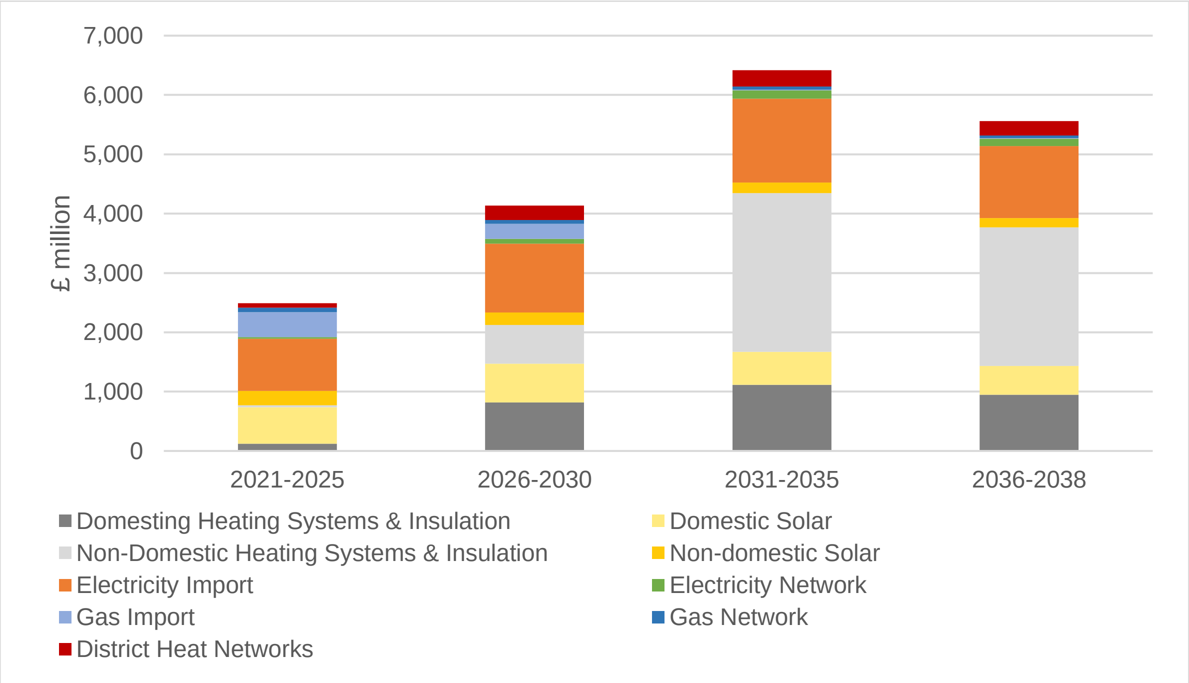
Central 1



Total cost (including energy consumption)

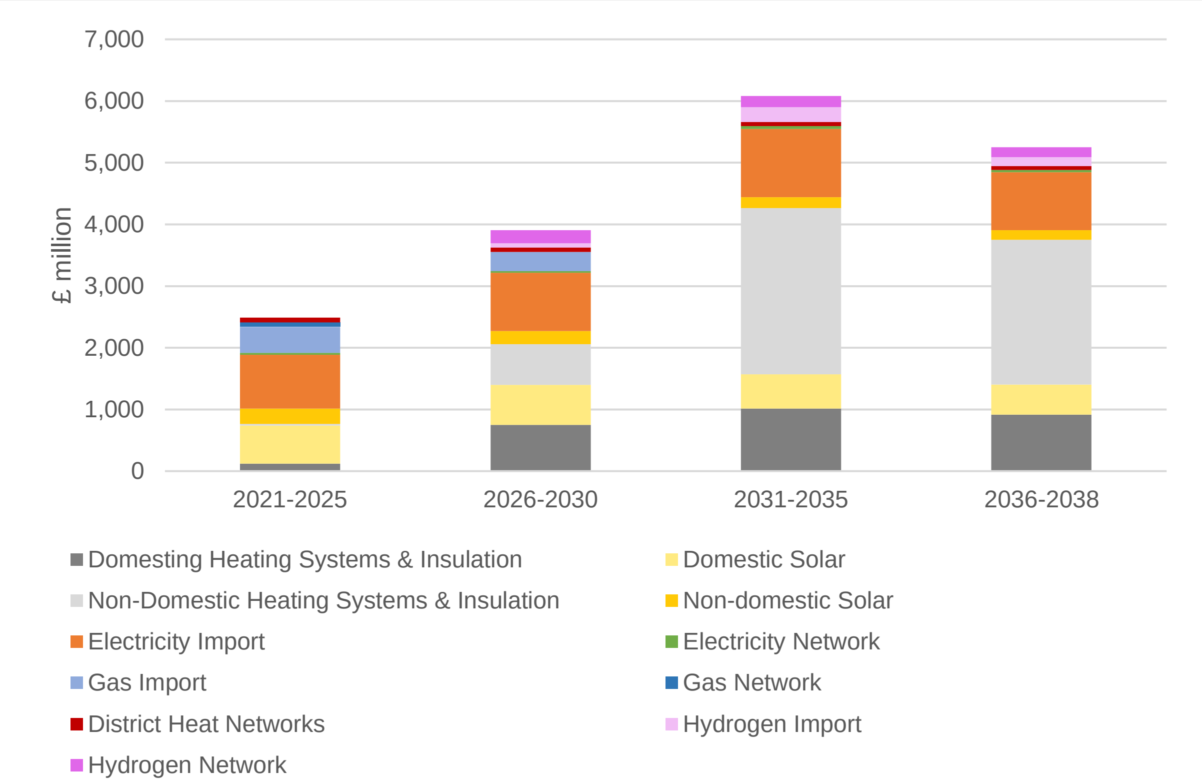
The primary scenario is based on a total energy system spend of £18.6bn (with a range of £17.5-18.6bn across all four scenarios). The cost is attributed to investment in energy networks, in buildings (for components such as fabric retrofit, heating system change and roof mounted PV) and for energy consumed. The chart below illustrates the split between these three main components. Notably, a significant proportion of this cost would have been spent without accounting for decarbonisation. Money is spent every day on maintaining existing energy systems, replacing old or failed systems (e.g. gas boilers in dwellings), improving energy efficiency and paying gas and electricity bills. This LAEP sets out an approach for redirecting some of that status quo expenditure*, boosted with additional investment, to the areas needed to achieve the carbon neutral target. For example, energy costs are re-directed to electricity use in place of natural gas.

Primary Scenario



* Status quo expenditure has not been calculated in this LAEP

Secondary Scenario



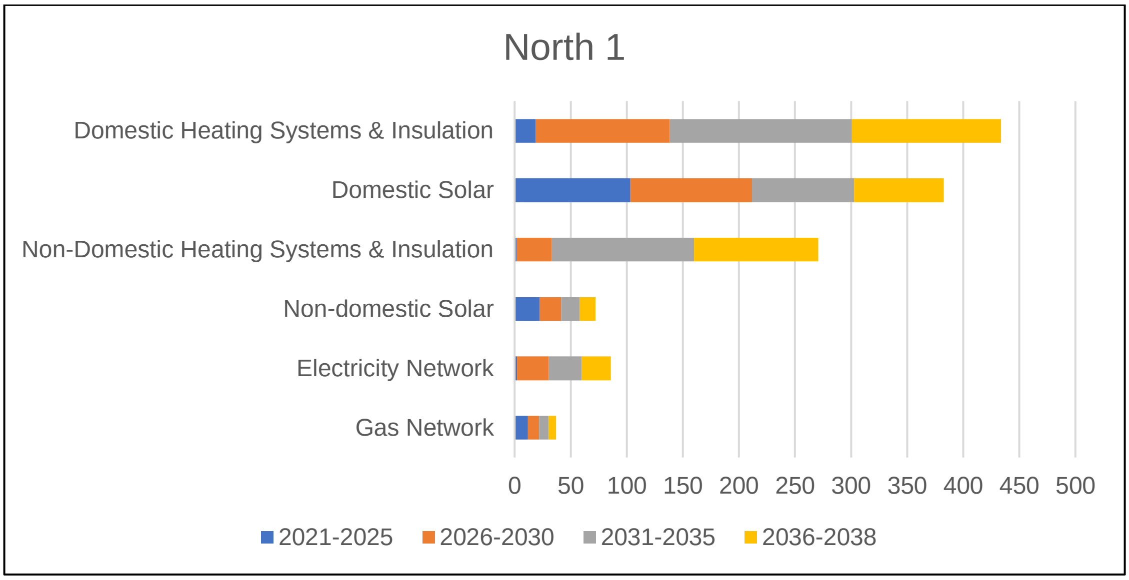
Investment (exclusive of energy consumption)

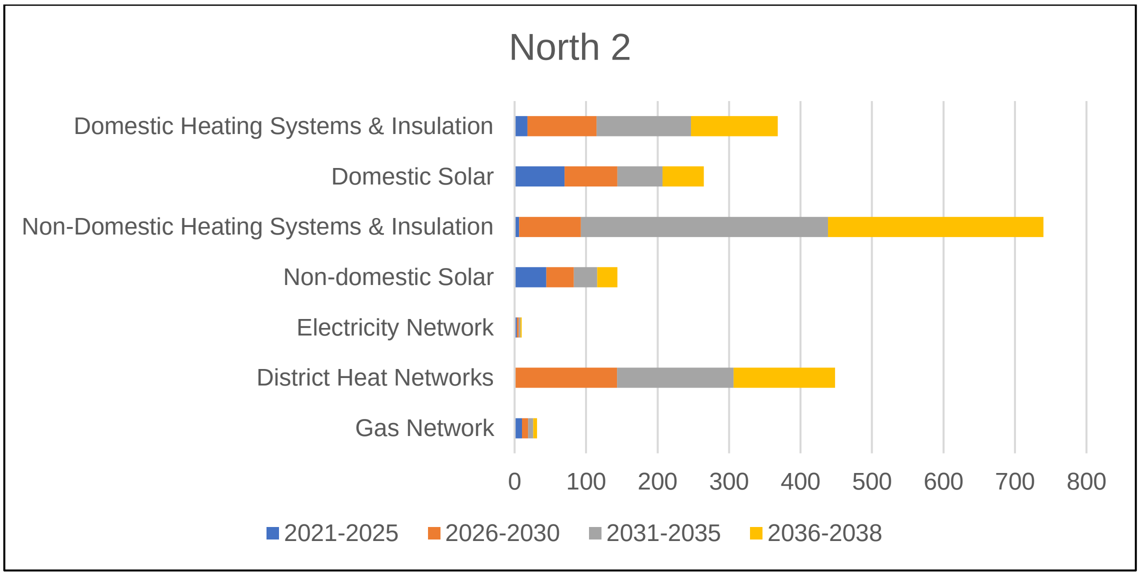
The tables below illustrate the total investment needed in the energy system to deliver the plan, equating to a total of £13.2bn for the primary scenario and £12.7bn for the secondary, with the charts on the following pages breaking this down by technology. Again a significant proportion of this investment will be required without working towards carbon neutrality, for example expenditure on replacement gas boilers is instead targeted at low carbon heating systems.

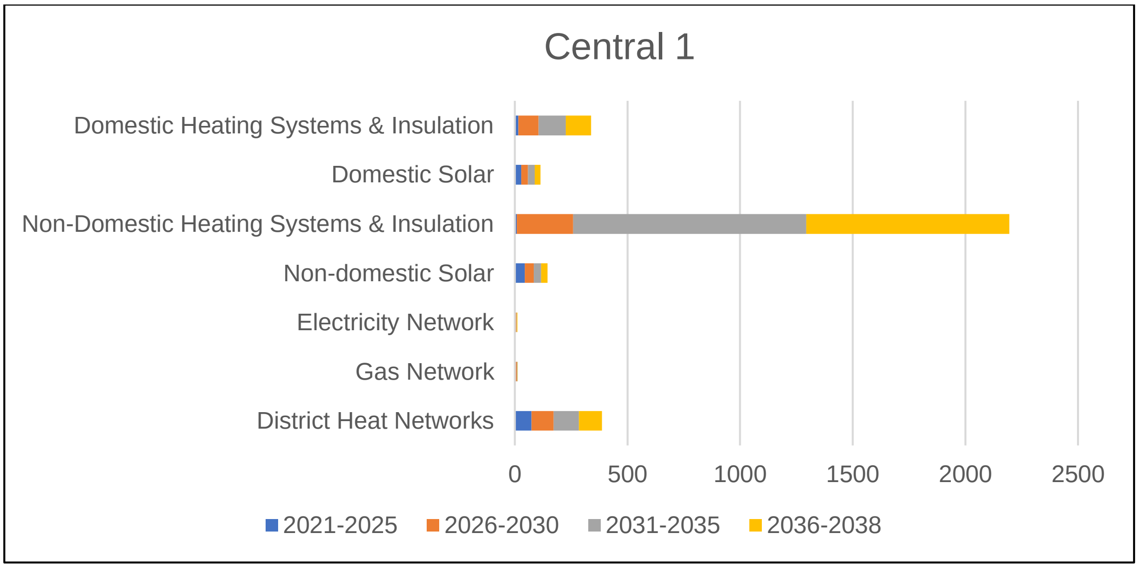
Zone	Total Investment (£m)	
	Primary Scenario	Secondary Scenario
North 1	1,280	1,200
North 2	2,005	1,635
Central 1	3,205	3,165
Central 2	1,395	1,455
Central 3	1,375	1,335
South 1	1,090	1,085
South 2	1,150	1,080
South 3	1,740	1,730

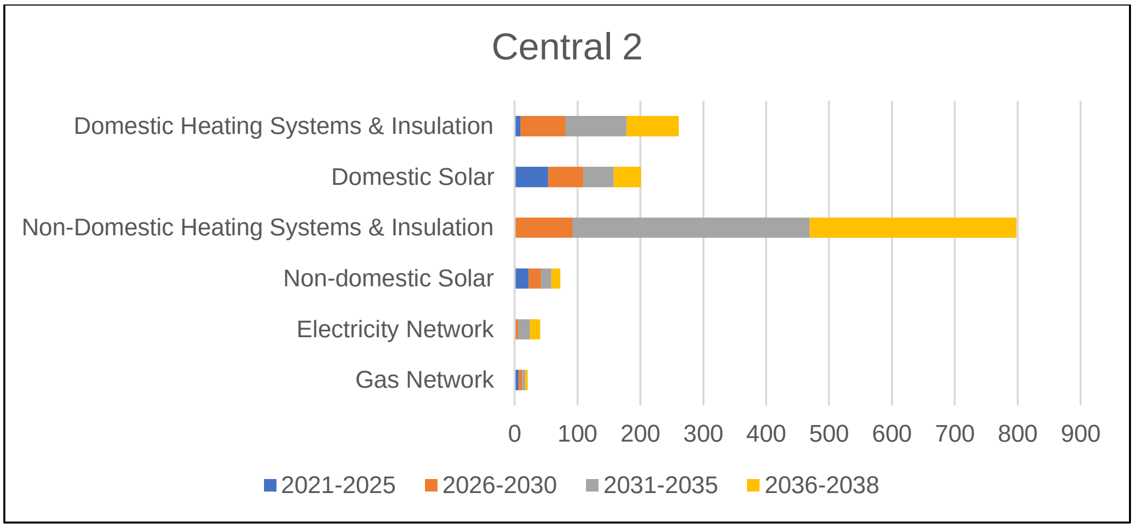
Investment type	Total Investment (£m)	
	Primary Scenario	Secondary Scenario
Domestic Heating Systems & Insulation	3,005	2,800
Domestic Solar	2,310	2,310
Domestic EV Chargers	40	40
Non-domestic Heating Systems & Insulation	5,690	5,725
Non-domestic Solar	795	795
Electricity Network	375	140
District Heat Network	835	275
Hydrogen Network	N/A	560

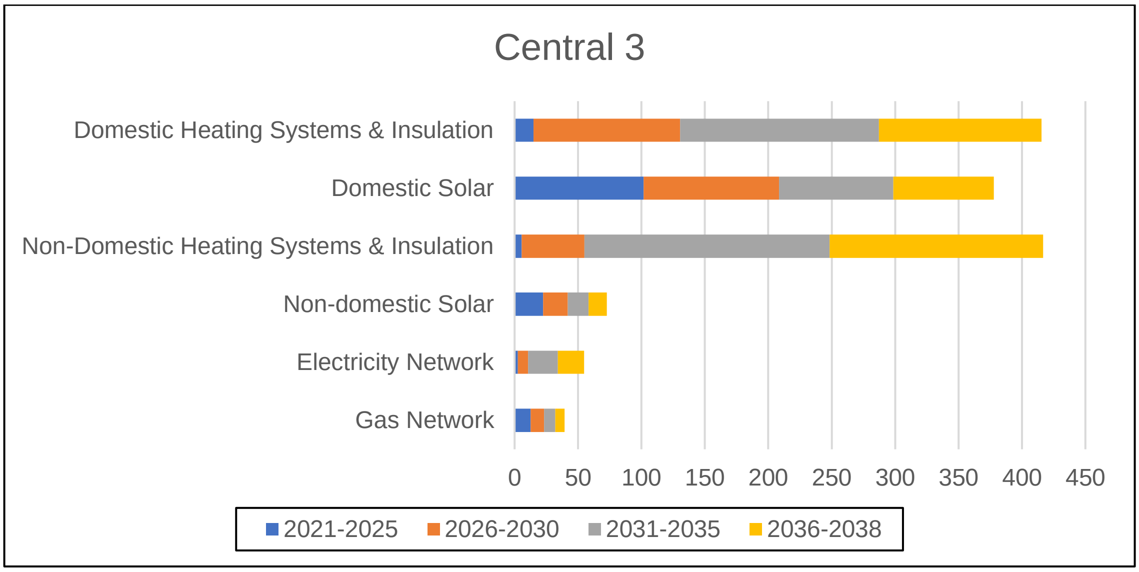
Investment in Manchester's energy system (£m) by time period across each area

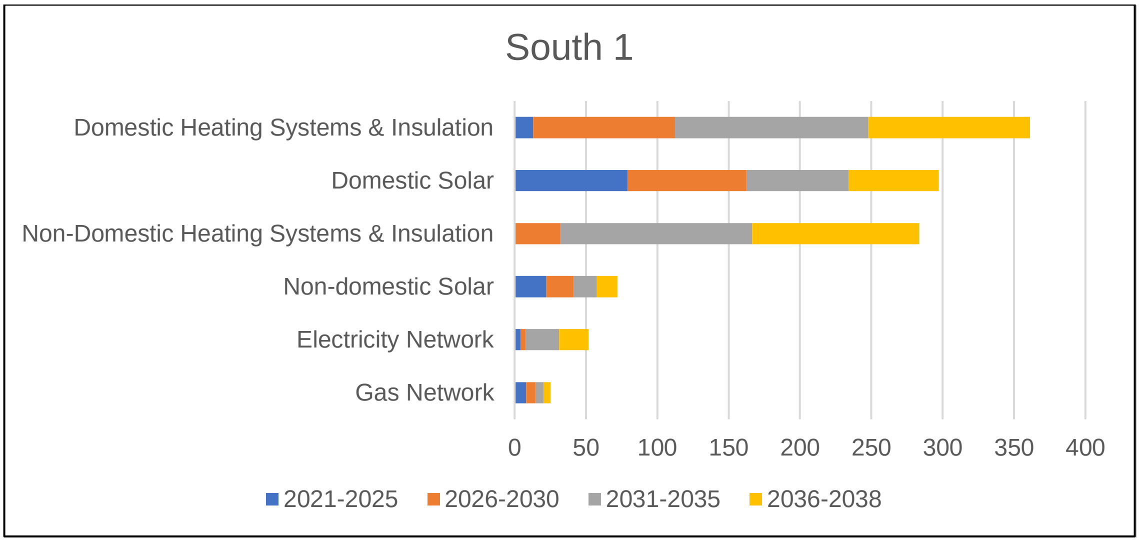


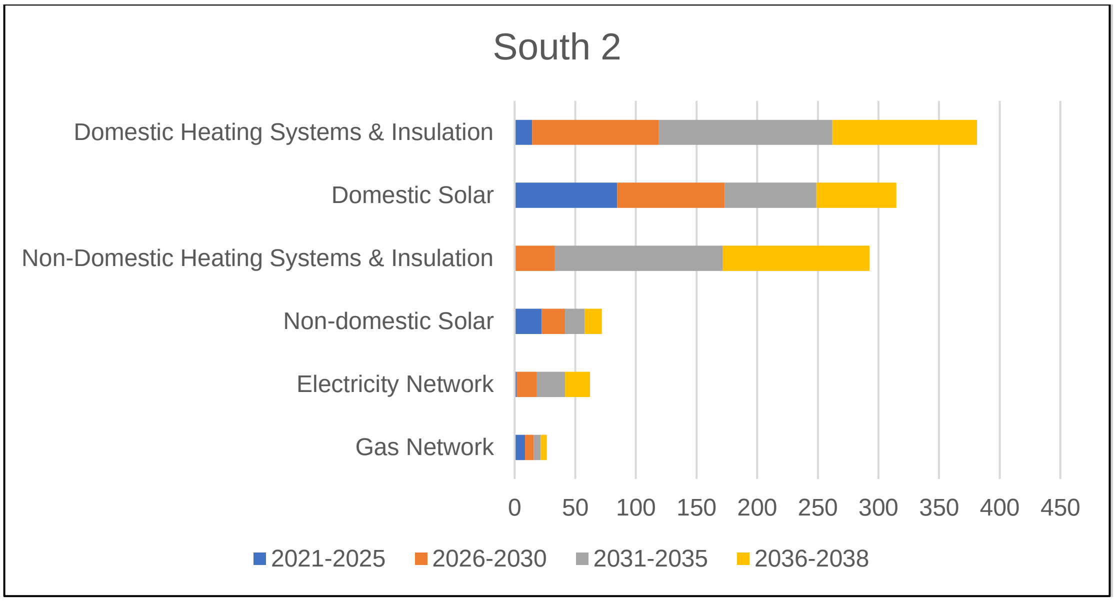




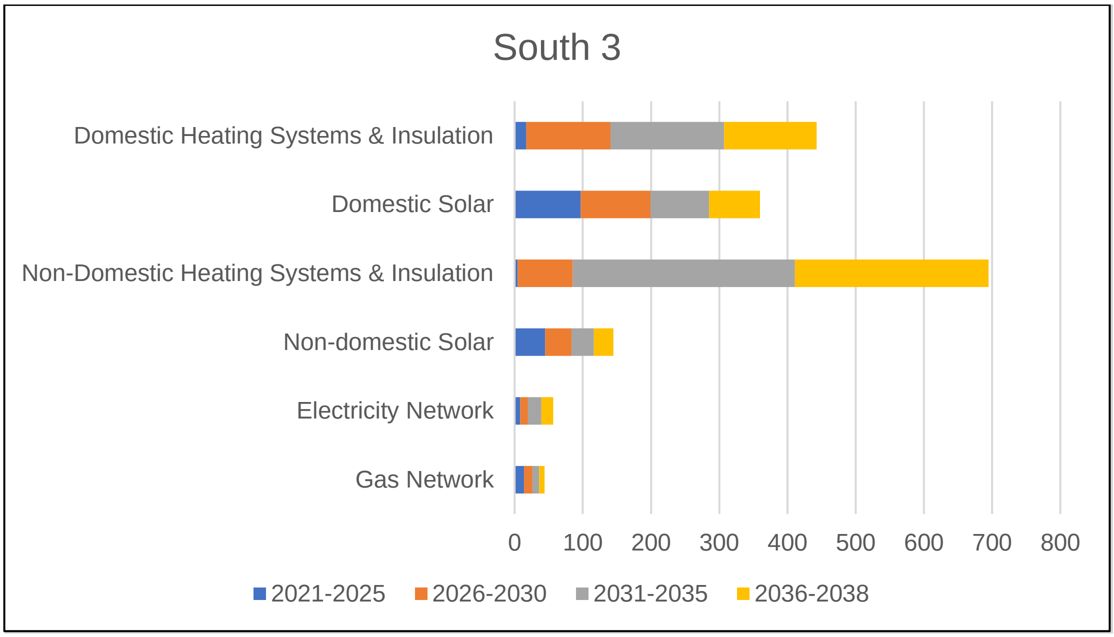

Central 2
Domestic Heating Systems & Insulation
Domestic Solar
Non-Domestic Heating Systems & Insulation
Non-domestic Solar
Electricity Network
Gas Network
0 100 200 300 400 500 600 700 800 900
2021-2025 2026-2030 2031-2035 2036-2038


Central 3
Domestic Heating Systems & Insulation
Domestic Solar
Non-Domestic Heating Systems & Insulation
Non-domestic Solar
Electricity Network
Gas Network
0 50 100 150 200 250 300 350 400 450
2021-2025 2026-2030 2031-2035 2036-2038


South 1
Domestic Heating Systems & Insulation
Domestic Solar
Non-Domestic Heating Systems & Insulation
Non-domestic Solar
Electricity Network
Gas Network
0 50 100 150 200 250 300 350 400
2021-2025 2026-2030 2031-2035 2036-2038



South 2
Domestic Heating Systems & Insulation
Domestic Solar
Non-Domestic Heating Systems & Insulation
Non-domestic Solar
Electricity Network
Gas Network
0
50
100
150
200
250
300
350
400
450
2021-2025
2026-2030
2031-2035
2036-2038



South 3
Domestic Heating Systems & Insulation
Domestic Solar
Non-Domestic Heating Systems & Insulation
Non-domestic Solar
Electricity Network
Gas Network
0
100
200
300
400
500
600
700
800
2021-2025
2026-2030
2031-2035
2036-2038

9. SUMMARY AND CONCLUSIONS

There are only sixteen years left to until 2038, the date by which Greater Manchester aims to be carbon neutral, and less than thirty years until 2050, the latest date by which the UK must reach Net Zero emissions*.

The technologies and infrastructure that make up the energy system typically last for decades, whilst the development, planning, design, delivery and operation of new energy infrastructure can have lead-times of five to ten years.

Whilst there is some flexibility to meet carbon neutrality in different ways depending on societal changes and technology innovation, there is an urgency for Manchester and Greater Manchester to prepare to start the transition now and over the next few years, focusing on low regret activities, building capacity and supply chains, etc. The key decision point of how to decarbonise heat will need to be made c.2025, primarily based on the role hydrogen will play in providing heat to buildings. The longer the delay in making this decision, the more unrealistic it would be to achieve the 2038 carbon neutral target.

Future Local Energy System in Manchester

All the scenarios investigated involve strong contributions from core activities and technologies and also identified a number of key opportunities and uncertainties. This have been categorised into four key areas:

1. **Reducing energy demand in Manchester**
2. **Increasing uptake of low carbon solutions in Manchester**
3. **Increasing local low carbon electricity production and storage**
4. **The future role of the gas grid in Manchester**

1. Reduced energy demand in Manchester: Reducing emissions, energy use and energy costs through making buildings more energy efficient has been shown to play an important role in all of the scenarios considered. In the primary scenario this means basic fabric retrofit of nearly 80,000 homes and deep retrofit of a further 21,500 homes requiring £1.2 bn of investment. Further investment in retrofit is required in the secondary scenario, due to the later decarbonisation of heating with hydrogen, and the higher cost of hydrogen fuel. Many of these homes can receive a cost-effective retrofit package, combining heating system replacements, solar PV and EV charger installations. Across all scenarios extensive fabric retrofit of existing homes is prominent both in cost-effectively reducing emissions in the near term, but also enabling the future installation of low carbon heating systems. It is important to note that new demands from transport, buildings and industry (moderated by improving energy efficiency) mean electricity demand increases in Manchester from 2,480 GWh of electricity consumed per year to 4,930 GWh by 2038.

* On 12 June 2019 the Government laid the draft Climate Change Act 2008 (2050 Target Amendment) Order 2019 to amend the Climate Change Act 2008 by introducing a target for at least a 100% reduction of greenhouse gas emissions (compared to 1990 levels) in the UK by 2050

2. Increasing uptake of low-carbon solutions in Manchester: By the early 2030s all new cars, vans and heating system replacements in homes and businesses must be low carbon. In the primary scenario in the 2020's the majority of this shift is to battery electric vehicles (BEVs) and electric heat pumps along with development of heat networks, that are primarily served by large scale heat pumps providing the heat generation. EV charging comprises a combination of domestic charge points (c.72,000) and public EV charging hubs, targeted at priority locations. Industry in Manchester must either adopt technologies that use zero carbon electricity or hydrogen instead of fossil fuels or install carbon capture and storage technologies.

3. Increasing production of local low carbon electricity and its storage in Manchester: Increasing electricity demand and reducing costs of generation from renewable sources sees an increase in local renewable energy production in Manchester. In the primary scenario 680 MWp of domestic and 550 MWp non-domestic roof mounted solar PV capacity is installed.

Deploying the maximum potential for rooftop solar PV would produce up to 920 GWh per annum of local, low carbon electricity, a significant contribution to Manchester's forecasted annual consumption of 4,930 GWh. A key consideration for progressing and implementing this LAEP will be to determine how best to deploy solar PV systems alongside other components, such as heat pumps and EV charge points that could be provided as an integrated solution. PV deployment achieves greater emissions savings in the early years when grid emissions are higher, so the scenarios see rapid, early deployment. If this cannot be achieved in practice, the optimum capacity to deploy may be different.

4. The Future role of the Gas grid in Manchester: The role of hydrogen for heating is uncertain. Whilst there are many activities underway across the sector to develop a potential hydrogen supply, at a suitable scale, there is currently no guaranteed commitment for this to be considered a reliable means of supporting the decarbonisation of Manchester. Greater Manchester's ambition of carbon neutrality by 2038 creates significant pressures regarding the deliverability of 100% hydrogen heating to all homes in Manchester. In the primary scenario, in the 2020's, increasing numbers of homes start to switch from gas to electric heating solutions and the majority of existing off-gas and new homes are heated using electricity by 2038. Manchester should not rule out the potential for hydrogen heating, however, neither should it plan for it with certainty. The secondary scenario found that a similar level of emission reduction could be achieved using predominantly hydrogen for heating (9.7 Mt CO_2 generated through to 2038 compared to 9.9 Mt CO_2 for the primary scenario) for a similar total system cost (£17.7bn compared to £18.6bn for the primary scenario). A hydrogen heat-based future could also be more appealing to Manchester's citizens, being potentially less disruptive. Therefore, the presented heat decarbonisation demonstration and scale-up priority areas have generally been identified in areas where it would not to be cost-effective to utilise hydrogen for heat even if available.

Key Findings

Achieving carbon neutrality by 2038 in Manchester in support of Combined Authority area is estimated to represent total energy related costs of between £17.5bn and £18.6bn across all scenarios

The plan for Manchester (based on the primary scenario):

- Will require capital investment of £13.2bn (excluding energy costs) in less than 20 years. This investment is broken down with an approximate spend of £705m on energy networks, £3,000m on Manchester's dwellings, £5,700m on Manchester's non-domestic buildings and £3,105m on energy generation technologies (excluding dwelling/building heating systems). This has the potential to build local supply chains and create jobs for the future as part of a green industrial revolution for Manchester

- By 2038 the local electricity network in Manchester could supply as many as 72,000 domestic EV charge points distributed across the local area and numerous EV community charging hubs, particularly in Central 1.

- Over 180,000 homes could have heat pumps with around 90% of homes being electrified for heating. This means that in the 2020's new homes will need to be electrically, or hybrid heated, connected to a heat network or at minimum be hydrogen ready. The majority of existing off-gas grid homes in Manchester will need to shift to a combination of electric and hybrid solutions

- Alternatively, hydrogen could be supplied to over 225,000 homes, as well as non-domestic buildings, allowing hydrogen boilers to replace gas boilers for heating and hot water, as well as providing low carbon fuel for high temperature industrial applications. This would mean much of the gas network would be retained and repurposed by 2038. Retrofit would need to be carried out for a greater number of homes, and to a deeper level, in this scenario.

- The gas network will continue in the immediate term to meet the majority of heating demands of homes and buildings although new connections will start to decline in the 2020s as new development favours electric or district heating solutions.

- Heat networks could grow and expand, particularly in the town centre of Manchester, subject to space restrictions. Existing homes could then be connected in clustered groups through targeted connection campaigns and new service offers

- The majority of homes with suitable characteristics will have solar panels and many of those could also have electrical (battery) and thermal storage systems

- This will provide access to a wide range of flexible resources including energy storage, heating systems and electric vehicles able to participate in future flexibility and local energy markets

The Scale of the Challenge

The table below details both modelled and assumed representative numbers. These are provided for illustrative purposes only, intended to demonstrate the scale of implementation, take-up, investment, and deployment needed, by time period, of specific components for Manchester to achieve carbon neutrality.

Local Energy System Aspects	Key Metrics	Value in 2038	
		Primary Scenario	Secondary Scenario
Local Energy Consumption	Local energy consumption (excluding transport fuels, GWh/yr)	5,011	5,325
	Number of dwellings	295,353	295,353
	Non-domestic buildings (m^2)	15,973,835	15,973,835
Local GHG Emissions	Local greenhouse gas emissions ($ktCO_2e/yr$)	78	49
Local Energy Demand Reduction	Basic domestic retrofit measures installed (nº of homes)	80,000	72,872
	Deep domestic retrofit measures (nº of homes)	21,500	62,878
Local Electrification	Petrol & diesel vehicles on the road (nº of vehicles)	22,400	22,400
	Pure electric vehicles on the road (nº of vehicles)	143,600	143,600
	Hybrids (including plug-in) on the road (nº of vehicles)	32,800	32,800
	Domestic EV charge points installed (nº)	72,250	72,250
	Heat pumps installed (nº of homes)	181,000	66,441
	Domestic rooftop solar PV generation capacity installed (MWp)	683	683
	Non-domestic rooftop solar PV generation capacity installed (MWp)	523	523
Local Heat Networks	Domestic heat network connections	31,900	2,957
Capital Investment*	Buildings and energy system (£bn)	13.2	12.7

* For the energy system components presented in the cost and investment chapter, i.e. excludes purchase of vehicles and dwellings/buildings

It must be recognised that achieving carbon neutrality by 2038 is hugely ambitious and challenging and will require major local policy interventions, investment by government and industry and both technology and business innovation.

A key challenge for Greater Manchester and Manchester over the next five years is to build collective and coordinated action such that long-term investment in low carbon infrastructure is made in the 2020’s and investment scale-up and mass market deployment of low carbon technologies is achieved through the 2030’s.

Achieving this will require action in the 2020s to act as the catalyst for change and to ensure supporting infrastructure is invested in as the backbone of a zero-carbon energy system for Manchester. It will require systematic changes in consumer and business behaviours, Manchester's local energy networks, the use of energy in its buildings and the ways people move around.

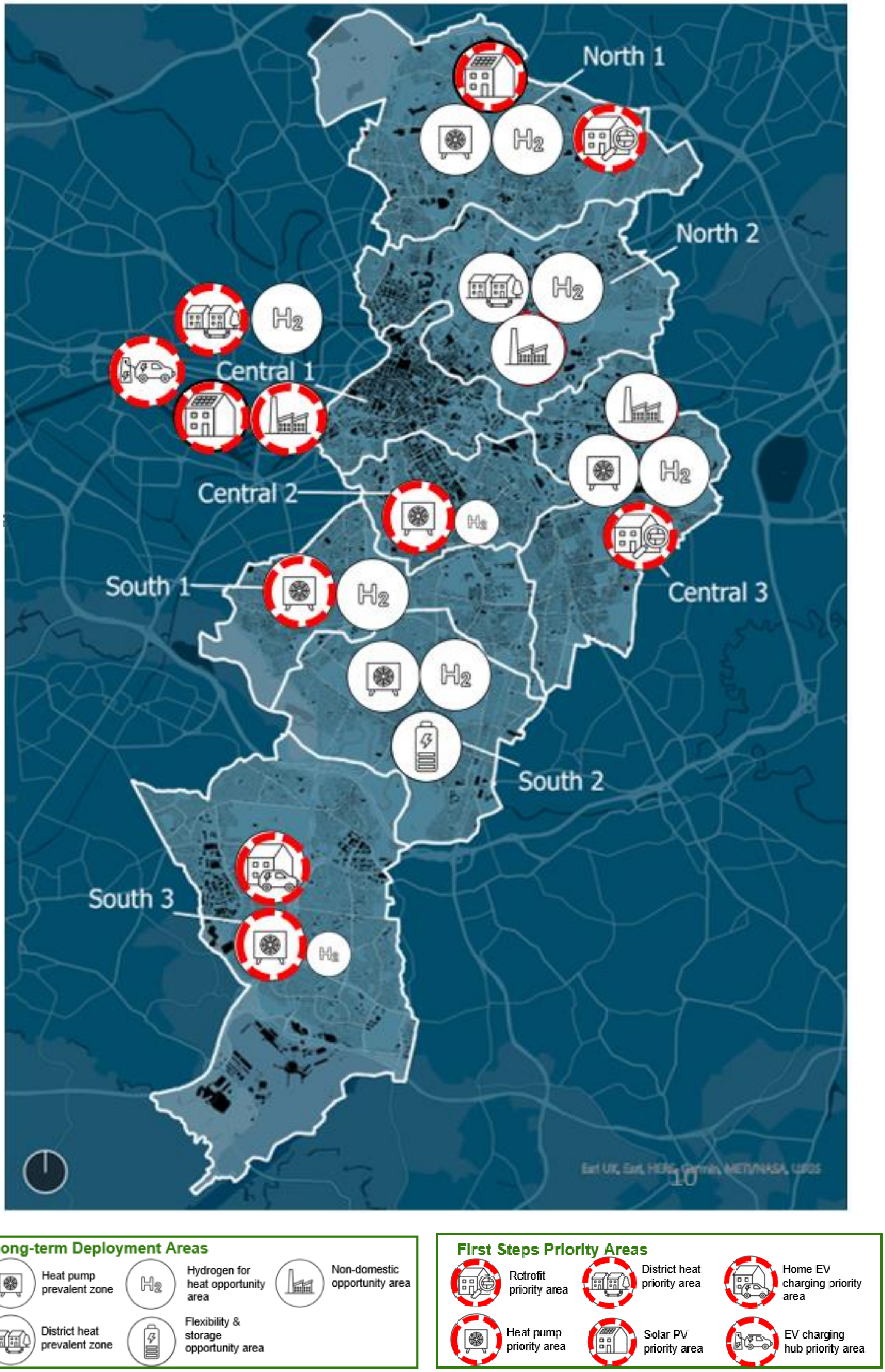
This LAEP provides Manchester with both:

- An overall vision that illustrates the scale of change needed, through to 2038, to work towards carbon neutrality
- And importantly, the identification of priority areas to both demonstrate and test how to roll out the measures that will be needed to decarbonise Manchester, whilst building the capacity needed for wide-scale deployment

The priority areas are summarised in the following map. This illustrates suggested areas and components for Manchester Council to work with GMCA and other key stakeholders to develop a detailed, area specific*, action plan and delivery programme.

* In addition to this LAEP, Manchester Council and GMCA are being provided with a more detailed and granular data set that can be used to identify potential target areas for demonstration and scale up activity. This data set identifies interventions and technology options at a neighbourhood level.

First Steps – Priority Areas (Demonstration & Scale up)



Next Steps

Using the insights within this LAEP and in the identified priority areas, Manchester Council will need to work with GMCA to determine how to take forward this LAEP. Suggested key next steps include:

- Determine approach for wider stakeholder collaboration, engagement, and consultation; utilising outcomes to refine target priority areas and to support the creation of a detailed action plan and delivery programme
- Determine approach for governance and tracking progress; incorporating mechanism for evaluating impact of interventions aligned to GM's carbon budget
- Develop process for evaluating actual intervention and technology options for implementation, in order to understand trade-offs between options*
- Work with ENWL to consider and prioritise potential demonstration and scale up of electricity-based components aligned to ENWL activity
- Work with Cadent regarding commitment and delivery of HyNet to Manchester, integrating Cadent plans and activity with this LAEP
- Work with both ENWL and Cadent to develop a whole energy system energy network planning approach for taking forward this LAEP
- Work with GMCA to establish process for cross border LAEP reconciliation and interaction with a wider GMCA approach
- Conduct further heat network feasibility analysis to develop initial schemes and further develop zones
- Determine approach for procurement and working with energy and technology suppliers and service providers, including considering relationship with developing local skills and supply chain
- Work with government and other key stakeholders to establish policy and funding mechanisms
- Establish programme of works and detailed plans for demonstration and scale up activity, including testing how to successfully provide new technologies, products, and services to Manchester's citizens
- Determine approach for ensuring the integration of components and activity so that measures are not considered in isolation

* For example: considering hydrogen, heat pump and hybrid systems and associated risks and benefits e.g. consumer demands and disruption; evaluating providing greater levels of dwelling retrofit e.g. to target reducing dwelling energy consumption costs

Wider LEM Project Partners

- GMCA Greater Manchester Combined Authority
- bruntwood
- OVO energy
- Carbon Co-op
- HITACHI Inspire the Next
- DAIKIN
- Cornwall Insight Creating Clarity
- GrahamOakes Community & Municipal Energy
- Cadent Your Gas Network
- regen transforming energy
- electricity north west
- Northwards Housing North Manchester's Council Homes

Greater Manchester Combined Authority. Support on renewable energy generation opportunities and engineering feasibility review was provided by Buro Happold.

Local knowledge, data, direction and guidance were provided by Manchester City Council and Greater Manchester Combined Authority.

Information relating to existing energy networks, and wider input to the development of this Plan were provided by the electricity distribution network operator Electricity North West and gas distribution network operator Cadent.

The following stakeholders also provided input during the development of this Plan: Department of Business, Energy and Industrial Strategy, Ofgem and Innovate UK.

About the GM LEM project

This report was produced as part of the Greater Manchester Local Energy Market (GM LEM) project, which forms a key part of Greater Manchester Combined Authority's plans for decarbonisation, set out in the 5 Year Environment Plan, complemented by the Smart Energy Plan. Together these enable Greater Manchester to work towards the target for a zero-carbon emissions city region by 2038. The GM LEM project is an ambitious integrated, whole system energy vision that addresses how energy is generated, traded, transported, supplied, and used across the city region. Co-ordinated by the Greater Manchester Combined Authority (GMCA), it brings together a diverse array of partners from the private, public and third sectors, including commercial and legal advisors, service design consultants, financial and regulatory specialists and the energy, technology, and systems resources. The two-year project is funded by Innovate UK.

About Local Area Energy Planning

Energy is a core part of national and local economies and infrastructure. Decarbonisation of the UK will require significant changes to energy systems, yet every local area is unique, and the changes needed to decarbonise will be specific to each area. Energy Systems Catapult (ESC) pioneered a new whole system approach to Local Area Energy Planning (LAEP) with pilots in three different local areas of the UK – Newcastle, Bury in Greater Manchester, and Bridgend in Wales. ESC has since worked with others to evolve this approach, including with Ofgem and Centre for Sustainable Energy to define a method for LAEP[*] 'done well', which we have sought to follow in the creation of this Manchester LAEP, within the constraints of the GM LEM project[†]. In this project the ESC's EnergyPath Networks toolkit has been used to perform the local analysis.

[*] https://es.catapult.org.uk/reports/local-area-energy-planning-the-method/
[†] https://es.catapult.org.uk/reports/local-area-energy-planning/

About Energy Systems Catapult

ESC was set up to accelerate the transformation of the UK's energy system and ensure UK businesses and consumers capture the opportunities of clean growth. ESC is an independent, not-for-profit centre of excellence that bridges the gap between industry, government, academia, and research. We take a whole systems view of the energy sector, helping us to identify and address innovation priorities and market barriers, in order to decarbonise the energy system at the lowest cost. We work with innovators from companies of all sizes to develop, test and scale their ideas. We also collaborate with industry, academia, and government to overcome the systemic barriers of the current energy market to help unleash the potential of new products, services and value chains required to achieve the UK's clean growth ambitions as set out in the Industrial Strategy.

About Buro Happold

Buro Happold is an international, integrated consultancy of engineers, consultants and advisers. Operating in 26 locations worldwide, with 55 partners and over 1,900 employees; for over 40 years we have built a world-class reputation for delivering creative, value led solutions for an ever-challenging world.

Document control:

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Restrictions	Open

Review and approval:

	Name	Position
Author	Lewis Bowick and Tian Coulsting	Local Energy Transition Consultant and Systems Integration Consultant
Reviewer	Richard Leach	Local & Site Energy Transition Manager
Approver	Rebecca Stafford	Senior Manager

Revision history:

Date	Version	Comments
07/07/2021	0.1	Initial draft
12/07/2021	0.2	Working draft for initial client consultation
27/07/2021	0.3	Updated draft for client review
21/10/2021	0.4	Final version
20/12/2021	**1.0**	**Client issue (Word format)**
10/01/2022	1.1	Minor corrections to punctuation etc.
16/05/2022	1.2	Minor corrections to format

GREATER MANCHESTER
LOCAL ENERGY MARKET
DOING THINGS DIFFERENTLY FOR THE ENVIRONMENT

Technical Annex

The technical annex summarises aspects of the evidence base that has been used to develop this LAEP; based on scenario based whole energy system modelling and analysis

THE FOUR SCENARIOS

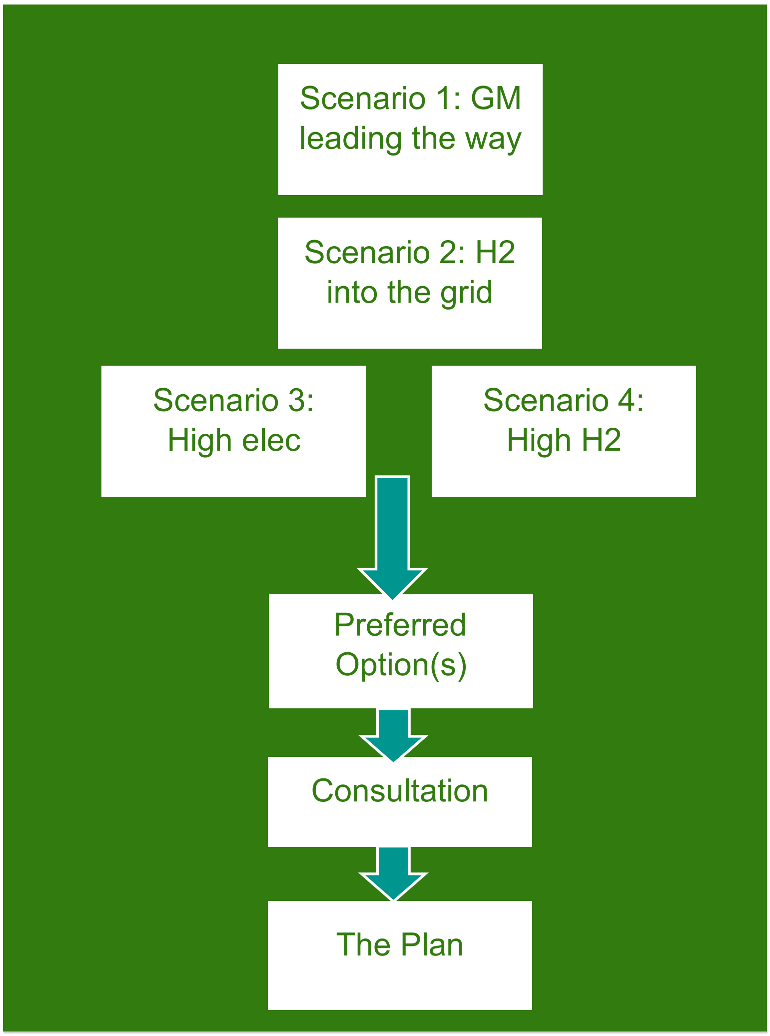
A variety of energy system scenarios are possible to deliver Greater Manchester and Manchester's future energy vision. It is not practical to consider every possible configuration of Manchester 's local energy system in a limited number of scenarios, therefore four main scenarios have been considered; these represent the prominent cost-effective options that could materialise.

The scenarios are not predictions or forecasts of the most probable outcomes. They represent plausible and affordable futures based on available information and have been used to inform a plan for Manchester. The decarbonisation of any local energy system will require considerable co-ordination, planning and investment as well as consumer and social engagement.

The scenarios have been developed through frequent engagement with GMCA, as well as consulting with a wider group of stakeholders including Cadent and Electricity Northwest. Further consultation and engagement with Manchester residents is proposed as part of the wider Greater Manchester Local Energy Market project and will continue to inform the development and refinement of the LAEP for Manchester and other districts

A brief description of the different scenarios developed and used to inform the plan is given here, with modelling outputs from the scenarios provided in the following pages.

Importantly, each future local energy scenario for Manchester has been developed to reach carbon neutrality by 2038, aligned to Greater Manchester's decarbonisation ambition and to also act as counterfactuals and alternative futures for Manchester. These scenarios are constructed using location specific information on Manchester's existing energy networks, buildings, local constraints, and resources in combination with data on technology performance and costs and modelled using ESC's EnergyPath Networks modelling toolkit.



Modelled scenarios and plan development

These scenarios provide an understanding of pace and scale of activity needed, costs and investment needed for local implementation in support of decarbonisation goals and the commonality and variation of measures across the different future local energy scenarios. The scenarios help to explore choices around how to reach carbon neutrality using different technologies and known solutions where they exist.

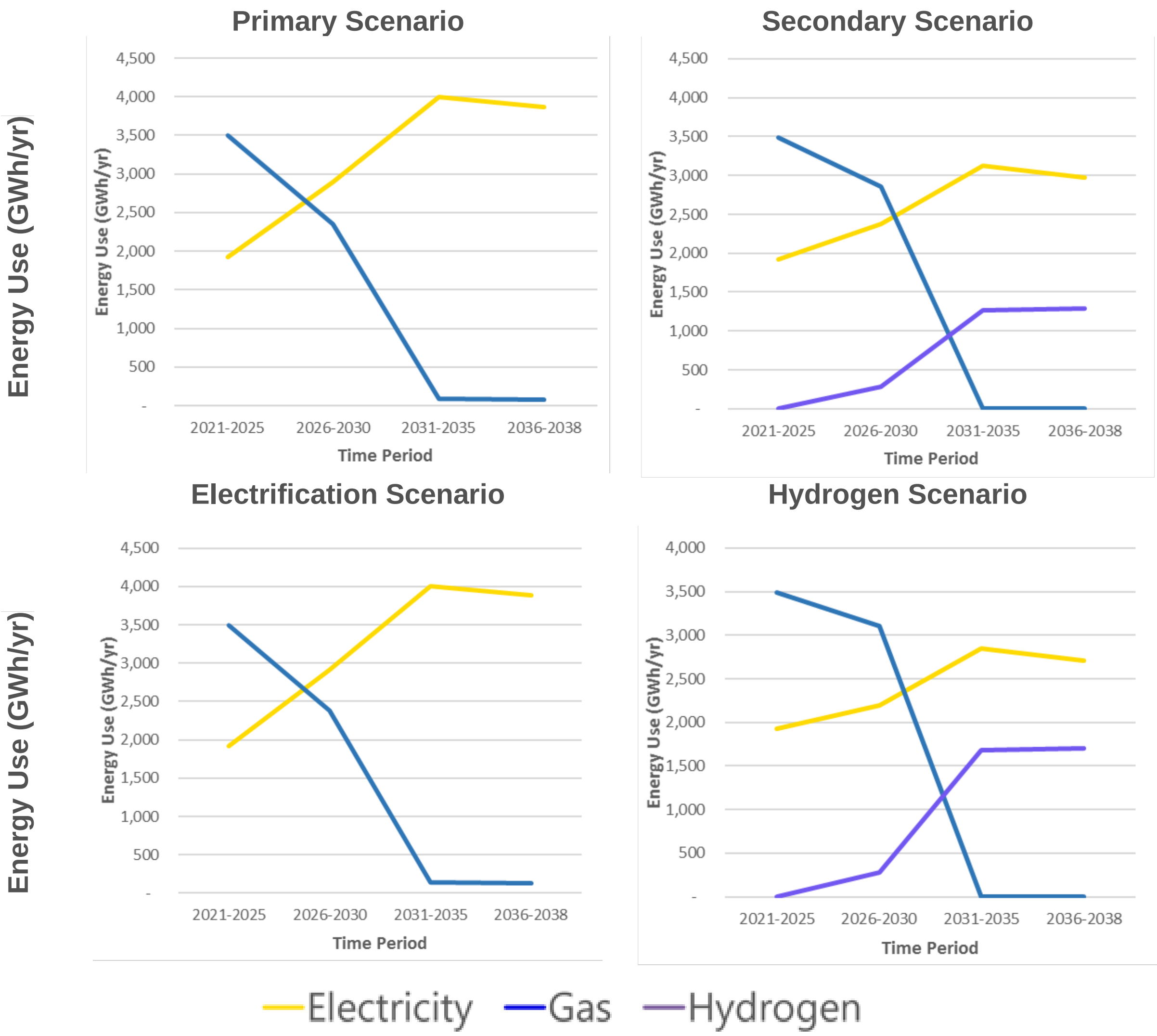
Scenario 1 – Leading the Way: This scenario focuses on meeting the carbon budget and target by making use of **proven measures within Manchester's local control** where at all possible.

Scenario 2 – An Alternative Future Local Energy Scenario:
We have assumed hydrogen options for residential heating and non-domestic buildings become available in Manchester from 2030 onwards, aligned to Hynet Phase 3 and the repurposing of the gas grid to hydrogen is an option

Scenario 3 – High Electrification: We have assumed the only low carbon options for buildings heating and hot water demand are electric based. This includes energy centres feeding local heat networks

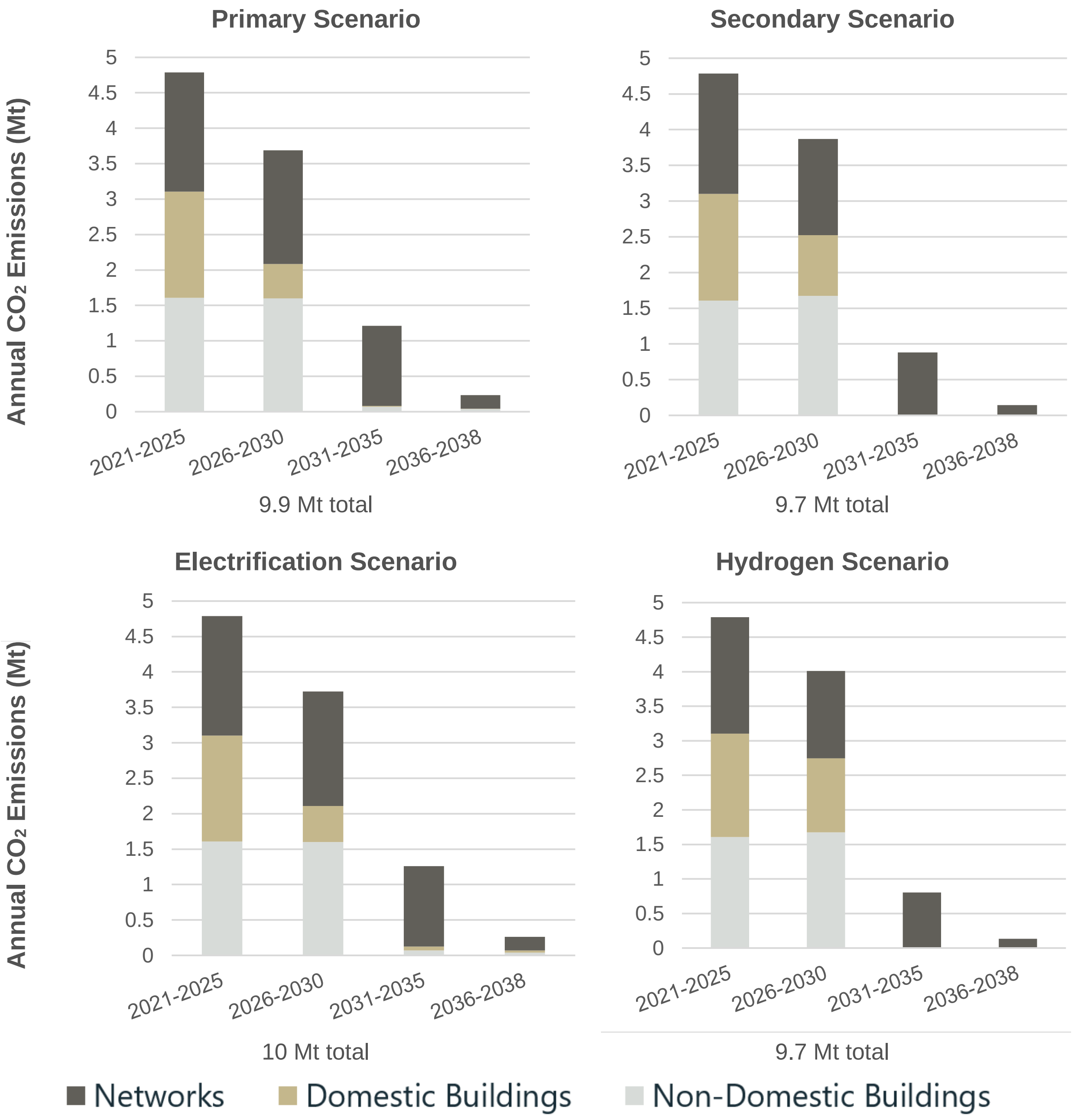
Scenario 4 – High Hydrogen: We have assumed the only available low carbon options for buildings heating and hot water demand are hydrogen based from 2031 onwards

Scenarios 3 and 4 provide context and evidence for what would happen if either hydrogen or electrification were pursued as the sole solution for the decarbonisation of homes and buildings in Manchester. Whilst this is considered to have a number of practical limitations to feasible implementation by 2038, these were considered useful as comparative scenarios.



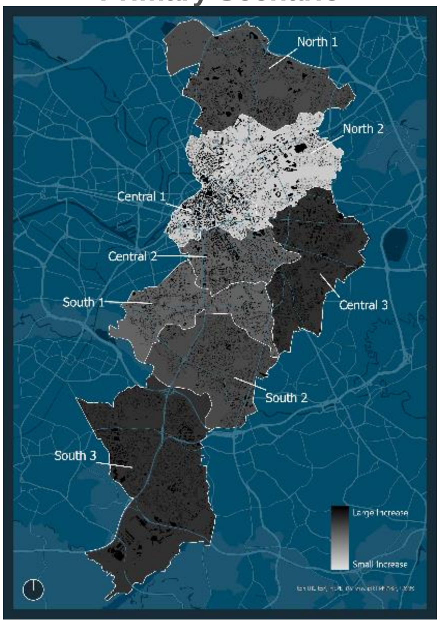
Figures shown exclude petrol and diesel fuel consumed for transport. The overall reduction in energy consumption due to increased efficiency is therefore greater than shown, due to the reduction in transport fuel consumption.

EMISSIONS

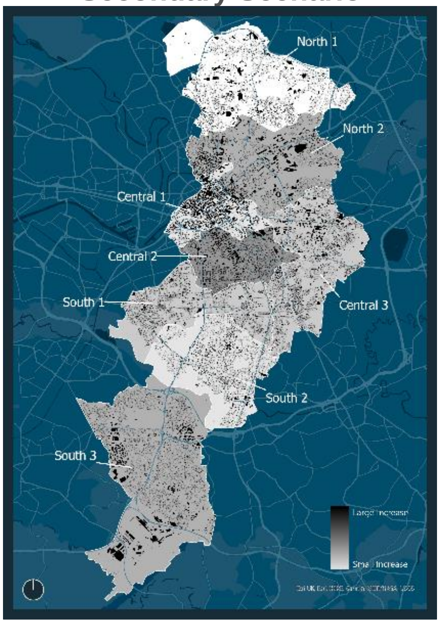

Primary Scenario
Secondary Scenario
Electrification Scenario
Hydrogen Scenario
Annual CO_2 Emissions (Mt)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
2021-2025
2026-2030
2031-2035
2036-2038
9.9 Mt total
9.7 Mt total
10 Mt total
9.7 Mt total
Networks
Domestic Buildings
Non-Domestic Buildings

HEATING ZONING OPTIONS: HEAT PUMP DEPLOYMENT BY 2038

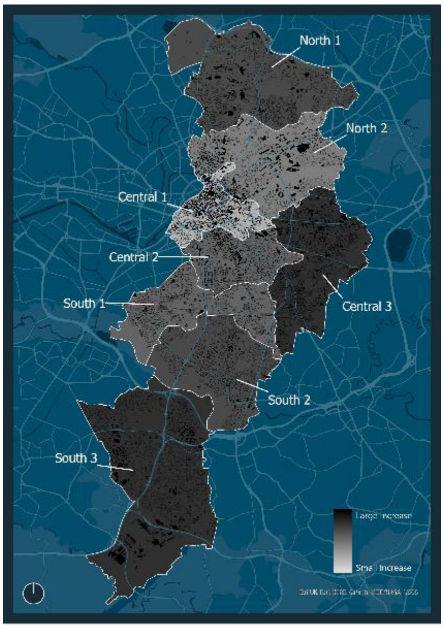
Primary Scenario



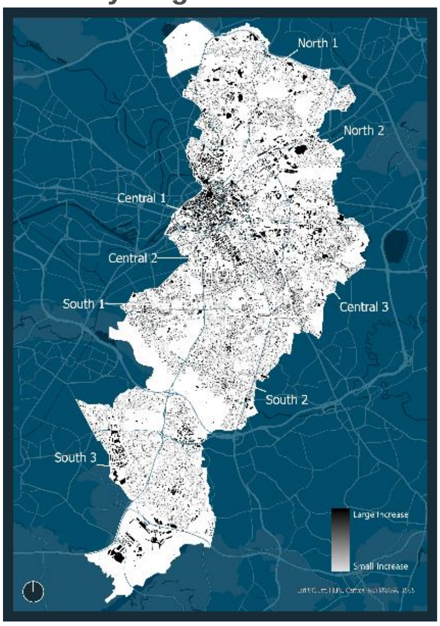
Secondary Scenario



Electrification Scenario

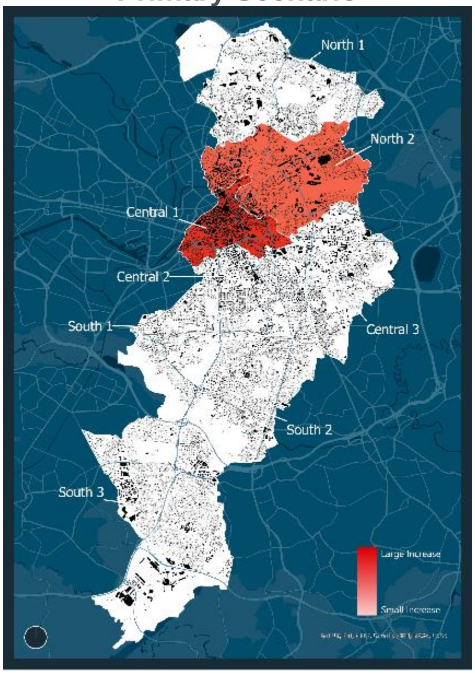


Hydrogen Scenario

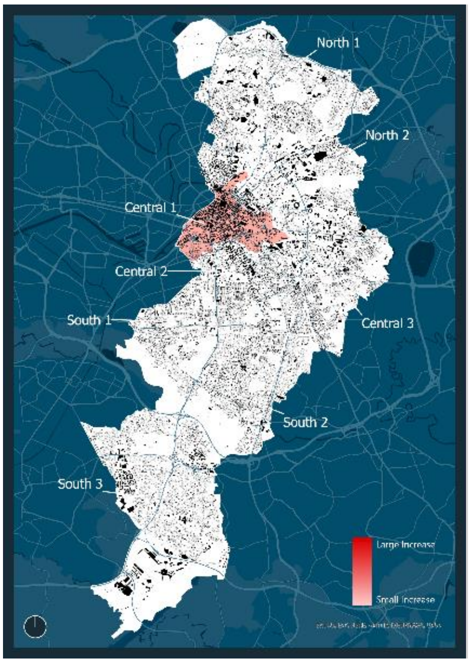


HEATING ZONING OPTIONS: DISTRICT HEATING CONNECTIONS BY 2038

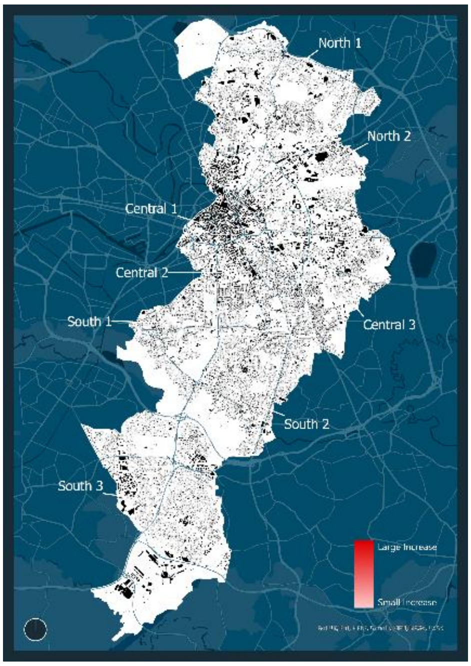
Primary Scenario



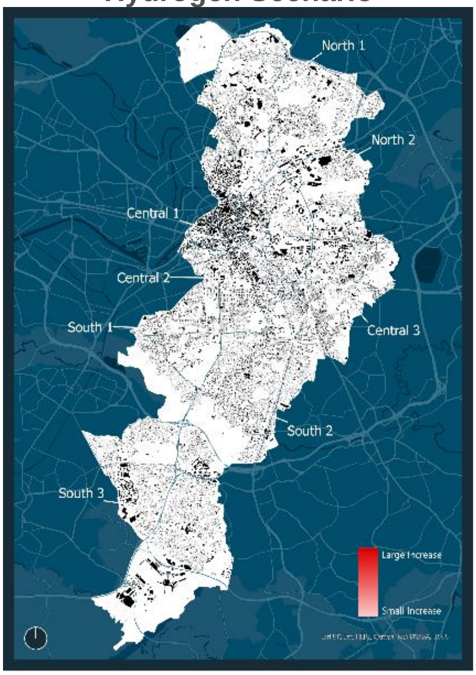
Secondary Scenario



Electrification Scenario

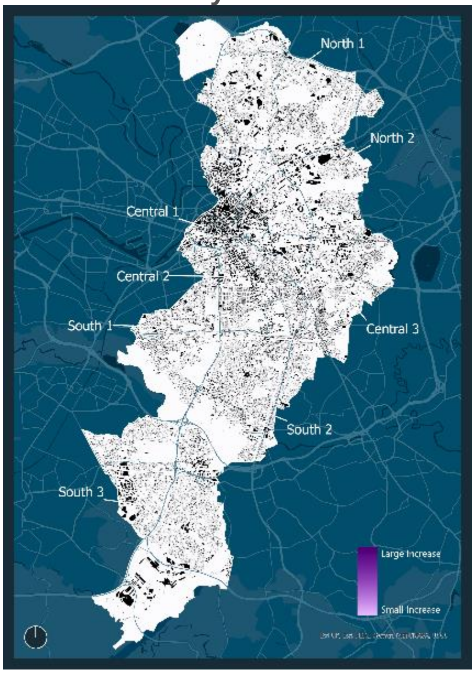


Hydrogen Scenario

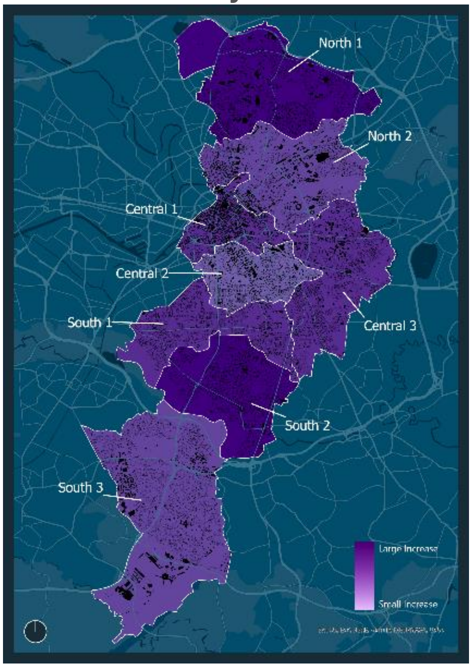


HEATING ZONING OPTIONS: HYDROGEN BOILER DEPLOYMENT BY 2038

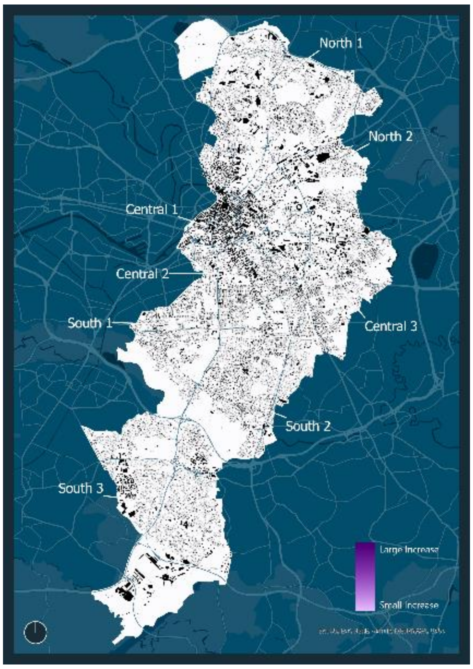
Primary Scenario



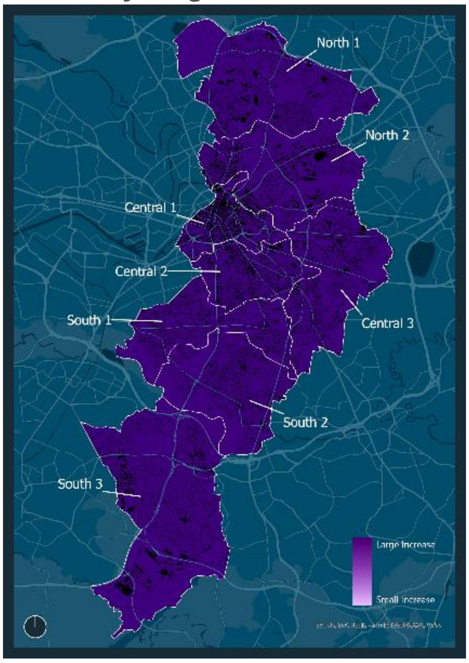
Secondary Scenario



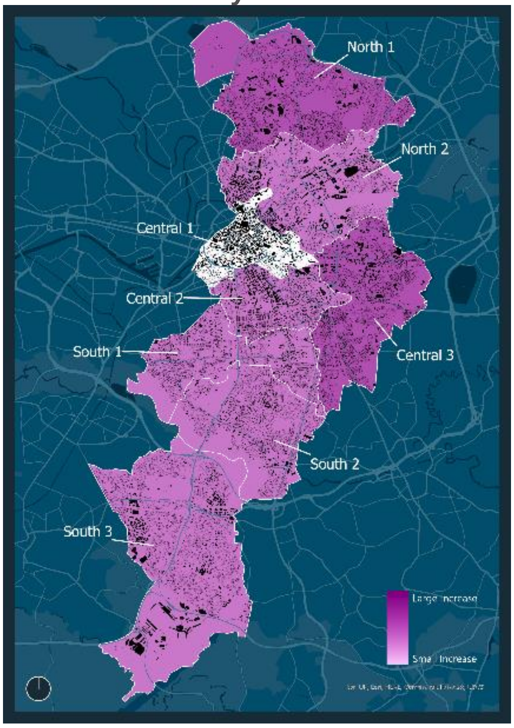
Electrification Scenario



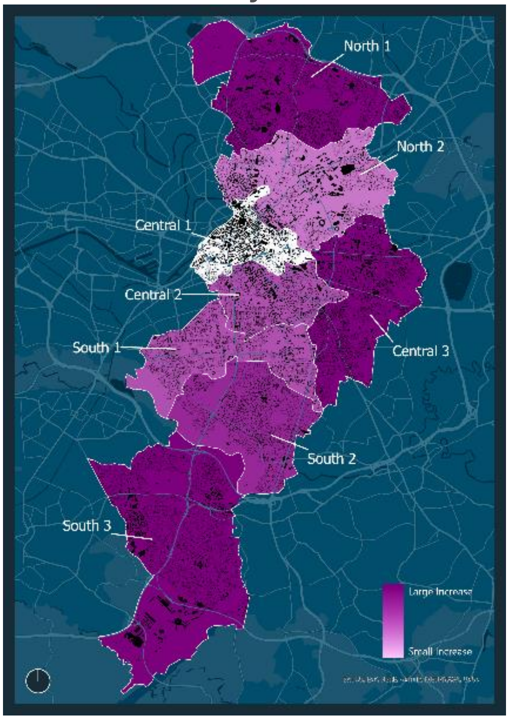
Hydrogen Scenario



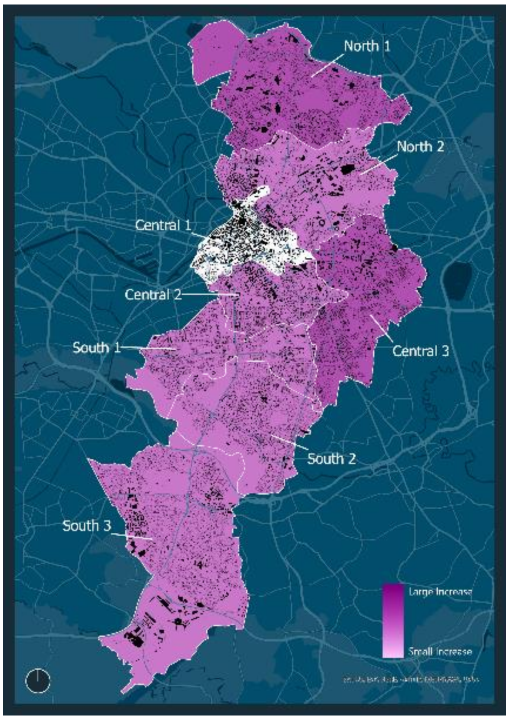
Primary Scenario



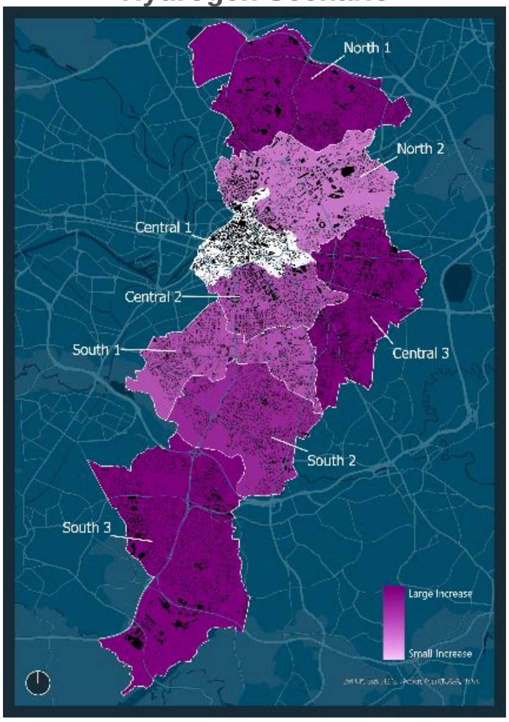
Secondary Scenario



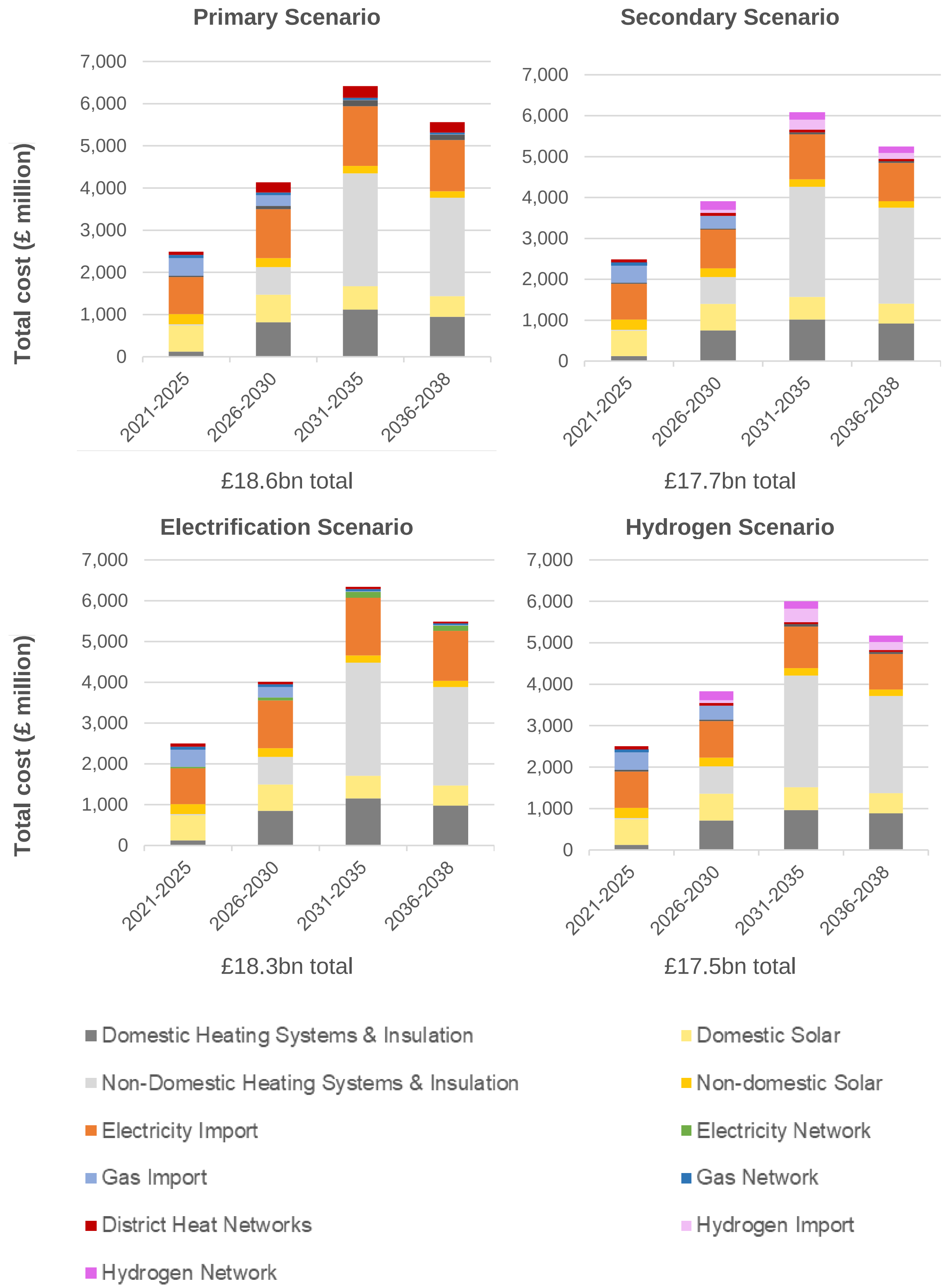
Electrification Scenario



Hydrogen Scenario



SYSTEM COST



Primary Scenario
Secondary Scenario
Total cost (£ million)
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
2021-2025
2026-2030
2031-2035
2036-2038
£18.6bn total
£17.7bn total
Electrification Scenario
Hydrogen Scenario
£18.3bn total
£17.5bn total
Domestic Heating Systems & Insulation
Domestic Solar
Non-Domestic Heating Systems & Insulation
Non-domestic Solar
Electricity Import
Electricity Network
Gas Import
Gas Network
District Heat Networks
Hydrogen Import
Hydrogen Network

Data Sources Annex

The data sources annex summarises the consistent baseline data used by the ESC used to develop this LAEP.

BUILDINGS

Domestic

- **Ordnance Survey AddressBase Premium, MasterMap Topography, Highways**
  - Shows location, footprint, and classification of buildings, plus road layout for network modelling.
  - Latest data obtained December 2020 for buildings and roads.
- **GMCA Accelerating Retrofit Domestic Buildings Dataset**
  - Detailed attributes of all domestic properties in GM produced by Parity Projects, using EPCs and filling gaps with other data.
- **Energy Performance Certificates (EPC)s***
  - ESC-built address matching algorithm to match housing attributes from EPCs
  - Informs building-level attributes – e.g. current heating system, levels of insulation.
- **Listed Buildings –** Historic England† as a potential constraint on retrofit

Non-Domestic

- **Ordnance Survey MasterMap Topography**
  - Provides status and classification of building (e.g. office, retail).
  - Informs building size and height.
- **OpenStreetMap** has not been chosen due to inconsistent national coverage compared with Ordnance Survey.
- **Non-domestic Energy Performance Certificates (EPC) and Display Energy Certificates (DEC)‡** to provide further building attributes and demands.
- **GMCA Public Sector Decarbonisation Scheme (PSDS)** to provide further demand data for significant public sector buildings and funded interventions in specific buildings
- **GMCA "Go Neutral"** provides further demand data for public buildings.
- Energy benchmarks (kWh/m^2) developed in conjunction with Arup

* https://epc.opendatacommunities.org/
† https://historicengland.org.uk/listing/the-list/data-downloads/
‡ https://epc.opendatacommunities.org/ Note: details of Green Homes Grant (GHG) and Local Authority Delivery (LAD) projects provided separately by Local Authorities where relevant

Future Building Stock

- **GMCA Existing Land Supply Sites**
  - For domestic, number given split by house/apartment, with planned construction date.

    For non-domestic, type given (office, retail, industry/warehouse) with planned construction date
- **GMCA Spatial Framework Allocation Sites**
  - Usage as above.
  - In total over 3,000 sites provided

Networks

- Relationships & NDAs with Electricity North West (ENWL) & Cadent
- **ENWL** (Electricity Distribution Network Operator)
    - Substation locations and capacities (for 11kV-400V upwards)
    - Typical component costs, combined in packages to generate reinforcement costs for different network assets.
- **Cadent** (Gas Distribution Network Operator)
    - Mapping of pipes including material, size and pressure.

Local Generation

- **Renewable Energy Planning Database***
    - Current planned and operational renewable energy installations (above 150kw)
- **Feed-in-tariff install reports†**
    - Current levels of domestic PV by postcode
- **GMCA "Unlocking Clean Energy in Greater Manchester" project**
    - Details of various solar PV, hydro-electric generation, battery storage and electric vehicle (EV) charging projects.
- **ENWL Embedded Capacity Register‡**
    - Identify registered generation assets within the region

Electric Vehicles

- **Zap-Map§**
    - Location and peak demand of public chargepoints.
    - **National Chargepoint Registry (NCR)**** has not been used since its data is included within Zap-Map's national database.
- **Future domestic EV uptake**
    - ESC in-house analysis on the expected uptake of EVs on the network.
- **GMCA Transport for Greater Manchester (TfGM) list of potential EV charging sites**
    - Work carried out by Arup to determine 60+ locations, number of connections and charge speed across GM.

* https://www.gov.uk/government/publications/renewable-energy-planning-database-monthly-extract
† https://www.ofgem.gov.uk/publications-and-updates/feed-tariff-installation-report-31-december-2020
‡ https://www.enwl.co.uk/get-connected/network-information/embedded-capacity-register
§ https://www.zap-map.com
** https://www.gov.uk/guidance/find-and-use-data-on-public-electric-vehicle-chargepoint