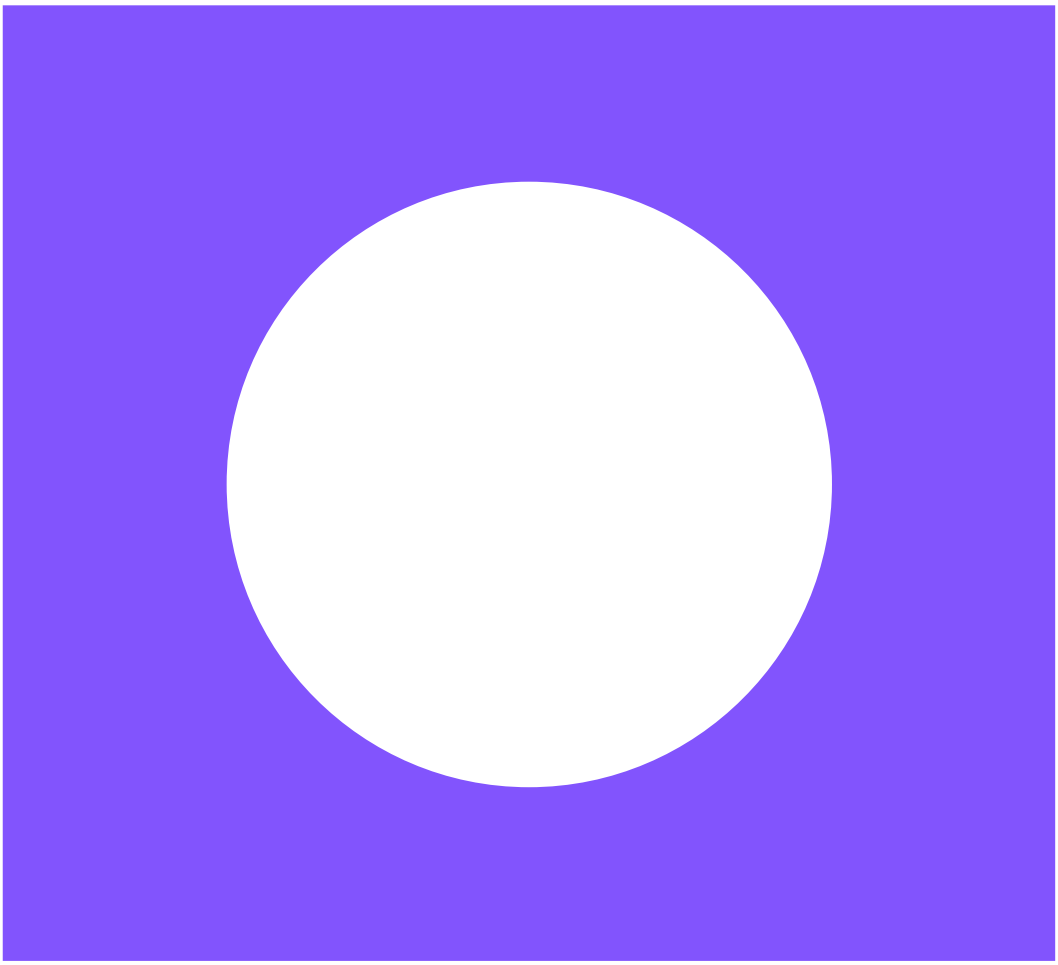
MOTT MACDONALD



Nottingham City LAEP

EMCCA LAEP 1D - Final

July 2026

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Nottingham City LAEP

EMCCA LAEP 1D - Final

July 2026

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Executive summary

The Nottingham City Local Area Energy Plan (LAEP) sets out a comprehensive, evidence-based roadmap for achieving a just, resilient, and affordable transition to net zero. Commissioned by the East Midlands Combined County Authority (EMCCA) and prepared by Mott MacDonald in partnership with IES, the plan integrates technical modelling, spatial analysis, economic appraisal, and extensive stakeholder engagement to identify how Nottingham can most effectively decarbonise its local energy system while delivering wider social and economic benefits. The LAEP is part of a coordinated regional approach, aligning local action with national policy objectives and EMCCA's 2050 net zero ambition.

Purpose and Context

The UK's legally binding target to reach net zero greenhouse gas emissions by 2050, reinforced by the Climate Change Committee's Seventh Carbon Budget, places local authorities at the forefront of delivery, an estimated 82% of UK emissions are within their sphere of influence. Nottingham City Council declared a Climate and Ecological Emergency in 2019, setting out the ambitious CN28 programme to drive progress towards carbon neutrality and deliver meaningful environmental action across the city. The LAEP responds directly to local challenges, including high levels of fuel poverty, reliance on fossil gas for heating, grid capacity constraints, and the need for economic regeneration that aligns with environmental sustainability.

Approach and Methodology

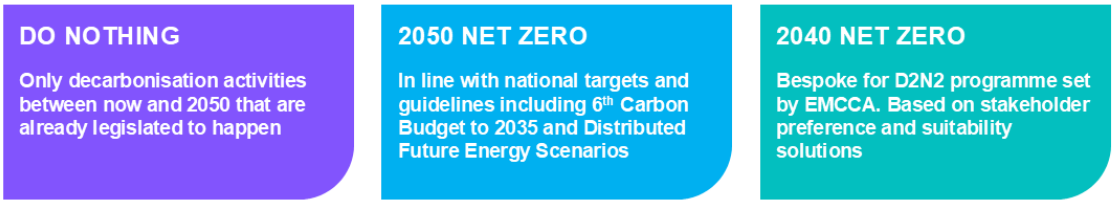
The LAEP was developed using the Energy Systems Catapult (ESC) methodology for place-based energy planning, combining:

- **Digital Twin Modelling**: IES's dynamic 3D model simulates energy demand, generation, and carbon emissions across Nottingham's building stock at the Middle Super Output Area (MSOA) level.
- **Scenario Modelling**: Quantitative comparison of three decarbonisation pathways; Do Nothing, Net Zero by 2050, and Accelerated Net Zero by 2040, using logistic (S-curve) uptake functions for key technologies.
- **Techno-Economic Analysis**: Appraisal of capital investment, operating costs, system benefits, and bill savings under each pathway.
- **Spatial Prioritisation**: GIS-based identification of focus zones for targeted interventions where energy, social, and grid considerations converge.
- **Stakeholder Collaboration**: Engagement with local organisations, including the City Council, utilities, large industries, housing providers, and community groups, to ensure the plan is co-created and deliverable.

Scope

The LAEP focuses on areas where the local authority and its partners can exert meaningful influence: homes and non-domestic buildings, personal road transport and charging infrastructure, locally influenced generation (such as rooftop solar), and decarbonisation choices facing local industry. Nationally controlled systems that are better addressed through central government or national operators, such as strategic rail, aviation, and utility-scale generation are outside the scope for emissions accounting and intervention planning. This focus enables Nottingham to concentrate resources on deliverable local actions.

The LAEP models three scenarios, with the preferred scenario being Net Zero by 2050, while also considering an accelerated 2040 pathway.



Current Energy and Emissions Baseline

In 2023[1], Nottingham's total territorial emissions were approximately 1,226 $ktCO_2e$, with transport (33%), domestic energy use (26%), and commercial activity (14%) as the largest contributors. Total energy consumption in buildings is dominated by space heating, with natural gas as the primary fuel. The city's housing stock is largely pre-1996, with 66% of homes rated EPC D or lower, highlighting the need for extensive retrofit. Fuel poverty remains a significant challenge, with 15% of households affected[2], higher than regional and national averages.

Energy Efficiency and Buildings Retrofit

Modelling shows that approximately 74,600 buildings require some level of retrofit to achieve net zero scenarios. Over 44,000 homes (40% of the stock) require light retrofit, while nearly 60,000 homes (54%) need deep retrofit. Light retrofit offers shorter payback periods and is well-suited for rapid scaling, particularly in owner-occupied homes. Deep retrofit is essential for older, solid-wall properties to enable efficient heat pump operation and for addressing fuel poverty hotspots. The recommended approach is to concentrate deep retrofit in a first wave of priority MSOAs where solid wall prevalence, fuel poverty, and low EPC ratings coincide.

Low-Carbon Heat

Heat decarbonisation in existing homes relies primarily on air-source heat pumps, installed alongside targeted fabric upgrades. Early installations should focus on areas where electricity network capacity and funding eligibility coincide. In parallel, heat network zoning should be pursued in identified areas, leveraging the city's existing infrastructure and the government's zoning programme. Nottingham's heat network, Enviroenergy, is one of the UK's largest, supplying over 5,000 homes and 100 non-domestic buildings.

Transport Electrification

The modelling projects a significant rise in electric vehicles (EVs) by 2050, with a planning assumption of one public charger for every 10 EVs. Siting of public chargers should prioritise areas lacking off-street parking, then expand to workplace and destination hubs. Nottingham already has a higher-than-average number of rapid public chargepoints, and the council fleet is transitioning rapidly to EVs.

Local Generation and Flexibility

Expanding local renewable energy generation is key to enhancing resilience and managing grid load. The analysis identifies significant potential for rooftop solar PV, with the capacity to generate over 266 GWh annually across domestic and non-domestic buildings. When paired with battery storage and demand-side response, this local generation can reduce peak demand, provide flexibility to the grid, and lower consumer bills.

[1] UK Government Emissions, 2023

[2] Fuel Poverty Strategy - Nottingham City Council

Industrial Decarbonisation

The plan prioritises electrification of low-temperature industrial processes, while high-temperature processes prepare for a potential transition to low-carbon hydrogen, contingent on supply chain and infrastructure development. Analysis suggests that industrial gas use for process heating can be substantially reduced by 2050, with associated emissions falling by around 94% under the fuel-switch scenarios. Large industrial sites are encouraged to develop time-phased decarbonisation plans, detailing what changes will occur, when they will occur, and what new energy vectors and network capacities will be needed.

Networks, Storage, and Headroom

Several primary substations and MSOAs have limited spare capacity, making timely reinforcement, connection planning, and flexibility critical to keeping electrification on track. There is a strong case for proactive investment in distribution network upgrades, as any net zero-compliant scenario is projected to add over 1,200 MW of After Diversity Maximum Demand (ADMD), exceeding current infrastructure capacity.

Close collaboration with the local distribution network operator (NGED) will be necessary to appropriately phase the scale roll-out of PV, ASHP and EVs.

Economics and Value for Money

The additional undiscounted capital expenditure for the 2040 and 2050 scenarios is estimated at £5.4 billion in today's prices. Although the required investment is substantial and the pace of transition will depend on sustained policy and grant support, it is expected to generate benefits through lower energy bills, carbon reduction, improved air quality, and employment stimulation in the local economy.

Prioritisation and Focus Zones

Spatial mapping identified focus zones where targeted interventions deliver maximum benefit, including areas with high fuel poverty risk, poor EPC ratings, and high grid utilisation.

Quick win projects include:

- Deep retrofit of social housing,
- Deployment of rooftop solar on public sector buildings,
- Rollout of public EV charging in high-demand zones,
- Pilot district heating networks in high heat-density clusters.

Next Steps

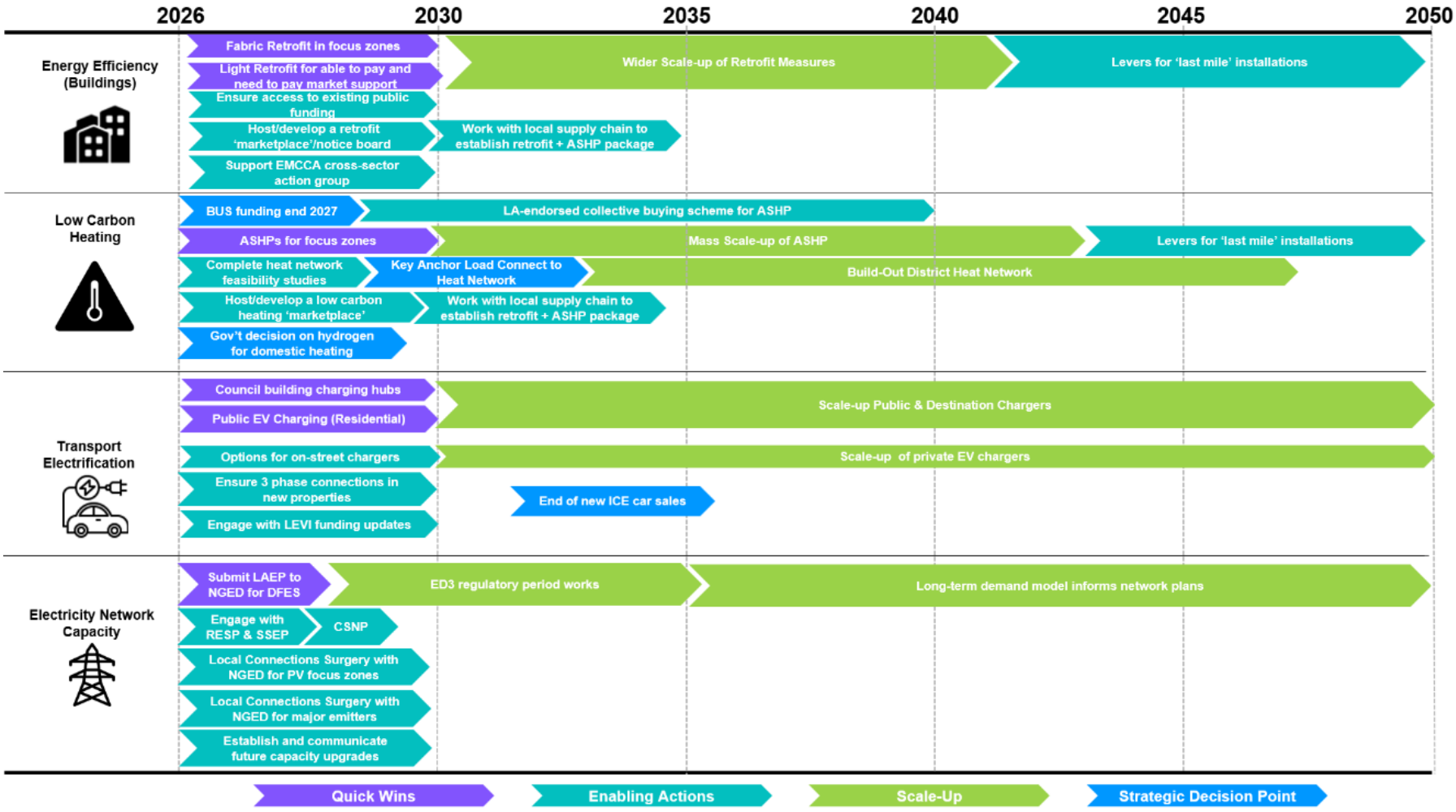
To ensure timely and effective delivery of the LAEP, the following actions are recommended:

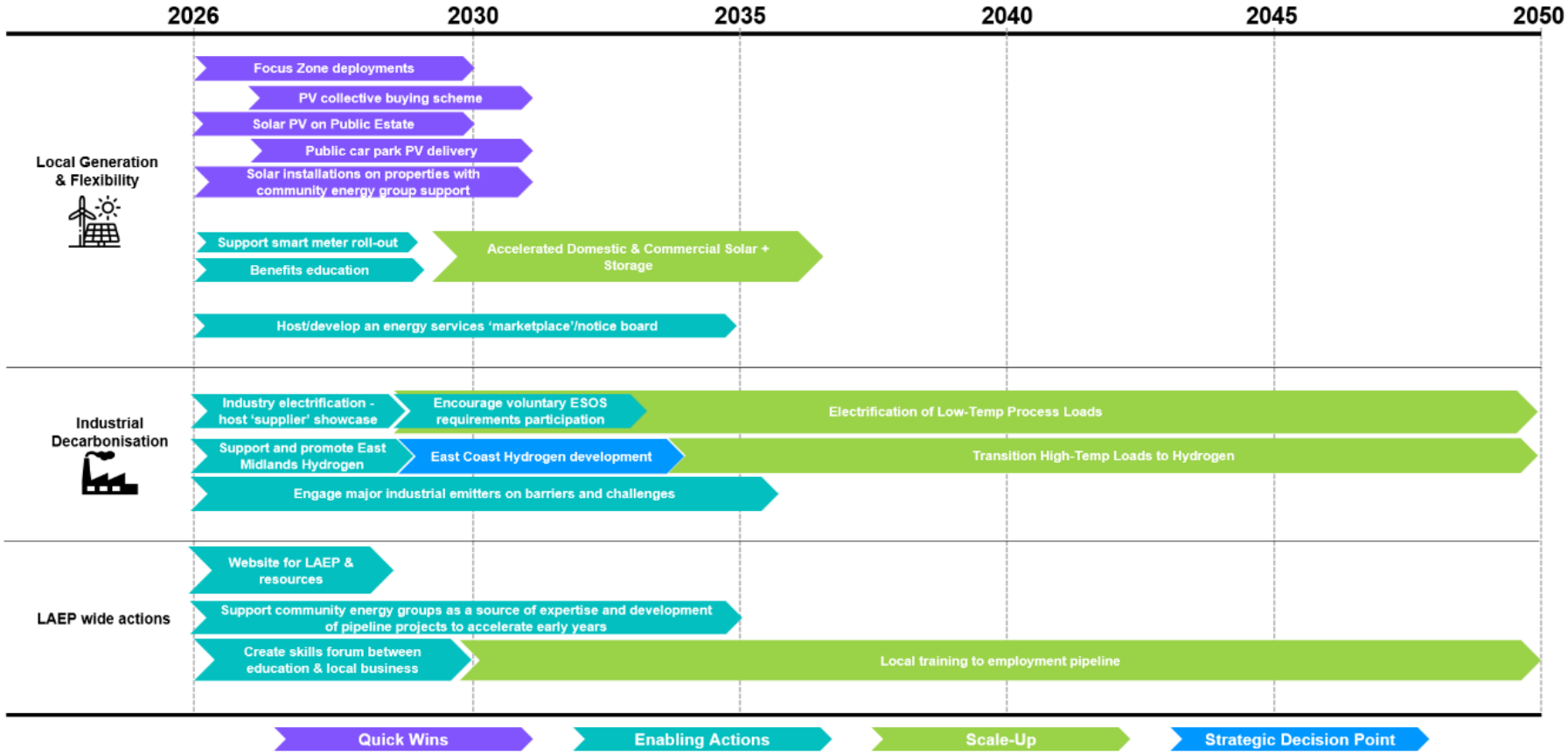
1. **Establish a Nottingham LAEP Delivery Partnership**: Create a cross-sector partnership chaired by Nottingham Council and supported by EMCCA, DNO, local businesses, housing associations, and community representatives. The partnership should integrate Nottingham's strategic energy procurement function to aggregate demand, coordinate long-term energy purchasing and flexibility services, and align procurement decisions with LAEP priorities. This body should oversee programme coordination, track implementation progress, and identify funding opportunities
2. **Launch Public Uptake and Engagement Programme with online 'hub'**: Implement the recommended community engagement and communication strategy with urgency. This programme is vital to build public confidence, share good news stories, and drive the necessary adoption of low-carbon technologies like heat pumps. Priority should be given to demonstration and pilot projects that showcase best practice and real-world results.

3. **Develop a Delivery Roadmap and Investment Plan**: Prioritise the short-, medium-, and long-term interventions including both quick wins and enabling actions.
4. **Secure Early-Stage Funding and Demonstrator Projects**: Identify and secure initial funding mechanisms (local, regional, and national) to kick-start demonstrator projects in focus zones that can showcase tangible early benefits and build public support.
5. **Hydrogen**: Initiate detailed engagement with key regional hydrogen stakeholders, such as East Midlands Hydrogen and Cadent Gas, to better advise on Nottingham's specific industrial demand and the infrastructure development timeline. This will allow for informed decision-making regarding long-term solutions for high-temperature, hard-to-treat loads.
6. **Monitor, Review, and Update the LAEP**: Establish a monitoring framework with key performance indicators (KPIs) aligned to emissions reduction, energy demand, and social outcomes. The LAEP should be reviewed on a five-year cycle to reflect policy developments, technological advances, and local progress.
7. **Continued Consultation on Local Projections for District Heating Rollout**, including quantification of the associated energy impacts, as well as further validation of non-domestic energy demand reviewing digital-twin land-use classifications
8. **Improved Identification of Construction Timelines for Non-Domestic Developments**, along with greater visibility of new domestic developments post 2029 energisation. This will ensure more accurate assessment of peak demand to support effective engagement and future planning with distribution and system operators.
9. **Continued Engagement with the DNO** to ensure LAEP modelling outputs are effectively incorporated into Distribution Future Energy Scenarios (DFES). Continued engagement with National Energy System Operator (NESO) to ensure planning for new developments and low-carbon technology rollout is reflected in regional network planning.

Nottingham City Phased Pathway

The diagram below presents a structured approach for Nottingham's net zero interventions, mapping the sequencing of actions and their interdependencies over time. The approach prioritises quick-win and low-regret measures that are cost-effective and capable of delivering immediate benefits. Enabling actions and pilot projects are positioned early to de-risk delivery and prepare for wider future roll-out, while key decision points and areas of uncertainty are explicitly identified to maintain flexibility as technologies mature and costs and funding landscapes evolve. Overall, the delivery sequence is designed to maximise early impact, manage risk, and build sustained momentum toward long-term decarbonisation.


2026
2030
2035
2040
2045
2050
Energy Efficiency (Buildings)
Fabric Retrofit in focus zones
Light Retrofit for able to pay and need to pay market support
Ensure access to existing public funding
Host/develop a retrofit 'marketplace'/notice board
Support EMCCA cross-sector action group
Wider Scale-up of Retrofit Measures
Levers for 'last mile' installations
Work with local supply chain to establish retrofit + ASHP package
Low Carbon Heating
BUS funding end 2027
ASHPs for focus zones
Complete heat network feasibility studies
Host/develop a low carbon heating 'marketplace'
Gov't decision on hydrogen for domestic heating
LA-endorsed collective buying scheme for ASHP
Mass Scale-up of ASHP
Levers for 'last mile' installations
Key Anchor Load Connect to Heat Network
Build-Out District Heat Network
Work with local supply chain to establish retrofit + ASHP package
Transport Electrification
Council building charging hubs
Public EV Charging (Residential)
Options for on-street chargers
Ensure 3 phase connections in new properties
Engage with LEVI funding updates
Scale-up Public & Destination Chargers
Scale-up of private EV chargers
End of new ICE car sales
Electricity Network Capacity
Submit LAEP to NGED for DFES
Engage with RESP & SSEP
CSNP
Local Connections Surgery with NGED for PV focus zones
Local Connections Surgery with NGED for major emitters
Establish and communicate future capacity upgrades
ED3 regulatory period works
Long-term demand model informs network plans
Quick Wins
Enabling Actions
Scale-Up
Strategic Decision Point


2026
2030
2035
2040
2045
2050
Local Generation & Flexibility
Focus Zone deployments
PV collective buying scheme
Solar PV on Public Estate
Public car park PV delivery
Solar installations on properties with community energy group support
Support smart meter roll-out
Benefits education
Accelerated Domestic & Commercial Solar + Storage
Host/develop an energy services 'marketplace'/notice board
Industrial Decarbonisation
Industry electrification - host 'supplier' showcase
Encourage voluntary ESOS requirements participation
Electrification of Low-Temp Process Loads
Support and promote East Midlands Hydrogen
East Coast Hydrogen development
Transition High-Temp Loads to Hydrogen
Engage major industrial emitters on barriers and challenges
LAEP wide actions
Website for LAEP & resources
Support community energy groups as a source of expertise and development of pipeline projects to accelerate early years
Create skills forum between education & local business
Local training to employment pipeline
Quick Wins
Enabling Actions
Scale-Up
Strategic Decision Point

1 Introduction

Mott MacDonald, in partnership with IES, has been appointed by the East Midlands Combined County Authority (EMCCA) and its local authority partners to lead the development of the Local Area Energy Plan (LAEP) for Nottingham City, supporting the area's journey toward achieving net zero carbon emissions. In response to escalating impacts of climate change and the global push towards sustainable energy solutions, the development of a LAEP has been identified as a crucial step in supporting climate ambitions across Derbyshire and Nottinghamshire.

This LAEP forms part of a wider regional local area energy plan commissioned by EMCCA. The East Midlands regional plan comprises of eight local area plans, of which Nottingham City is one. This LAEP has therefore been prepared to be comparable to the other local plans, and to contribute to the wider regional plan. This report presents the outcomes of the Nottingham City LAEP, following a comprehensive process of data acquisition, scenario modelling, stakeholder collaboration, and spatial analysis.

1.1 Purpose of the LAEP

A LAEP is a long-term, evidence-based plan that sets out the most effective and efficient pathway for an area to transition to a low-carbon, smart, and flexible energy system. It provides a strategic framework to coordinate investment in energy infrastructure, shape local policies, and guide decision-making across stakeholders. By aligning spatial, technical, and socio-economic considerations, LAEPs ensure that local authorities, businesses, network operators, and communities can collectively plan for a cost-effective and just transition to Net Zero.

Local authorities have a pivotal role to play in enabling the UK's net zero transition. An estimated 82% of the UK's carbon emissions fall within local authorities' scope of influence[3]. There is a growing need for place-based energy strategies that align national goals with local opportunities, priorities, and constraints.

A LAEP is a bottom-up, data-driven, whole-system approach that integrates technical evidence, stakeholder engagement, and non-technical factors to create a comprehensive net zero plan tailored to Nottingham's unique characteristics.

The LAEP considers energy supply and demand, transport, buildings and local industry. It looks at current energy use and future decarbonisation opportunities for electricity, heat, and gas networks, the built environment (industrial, domestic, and commercial), and the potential for low carbon fuels, namely hydrogen. The plan will involve collaboration with various stakeholders to develop a realistic, data-driven action plan.

The primary goal of the Nottingham City LAEP is to identify the most cost-effective ways to decarbonise the city, aligning local plans and priorities with broader national policies and strategies. It provides a strategic roadmap for the city to achieve net zero emissions at the local level. Additionally, the LAEP is coordinated alongside other areas within the wider EMCCA region to ensure a consistent and joined-up approach between Derby City, Derbyshire, Nottingham, and Nottinghamshire (D2N2).

Our standardised approach will ensure alignment in outputs, which will significantly increase the ability for projects across areas to scale up through similar enabling mechanisms such as training programmes, funding allocations and aligned priorities.

[3] HM Government. Net Zero Strategy: Build Back Greener. Department for Business, Energy & Industrial Strategy, October 2021. Available at GOV.UK

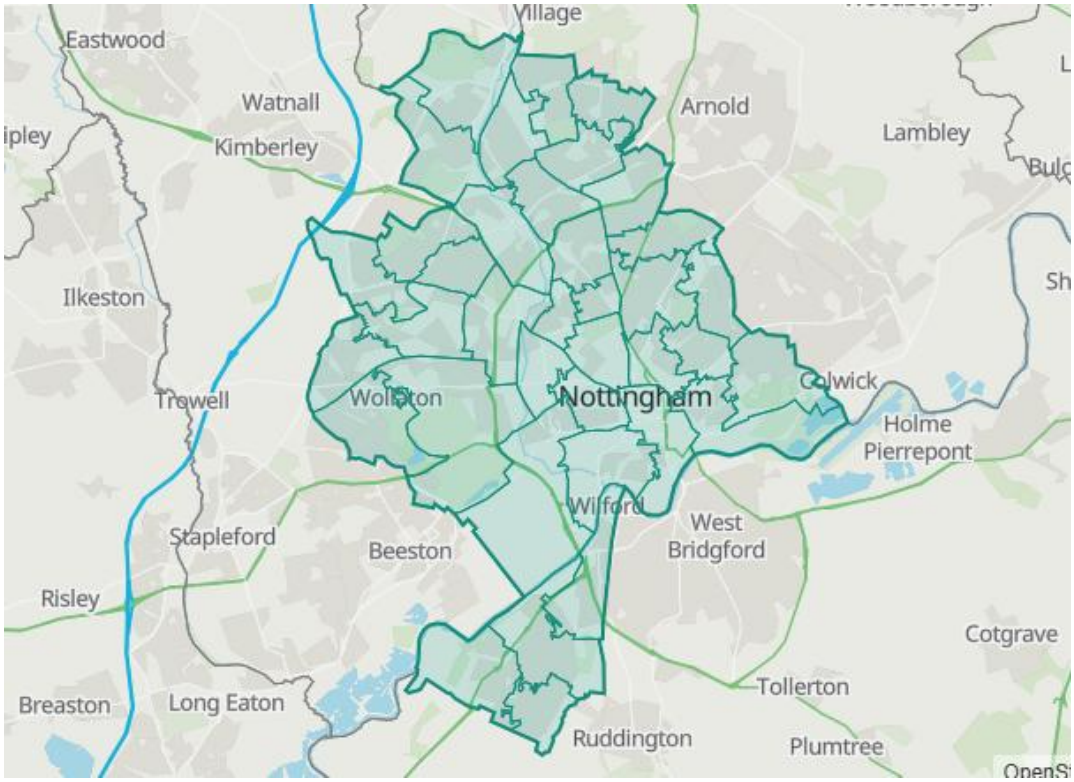
1.2 Geographical Boundary of the LAEP

Nottingham is a city in the East Midlands region of England with a population of 331,077 people, and it covers an area of approximately 75km^2.[4]

Nottingham is recognised as a leading economic and cultural centre in the East Midlands, with a GDP of approximately £14.1 billion. Historically renowned for its lace and textile industry, the city has evolved into a modern hub for advanced manufacturing, life sciences, and digital technology. The city combines historic significance, famed for the legend of Robin Hood and its Victorian Lace Market, with modern strengths in life sciences, digital technology, and advanced manufacturing.

Home to two major universities, Nottingham is also a UNESCO City of Literature and a hub for research and innovation. Its green spaces, cultural venues, and sustainability initiatives further reinforce its reputation as a dynamic, forward-thinking city.

Figure 1.1: Nottingham LAEP Geographical Boundary[5]



1.3 LAEP Scope

The LAEP considers energy supply and demand, transport, buildings, local industry, and the environment with the scope summarised in Table 1.1. It examines current energy use and future decarbonisation opportunities for electricity, heat, and gas networks, the built environment (industrial, domestic and commercial), and the potential for hydrogen and other low-carbon fuels. The plan involves collaboration with various stakeholders to develop a realistic, data-driven action plan.

[4] Local indicators for Nottingham - ONS

[5] Nottingham - ONS

Table 1.1: LAEP Scope

Category	Description
Buildings	Identifying priority areas for retrofitting of domestic homes and public buildings to improve energy efficiency. Identifying priority areas for heat pump installation or other low-carbon heating. Identifying opportunities for the installation of rooftop solar panels and low-carbon, flexible energy technologies, such as batteries, to reduce demand at peak times.
Transport	Identifying priority locations for the installation of electric vehicle (EV) charge points based on projected EV use, particularly around dwellings without off-street parking.
Energy	Identifying suitable sites for large-scale, low-carbon energy developments such as onshore wind, solar energy farms, and district heat networks. Analysis of changes in peak demand due to Low Carbon Technology (LCT) and new greenfield developments to engage with local electricity distribution network operators (DNOs) to inform the electricity network planning. Providing information for electricity DNOs to ensure the electricity network can handle expected extra capacity and grid connections.
Local Industry	Understanding the options for decarbonisation of local industry.

1.4 Emission Boundary

The LAEP is focused on areas where local authorities can exert meaningful influence, including buildings, private transport, local energy generation and industrial emissions within the distribution network footprint.

While the Nottingham City LAEP provides a strategic framework for guiding the area's transition to net zero, it is essential to define the boundaries of its scope. In line with the Energy Systems Catapult (ESC) LAEP methodology[6] and the practical remit of local authorities, the areas set out in Table 1.2 are considered out of scope for emissions accounting and intervention planning.

Table 1.2: Emissions Scope

Emission Source	Justification
National and Strategic Transport Infrastructure	Emissions from vehicles transiting through Nottingham City on national motorways are excluded as these journeys are not locally generated and fall outside the remit of local transport planning.
Rail electrification	Emissions from diesel-powered rail services and the potential electrification of rail infrastructure are excluded, as these are governed by national transport policy and infrastructure investment decisions.
Aviation	Emissions from domestic and international aviation are excluded, as flight operations and airport infrastructure are governed by national and international regulatory frameworks beyond local authority control.
Large-scale energy generation	Emissions from large-scale distributed generation connected at the Grid Supply Point (GSP), Bulk Supply Point (BSP) and Primary level have been excluded from this analysis, as these assets contribute to national energy supply and their associated emissions are already captured within the carbon intensity factors used for electricity consumption. The LAEP focuses on distribution-connected and locally influenced generation, such as rooftop solar and community-scale renewables.
Land use change and peatland emissions	Although significant in the regional carbon balance, emissions from land use change and peatland degradation are excluded. These are typically addressed through broader land management and agricultural strategies.
Agricultural emissions	Emissions from agricultural activities, including methane and nitrous oxide from livestock and fertiliser use, are excluded due to limited local authority control and the need for sector-specific national strategies.

[6] Guidance on Creating a Local Area Plan | Energy Systems Catapult

Emission Source	Justification
Embodied emissions from construction	Embodied emissions (sometimes referred to as capital carbon) includes the emissions emitted in fabricating goods (construction or consumer goods), transporting them to their point of use, and in the case of construction the emissions emitted during construction. These emissions, and any interventions to reduce them, are excluded from the LAEP.

Note: other exclusions may exist, which will be presented in the technology intervention areas, and associated appendices.

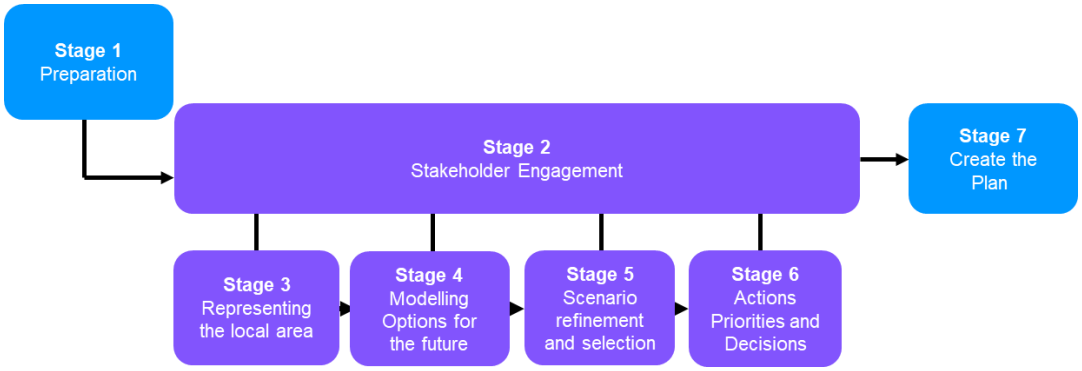
These exclusions reflect the standard practice in LAEP development, which typically omits non-energy sources of greenhouse gas emissions and aspects of the energy system expected to be overseen by central government. This approach supports targeted, actionable planning while maintaining alignment with national decarbonisation strategies.

1.5 LAEP Structure

This plan is structured into themed chapters that enable stakeholders to quickly locate and engage with the information most relevant to their interests and responsibilities. It is designed to be both comprehensive and accessible, supporting a wide range of users in understanding and applying the evidence-based roadmap for Nottingham's targets to reach net zero. This LAEP presents modelling net zero by 2040 and 2050 scenarios to align with the broader D2N2 regional LAEP.

Figure 1.2 below presents the summary approach of the LAEP, structured by ESC guidance.

Figure 1.2: LAEP Structure Diagram



A glossary of key terms and abbreviations used throughout this report is provided in Appendix A.

2 Policy Context

This section presents an overview of key national, regional and local policies influencing Nottingham's emissions levels and resulting net zero progress. This has enabled a context-driven approach, as far as possible, for quantification of positive and negative influences on future pathways to net zero specific to Nottingham city.

2.1 National Policies

2.1.1 Overview of National Climate Targets and Strategic Direction

The UK's climate policy is anchored in the UK Climate Change Act 2008[7], as amended in 2019 to set a legally binding target of net zero greenhouse gas emissions by 2050. Interim targets include a 68% reduction by 2030 and 78% by 2035, compared to 1990 levels. These targets are territorial, excluding emissions embedded in imports. The Net Zero Strategy: Build Back Greener outlines sector-wide decarbonisation, with a key emphasis on clean electricity by 2035 and recognition that 82% of emissions fall within local authority influence, making LAEPs a critical delivery mechanism.

In 2024, the Climate Change Committee (CCC) updated its recommendations to accelerate progress toward the 2030 target[8]. These include tripling offshore wind, doubling onshore wind, and increasing solar capacity fivefold. The CCC also called for 10% of UK homes to be heated by heat pumps and for nearly all new cars sold to be electric by 2030. These recommendations are reinforced by the Seventh Carbon Budget (2025)[9], which proposes a cap of 535 $MtCO_2e$ for 2038–2042 and an 87% emissions reduction by 2040. Sector-specific targets include an 86% reduction in surface transport emissions and major contributions from electrification and land use change.

2.1.2 Energy Infrastructure, Market Reform and Planning Policies

The UK Government has introduced several legislative and strategic reforms to modernise energy infrastructure and accelerate clean power deployment. The Great British Energy Act (2025)[10], establishes Great British Energy (GBE), a publicly owned company tasked with investing in and operating low-carbon energy infrastructure. Backed by £8.3 billion in public capital, GBE will co-invest with the private sector, support community energy schemes, and help deliver the government's target of a fully clean electricity system by 2030.

The proposed Energy Independence Act aims to phase out new oil and gas exploration licences, improve home energy efficiency, and expand support for insulation and low-carbon heating. Ofgem has approved a £24 billion investment programme to upgrade electricity and gas networks, expand grid capacity to connect 126 GW of clean power by 2030, and deploy flexible technologies such as storage and smart grids. The Clean Power Action Plan (2024) sets regional caps for solar and battery storage to 2030, including 2.1 GW of transmission-connected solar photovoltaics (PV)

and 500 MW of battery storage in Central England, guiding local connection priorities.

[7] The Climate Change Act 2008 (2050 Target Amendment) Order 2019

[8] Progress in reducing emissions 2024 Report to Parliament - Climate Change Committee

[9] The seventh carbon budget (2025)

[10] Great British Energy Bill 2024-25

To support delivery, the Planning and Infrastructure Bill (2025)[11] proposes reforms to streamline consenting for critical infrastructure, introduce strategic nature recovery mechanisms, and enable cross-boundary spatial planning. Ofgem's Connections Reform replaces the "first come, first served" grid queue with a strategic prioritisation process, favouring projects with planning progress and alignment to national decarbonisation pathways. This may affect the sequencing and viability of local solar and storage projects.

Furthermore, Great British Energy's (GBE's) Local Power Plan[12], announced in February 2026, sets out a vision for transforming the UK's local and community energy sector so that, by 2030, every community has the opportunity to benefit from and own a local energy project. Through up to £1bn investment in a combination of grants, loans, advice, expert help and more, this plan will support more than 1,000 projects, increase shared ownership, and catalyse the development of scalable, self-sustaining business models for community energy organisations. GBE already have a formalised agreement with the EMCCA to support the region to access the benefits of local and community energy.

2.1.3 Buildings, Heat and Local Delivery Mechanisms Policies

Built environment accounts for around 25% of UK emissions[13], making them a key focus of decarbonisation efforts. The Heat and Buildings Strategy (2021)[14], sets out plans to phase out new gas boilers by 2035, scale heat pump installations to 600,000 per year by 2028, and ensure all new buildings are net zero-ready. The Future Homes and Buildings Standard (FHBS, 2025)[15] will require all new homes and non-domestic buildings to be built to high energy efficiency standards, with low-carbon heating systems and improved ventilation, from 2027 onwards. Homes built under the new standard are expected to produce 75–80% fewer emissions than those built under current regulations.

The Warm Homes Plan (2025)[16] complements these efforts by targeting fuel poverty, aiming to lift over one million households out of fuel poverty by 2030 while accelerating the shift to clean, homegrown energy. Together, these policies provide a robust framework for local authorities to deliver decarbonisation through LAEPs, with clear national targets, funding mechanisms, infrastructure upgrades, and building standards to support local action.

2.1.4 Transport and Industrial Strategy Policies

The Integrated National Transport Strategy (INTS, 2024)[17], is developing a unified vision for England's transport system, aiming to improve integration across modes, support decarbonisation, and enhance accessibility. It promotes the use of data and technology to improve journey planning and system efficiency and will guide transport policy and investment decisions over the next decade.

Until the INTS is released, the pre-existing UK Transport Decarbonisation Plan (2021)[18] outlines measures to achieve net zero transport emissions by 2050. Key actions include ending the sale of petrol and diesel cars by 2030, requiring all new vehicles to be zero-emission by 2035, and investing in public transport, walking, cycling, and sustainable aviation and maritime fuels. Supporting infrastructure includes EV charging points and hydrogen refuelling stations.

[11] Guide to the Planning and Infrastructure Bill - GOV.UK

[12] Local Power Plan | Great British Energy

[13]

[14] Heat and buildings strategy

[15] Future Homes and Buildings Standard

[16] Warm Homes Plan

[17] Integrated National Transport Strategy for England

[18] Transport decarbonisation plan

Recent updates include the Zero Emission Vehicle mandate and Sustainable Aviation Fuel mandate from 2025.

The UK's Modern Industrial Strategy (2025)[19] provides long-term policy certainty for high-growth sectors, including clean energy industries. It supports investment in regional clusters, supply chain development, and skills for the energy transition. The Clean Energy Industries Sector Plan, part of the strategy, is particularly relevant to LAEPs, focusing on enabling local delivery of low-carbon infrastructure and workforce development.

2.2 Regional Policies

2.2.1 EMCCA's Growth Plan

EMCCA set out a ten-year Growth Plan[20] to drive inclusive, sustainable economic growth by investing in skills, innovation, clean energy, transport, housing and high-impact sectors so that prosperity is shared across all communities. In alignment with national targets, EMCCA aims to be carbon neutral by 2050. To realise this ambition, some opportunities have been identified which include building new low-carbon homes, retrofitting existing homes in line with the 2025 EMCCA Retrofit Strategy[21], promoting renewable energy, protecting and enhancing green spaces, exploring the establishment of heat network zoning to decarbonise heating and hot water, and potentially increasing the region's electricity network capacity.

2.2.2 D2N2 LEP Energy Strategy 2019-2030

The D2N2 Local Enterprise Partnership (covering Derby, Derbyshire, Nottingham, and Nottinghamshire) set out a regional energy strategy[22] for 2019-2030 to support economic growth while reducing carbon emissions. It targets a 60% reduction in emissions from 1990 levels by 2030, with ambitions for 100% low-carbon energy supply, of which 60% should come from renewables. The strategy also promotes smart transport, aiming for 70% of vehicle miles to be ultra-low emissions by 2030, and supports community energy generation with a goal of 15 MW installed capacity. It encourages upgrading buildings to EPC C or above, expanding electricity storage by 180 MW, and investing in energy efficiency to reduce regional energy bills by over £1 billion annually.

2.2.3 Nottinghamshire County Council – Carbon Reduction Plan

The Nottinghamshire County Council Carbon Reduction Plan (2022–2032) [23]sets out a roadmap for the council to achieve carbon neutrality by 2030 for its own operations. The plan focuses on reducing greenhouse gas emissions from activities related to energy use in buildings, highways assets (mainly street lighting), and work-related travel and transport. It provides a framework for action and defines the scope of emissions to be measured and reported, ensuring that progress towards the 2030 goal is transparent and accountable. The plan demonstrates the council's commitment to leading by example in the transition to a low-carbon future within Nottinghamshire. The Plan reflects a county-wide ambition and should be read alongside, rather than as a substitute for, the distinct targets of Nottingham City Council.

[19] The UK's Modern Industrial Strategy 2025 - GOV.UK

[20] East Midlands growth plan launch

[21] East Midlands local retrofit strategy

[22] Energy Strategy 2019-2030

[23] Nottinghamshire County Council - Carbon Reduction Plan 2022-2032

The roadmap projects a bold transition for Nottinghamshire and the wider region towards a low-carbon, sustainable future, aiming for significant emissions reductions, widespread adoption of renewable energy, and major improvements in energy efficiency by 2030. By 2030, the vision is for Nottinghamshire to have upgraded most buildings to high energy performance standards, shifted a large share of transport to ultra-low emission vehicles, expanded heat networks, and achieved substantial progress towards carbon neutrality, in line with both local and regional targets. Key takeaways include the importance of coordinated action across electricity, heat, and transport sectors, the need to address challenges like population growth and economic expansion, and the value of aligning local initiatives with regional and national strategies to ensure an effective and resilient energy transition.

2.2.4 The Nottinghamshire Council Plan

The Nottinghamshire Council Plan (2025–2029)[24] sets out a strategic vision to build thriving communities and a connected county. Key priorities include improving early years education, supporting carers, reducing health inequalities, and expanding community-based services. The plan emphasizes economic growth through partnerships with the EMCCA, focusing on transport upgrades, digital connectivity, clean energy, and green technologies. It also addresses local government reorganisation, financial sustainability, and workforce development to ensure efficient service delivery.

2.2.5 Nottinghamshire's Electric Vehicle (EV) Charge Point Framework

The Nottinghamshire EV Strategy[25] sets out a clear vision and approach to expanding EV infrastructure by developing a comprehensive, accessible, and future-ready charging infrastructure across the county. It supports Nottinghamshire's broader climate goals by aiming to reduce transport-related emissions and improve air quality. The strategy focuses on equitable access, ensuring that both urban and rural communities, especially those without off-street parking, can benefit from the shift to electric vehicles. It also emphasises collaboration with local authorities and private partners to deliver infrastructure that meets current and future demand.

2.2.6 East Midlands Local Retrofit Strategy

The East Midlands Local Retrofit Strategy (2025–2028)[26] sets out a coordinated regional plan to accelerate domestic energy-efficiency upgrades and low-carbon home improvements. Improving the energy efficiency of homes, reducing fuel poverty, and cutting carbon emissions by accelerating high quality retrofit delivery across the region. Developed with contributions from more than fifty organisations, it promotes a whole system model that brings together communities, skills, supply chains, finance, and governance to create warmer and healthier homes while supporting local jobs and economic growth. The strategy positions retrofit as both a climate priority and a significant social and economic opportunity for the East Midlands.

2.2.7 EMCCA Mayor's Transport Plan

The draft Mayor's Transport Plan[27] sets out a 15-year vision for an affordable, reliable, and better-connected transport system across the East Midlands, aiming to reduce car dependency and improve access to jobs, services, and education. It supports lower-emission travel through better public transport, active travel (walking and cycling), and reduced congestion, creating the

[24] Nottinghamshire Council Plan 2025

[25] Nottinghamshire EV Charging ectricvehiclechargepointframework.pdf

[26] East-Midlands-Local-Retrofit-Strategy-summary.pdf

[27] Transport Strategy - East Midlands Combined County Authority

conditions for transport electrification (including EV uptake and cleaner buses) and improved air quality across the region.

2.3 Local Policies

In 2019, Nottingham City Council declared a Climate and Ecological Emergency, formally recognising that climate change and biodiversity loss pose urgent threats requiring immediate action. This declaration committed the city to ambitious goals, including achieving carbon neutrality by 2028, integrating climate considerations into all council decisions, and protecting ecosystems alongside reducing emissions. It marked a turning point for local policy, aligning Nottingham with global scientific warnings and setting the foundation for its Carbon Neutral Charter and subsequent action plans focused on energy efficiency, renewable energy, sustainable transport, and nature-based solutions.

2.3.1 Nottingham Council Plan 2025-29

The Council Plan 2025-29[28] sets out Nottingham City Council's vision of "a renewed council, delivering for local people, leading Nottingham forward", underpinned by three core missions: A Renewed Council, Delivering for Local People, and Leading Nottingham Forward. The plan commits to improving governance, transparency and financial stewardship, adopting a "One Council" approach, and ensuring the council delivers the basics well and provides value for money. It focuses on safe and empowered communities, affordable housing, health and wellbeing, and education and skills, while also driving economic growth, improving infrastructure and connectivity, celebrating cultural heritage, and championing sustainability, including progress towards carbon neutrality. Delivery is supported by clear priorities, aligned strategies and a Performance and Delivery Plan, with the council committing to publicly measuring, monitoring and reporting progress through performance dashboards and outcomes. The plan also emphasises strong partnership working with residents, businesses, public bodies and voluntary organisations to pool resources, share expertise and deliver shared goals more effectively for Nottingham.

2.3.2 Carbon Neutral Nottingham 2028 (CN28)

Carbon Neutral Nottingham 2028 (CN28)[29] is Nottingham City Council's flagship initiative to make the city carbon neutral by 2028, covering all citywide territorial emissions within the Nottingham local authority boundary. CN28 sets out a comprehensive framework through the Carbon Neutral Charter and Action Plan. It focuses on reducing emissions across transport, buildings, energy generation, waste, and consumption, as well as promoting carbon removal and resilience to climate impacts. Actions include expanding renewable energy, retrofitting homes, electrifying council fleets, and improving public transport and active travel options. The plan also emphasizes biodiversity protection and community engagement, aiming to cut citywide emissions by over 1 million tonnes annually and create a sustainable, low-carbon future. Nottingham is on track to fall below 1 $MtCO_2$ in 2025, marking a significant milestone in the city's decarbonisation trajectory under CN28[30].

[28] Our Council Plan 2025-29

[29] Carbon Neutral Nottingham 2028

[30] DESNZ UK local authority and regional greenhouse gas emissions statistic (2005 to 2023), supplemented by NCC in-house forecast based on national sector pathway mapping and NESO Future Energy Scenarios. Figures reported on a CO_2-only basis for trend consistency with the CN28 2005 baseline

2.3.3 Nottingham Heat Network Zoning

The Nottingham Heat Network Zoning (2025)[31] policy identifies Nottingham as an Advanced Zoning Programme city with one of the UK's largest and oldest heat networks, Enviroenergy, which connects over 5,000 homes and 100 non-domestic buildings. The policy outlines the creation of 12 heat network zones, two of which are strategic, designed to decarbonise heating and hot water across the city, with a total annual heat demand of 650 GWh for all zones and 550 GWh for the strategic zones. The Nottingham City Centre zone is the largest, and significant buildings such as hospitals and redevelopment sites are included. The policy also highlights potential heat sources like the Eastcroft energy-from-waste plant, water source heat pumps, mine water heat, and air source heat pumps, supporting Nottingham's ambition to expand low-carbon heating infrastructure and reduce emissions.

[31] Nottingham Heat Network Zoning

3 Current Emissions and Energy Baseline

This section presents an overview of the current greenhouse gas emissions and energy system in Nottingham City. This is intended to establish the starting point for the change required to achieve net zero.

3.1 The Energy Baseline Definition

The LAEP energy baseline for both local authorities is a simulation of energy supply and demand across all buildings within each council's boundaries for the year 2022. It includes both domestic and non-domestic buildings, although confidence in the input data for non-domestic buildings is lower, and emissions from industrial activities beyond gas consumption are not available at this stage.

The baseline covers 116,083 Unique property Reference Numbers (UPRNs) in Nottingham City, each with a rich set of attributes. Simulated energy consumption and associated carbon emissions are available at annual and monthly granularity, and can be broken down by heating, domestic hot water (DHW), and electrical loads (including lighting, auxiliary loads and equipment). These results can be aggregated at Middle Super Output Area (MSOA) and Local Authority levels and are accessible via the IES 3D digital map (also referred to as the IES Digital Twin), which visualises all buildings and energy assets across the districts.

3.2 Creation of the Energy Baseline

The local authority's baseline was developed using IES' Digital Twin software, which integrates geographic information system (GIS) and building data to simulate energy use and carbon emissions across the building stock. The key datasets utilised are set out below.

- **The Ordnance Survey National Geographic Database (OS NGD)** Buildings dataset was used to generate 2D building geometries.
- **Energy Saving Trust's Home Analytics** datasets for domestic and non-domestic buildings provided information on building characteristics such as fabric, heating systems, and fuel types.

These datasets include energy performance certificate (EPC) data and predictive modelling for homes without EPCs. For non-domestic buildings, data availability is more limited, restricting the scope of analysis for interventions such as fabric improvements. Where data gaps exist, assumptions are made to enable all buildings to be included in the analysis. A list of attributes available from Energy Savings Trust data for domestic and non-domestic buildings is included in Appendix B.

A baseline energy profile is created using IES' technology, resulting in a dynamic 3D digital map of the area. The modelling is organised by MSOAs, with each MSOA containing around 3,000 to 6,000 buildings. These zones represent the smallest geographical units with sufficient government energy data (electricity and gas) for comparison, and each has its own masterplan-scale energy model.

Detailed IES Modelling Methodology is included in Appendix C.

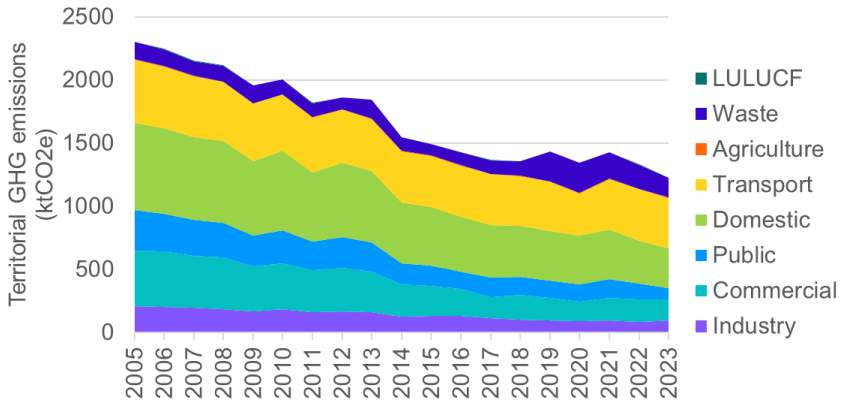
3.3 Current Emissions and Energy Use

The total emissions in Nottingham is approximately 1,226 ktCO2e.[32] Figure 3.1 illustrates the historical emissions of Nottingham from 2005 to 2023 split by sector, based on UK Government data. Over this period, the Nottingham City area has experienced a gradual reduction in carbon emissions across industry, transport, domestic and commercial properties and waste, largely driven by the decarbonisation of the national grid, energy efficiency improvements as well as local action for decarbonisation.

Nottingham's transport sector represents the largest emissions contributor, accounting for 33% of total emissions, followed by the domestic sector at 26%, commercial at 14%, and industry at 8%. The LAEP scope includes emissions from industry, commerce, public, and domestic sectors, as well as transport sector (limited to A roads and minor roads) targeting 95% of Nottingham's total carbon emissions.

This targeted scope ensures that the LAEP addresses the most significant sources of local emissions and supports the development of effective, place-based decarbonisation strategies.

Figure 3.1: Total Historic Emissions for Nottingham ($ktCO_2e$)



Source: UK local authority and regional greenhouse gas emissions statistics - GOV.UK

The 2023 data in Figure 3.2 illustrates the dominance of the transport sector, contributing 33% of local emissions within the 2023 baseline year, followed by the domestic sector at 26% and commercial sector at 14%. The fourth-largest share of emissions comes from waste at 13%, largely reflecting the treatment of residual waste through energy-from-waste and incineration processes.

[32] UK Government Emissions, 2023

Figure 3.2: Nottingham City Emissions Breakdown (2023)

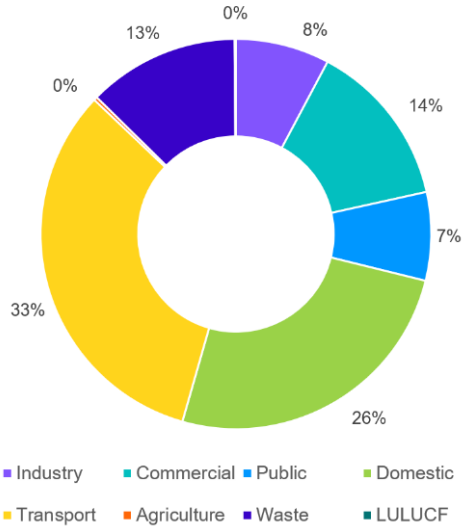
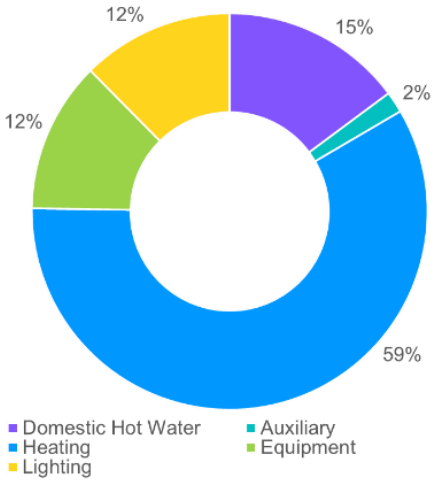


Figure 3.3: Nottingham City Building Energy Use Breakdown (GWh)



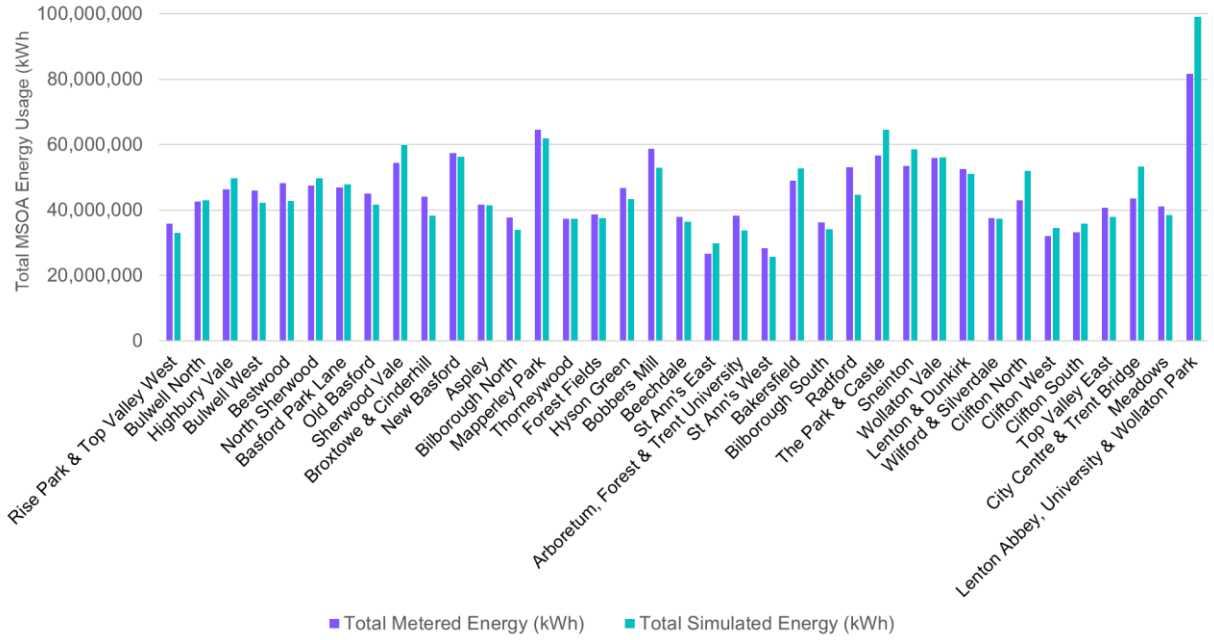
Source: UK Government Emissions 2023

3.4 Energy Baseline Validation

Utilising data from the Energy Savings trust to model energy use in the Digital Twin, results from the Digital Twin were validated against UK Government data, which includes electricity and gas metered consumption. In terms of data accuracy, therefore, this means fuels such as oil, LPG, and biomass were excluded, leading to potentially skewed results in rural areas where these fuels are more commonly used. As Nottingham City is a highly urban area this modelling approach is unlikely to significantly affect the accuracy of the results.

Figure 3.4 shows the energy simulation results for electricity and gas consumption compared to government data at MSOA level for Nottingham's domestic buildings.

Figure 3.4: Energy simulation results at MSOA level for Nottingham's domestic buildings



For both domestic and non-domestic buildings, a floor area correction was applied by IES into their modelling, which accounts for the simulation software's assumption that the entire building footprint is thermally conditioned, including spaces such as cupboards, internal voids, and wall thicknesses. Where high-confidence conditioned floor area values were available from the Energy Saving Trust, these were compared to modelled areas to derive scaling factors used across the building stock.

To enable a like-for-like comparison, oil, LPG, and biomass consumption were removed from the simulation results, aligning with the scope of the government dataset. Given the limitations of the available data, the results are considered acceptable. A tolerance range of ±20% was set, and all MSOA results fall within this range. Detailed results of the validation for each MSOA are available in Appendix E.

4 Stakeholder Engagement Approach

Stakeholder engagement has been the foundation for the overall progress of the project, with frequent interaction with stakeholders undertaken at every stage. We worked with diverse sets of stakeholders from commercial and community backgrounds with specific interests, which ensured efficient review and feedback at different points of the project.

4.1 Engagement Objectives

Stakeholder engagement provided the project team with feedback which informed the preferred pathway we chose as part of this LAEP. They assisted with the development of a sequenced plan of proposed actions to achieving Nottingham's net zero goals.

The aims of stakeholder engagement, which were originally developed at the beginning of this project, tied together the objectives of both this project and the wider LAEP programme. These were:

- Identify the critical stakeholders needed to deliver the priority projects.
- Increase stakeholders' understanding of energy systems and the LAEP process.
- Develop stakeholder trust and buy-in to proposals of the LAEP.
- Encourage a wide range of views and insights from stakeholders to refine the LAEP, identifying opportunities and constraints that will improve the deliverability.
- Increase stakeholders' understanding of the LAEP process and how it feeds into the net zero targets of Nottingham's 2035 net zero goal.
- Establish a sound foundation for effective and sustained local action to reduce carbon emissions in line with the borough councils net zero targets.

4.2 Stakeholder Mapping

A desk-based stakeholder mapping exercise was undertaken to produce an initial register of names and contact details for each area. With feedback and additional contacts provided by the Steering Group, this created our stakeholder register, with contact details and a tracker for all touchpoint contacts held in our secure SharePoint site. The stakeholder list was regularly reviewed with the steering group to ensure relevant contacts were added and consulted throughout the process.

4.3 Stakeholder Management

The interest and position of stakeholders relevant to the project was considered throughout and informed the appropriate methods of communication with each stakeholder group, whether through group stakeholder engagement sessions or organising 1:1 calls or discussions where appropriate.

The grouping of stakeholders into the following categories ensured that each stakeholder group receives tailored engagement and information regarding the scheme and its proposals. Definitions of each of the stakeholder groups is provided below.

Table 4.1: Stakeholder Prioritisation

Category	Influence	Interest	Ranking
Steering Group	**High**	**High**	**High**

Category	Influence	Interest	Ranking
Primary Stakeholders	**High**	**Medium**	**High**
Group 1 Stakeholders	**Medium**	**Medium**	**Medium**
Group 2 Stakeholders	**Medium**	**Medium**	**Medium**

Steering Group (SG)

A small group of individuals who represent the local authorities, working closely with the project team to advise on engagement, decision making and assist with further stakeholder mapping, along with EMCCA, Mott MacDonald and IES.

Primary Stakeholders (PS)

Primary stakeholders were directly involved in the LAEP process and had significant influence over its outcomes. They provided local insights, priorities, and data inputs, shaping the content and direction of the LAEP, including modelled scenarios and optimised pathways. These stakeholders included key Nottingham City council representatives, large energy users, active local community groups.

Group 1 Stakeholders (G1)

These stakeholders were categorised due to their influence over all LAEP's included in the D2N2 programme, primarily network operations and the universities. These stakeholders were engaged separately at programme level, and included National Grid, Cadent Gas and other utilities.

Group 2 Stakeholders (SS)

Group 2 stakeholders are secondary contributors to the LAEP process, providing supporting input that helps inform decisions and shape the plan's outcomes. This group includes local citizens' organisations such as residents' associations, community energy groups, other local government organisations (regional government), additional large industrial or commercial energy users. Their engagement ensures that a diverse range of perspectives and expertise are considered in the development and refinement of the energy plan.

Table 4.2: Summary Stakeholder Register

Stakeholder Category	Organisations Engaged
Steering Group	**Nottingham City Council, D2N2/EMCCA Representatives, Mott MacDonald, IES**
Primary Stakeholders	Universities and Higher Education organisations include the University of Nottingham and Nottingham Trent University, along with its Estates Department and Sustainability Manager. These institutions play a key role in research, education, and campus sustainability initiatives, making them influential stakeholders in any regional decarbonisation or energy strategy. Healthcare and NHS organisations encompass Nottingham University Hospitals NHS Trust, Queens Medical Centre, Nottingham City Hospital, Notts Healthcare NHS Foundation Trust, and Nottingham Citycare Partnership CIC. These entities represent major energy consumers with complex operational needs, and their involvement is critical for achieving sustainability goals in the healthcare sector. Local Government and Public Services include Nottingham City Council's Enviroenergy division, Nottinghamshire Police (both Environmental Sustainability Lead and Estates Manager), East Midlands Chamber of Commerce, HM Prison Nottingham, and Nottingham City Transport. These organisations are central to policy implementation, infrastructure management, and community engagement, making them essential partners for city-wide energy and sustainability projects. Utilities and Energy are represented primarily by E.ON, a major energy provider with significant influence over regional energy supply, infrastructure, and decarbonisation pathways. Their participation is vital for aligning energy generation and distribution with sustainability objectives. Private Companies and Industry stakeholders include Boots, Experian's Nottingham headquarters, Compleat Food Group's Tottle Bakery, and Clean Linen & Workwear. These businesses contribute to the local economy and have varying levels of energy demand, offering opportunities for collaboration on efficiency and carbon reduction initiatives. Leisure, Sport, and Venues cover the National Ice Centre and Motorpoint Arena Nottingham, Crowne Plaza Hotel, David Lloyd Leisure Centre, Lark Hall Retirement Village, and Tollhouse Hill. These facilities are significant energy users and provide public-facing opportunities to showcase sustainability efforts and engage communities.
Group 1 Stakeholders	Cadent gas, Severn Trent Water, National Grid, National Energy System Operator (NESO), University of Nottingham, NHS
Group 2 Stakeholders	Business and Industry group includes organisations such as Nottingham City Business Club, Boots, Hockley Developments, Willmott Dixon, and Savoy Systems. These stakeholders represent key players in the local business community, property development, construction, and technology sectors. Their involvement brings commercial insight and practical experience to the energy planning process. Community and Housing stakeholders in this category include Nottingham Energy Partnership, Nottingham Community Housing Association, Nottinghamshire Community Energy, Nottingham Climate Assembly, and Nottingham Green Partnership. These organisations focus on community energy initiatives, affordable housing, sustainability advocacy, and grassroots engagement, ensuring that the voices of residents and local communities are represented. Academia stakeholders include Nottingham Trent University Estates Department is the primary academic stakeholder in Group 2. Their participation provides expertise in sustainability, campus energy management, and research-driven approaches to decarbonisation. Partnerships and Networks stakeholders include Nottingham Partners serves as a collaborative network, connecting businesses, public sector bodies, and other organisations across Nottingham. Their role is to facilitate partnership working and strategic alignment. Professional Services and Consultancy includes ARUP, a global consultancy specialising in engineering and sustainability, contributes technical knowledge, strategic advice, and best practice insights to the stakeholder group.

The stakeholder list was regularly updated with insights from Steering Group, with ongoing efforts to reach out to new contacts and maintain communication with existing ones. Invitations and follow-up emails were routinely sent to ensure that the relevant parties are kept informed and have the opportunity to contribute.

4.4 Stakeholder Engagements

The engagement process was designed to be iterative and two-way to ensure that all local and relevant stakeholders are given the opportunity to provide input to this LAEP, whilst avoiding stakeholder fatigue. Insights gathered during stakeholder meetings were fed back into the project team, and any resulting changes or refinements to the LAEP were communicated transparently to contributors. This feedback loop fostered trust, built consensus, and encouraged stakeholders to become advocates for the plan. The summary of engagement sessions is detailed in Table 4.3. Feedback gathered from these engagements was systematically fed back into the project and wider programme team, and summary of the workshops were widely shared with the participants.

Table 4.3: Stakeholder Engagement Summary

Communication Channel	Frequency / Format	Description / Stakeholder Engagement Activities
Programme Workshops	Periodic (virtual & in-person)	Workshops with Primary and Group 2 to gather insights on the LAEP, present data, and refine future plans. Sessions included presentations, Q&A, and themed discussions.
Email	As needed	Regular briefing emails sent ahead of workshops to outline aims, objectives, and key themes. Enabled two-way engagement, allowing stakeholders to raise questions, provide feedback, and request further information or clarification.
Stakeholder Survey	Email surveys	Structured survey distributed to Primary and Group 2 organisations to collect information on local net zero targets, decarbonisation strategies, energy data, and carbon reduction targets. The organisations responding to the survey included Nottingham City Council (across several departments), Nottinghamshire Police, Nottingham Trent University, University of Nottingham, E.ON UK PLC, and Nottingham University Hospitals NHS Trust. Additional data and feedback were received via email, reflecting a willingness among stakeholders to engage and share local perspectives.
Targeted Workshops	As needed	Workshops included discussions district heating, renewable generation, regeneration, and a session with the University of Nottingham. Sessions addressed current and planned energy projects, data sharing for modelling, integration with of digital twins, retrofit and community energy schemes, and the alignment of local initiatives with national policy and technical constraints. Key outcomes included improved data coordination, identification of barriers and opportunities, and strengthened partnerships between the council, technical experts, and academia.

Throughout the Nottingham City LAEP programme local stakeholders were engaged at each stage of the LAEP development. The summary of the engagement sessions and insights are captured below:

Table 4.4: Stakeholder Sessions for Nottingham City LAEP

Session	Stakeholders	Outcomes
Stakeholder Briefing Session	Primary, Group 2	Introduced LAEP aims, roles of LAEP stakeholders and SG/Primary/Group 2, and staged engagement plan; set expectation for baseline verification and scenario workshops.
Baseline Presentation	Primary, Group 2	Reviewed the outcomes of the baseline simulations and discussed the verification results.
District Heating Focus Session	SMEs	Reviewed inclusion of existing and potential zones; gathered inputs on suggested approach to modelling district heating in Nottingham City.
Renewables/Regeneration Focus Session	SMEs	Reviewed and agreed approach to modelling of renewable energy and regeneration in Nottingham City.

Session	Stakeholders	Outcomes
		Requested site-specific inputs for solar/wind and regeneration areas.
Interventions Modelling Session	Primary, Group 2	Walked through fabric retrofits, electric heating, solar PV, and district heating scope; set actions to quantify overlaps and bring figures back to SG.
Prioritisation Session	Primary, Group 1, Group 2	Presnted prioritiation of projects
Draft LAEP Report Presentation	Steering Group	Session in January 2026.

LAEP engagement followed a staged plan. A Stakeholder Briefing that set introduction invited Primary and Group 2 stakeholders to provide data inputs and modelling feedback. The baseline presentation with the Steering Group verified simulations and triggered an information request, while the Steering Group agreed focused sessions on district heating, renewables/solar & wind, and regeneration. The focus meetings gathered asset and site inputs and refined boundaries ahead of the interventions session, where stakeholders reviewed fabric, heating, PV, storage, and heat-network assumptions and set follow-ups on overlaps and figures. Through subsequent Steering Group and Pathways activities, the team reviewed the interventions methodology, advanced district-heating integration, addressed non-domestic data quality, shared pathway materials for feedback, and agreed revised dates for partial and full modelling outputs ahead of the draft report, with the Steering Group confirming actions on slides, PV analysis, and DH accuracy.

Outcomes of Stakeholder Survey

Stakeholders were formally invited to participate in the stakeholder survey to feedback local data and decarbonisation priorities. The outreach covered local authority members, large energy users, academic institutions, utility providers, community organisations, and public sector bodies. Ten responses were collected, with input from organisations such as Nottinghamshire Police, Nottingham City Council, Nottingham Trent University, E.ON, and the University of Nottingham. Additional data and feedback were received via email, reflecting a willingness among stakeholders to engage and share local perspectives.

- **Net Zero and Climate Targets:** Stakeholders were asked about their organisational climate commitments. Responses revealed a spectrum of progress: some organisations, like Nottingham City Council and the University of Nottingham, have established net zero targets and strategies, while others are still developing their plans. This diversity highlights both leadership and areas where further support or coordination may be beneficial.
- **Decarbonisation Strategies:** Participants described their approaches to decarbonisation, including renewable energy generation, energy storage, and timelines for achieving net zero. Some provided detailed strategies and ongoing initiatives, while others indicated that plans are in development or managed by specialist teams. This reflects the evolving nature of organisational responses to climate challenges.
- **Energy and Emissions Data:** The survey requested current and projected energy consumption and carbon emissions data. While several stakeholders were able to provide data or expressed willingness to share further information, others noted limitations due to data availability or confidentiality. For example, E.ON shared site-specific data and highlighted company-wide sustainability initiatives.
- **Additional Insights and Collaboration:** Stakeholders contributed further insights, including references to ongoing projects, offers to provide additional data, and requests for continued dialogue. This collaborative spirit is a positive indicator for the LAEP's success, though some challenges remain in ensuring consistent data sharing and engagement across all organisations.

The stakeholder survey has provided valuable insights into the current state of organisational climate action in Nottingham. There is clear momentum towards net zero, with many stakeholders actively developing or implementing decarbonisation strategies. The process has also highlighted the importance of ongoing engagement, data sharing, and support to ensure all organisations can contribute effectively to the city's energy transition.

4.5 Key Stakeholder Insights

The following insights capture the perspectives, contributions, and key feedback provided by Nottingham's diverse stakeholders, highlighting the collaborative approach and the range of expertise that informed the development of the LAEP.

Table 4.5: Key Stakeholder Insights Summary

Stakeholder	Insight
Nottingham City Council	Provided detailed data on solar PV, regeneration projects, and district heating. Emphasised digital twins, GIS data, and cross-departmental coordination. Noted technical and financial constraints for district heating expansion and the role of planning policy.
Utility Provider (E.ON)	Shared decarbonisation strategy, net zero targets, and progress on large-scale projects. Provided emissions data and insights on electrification and grid capacity.
NHS Trust	Shared experience with LCTs, challenges with capital and operational constraints, and phased retrofit plans. Provided data on emissions reductions and future heat network expansion.
University of Nottingham	Offered expertise in retrofit, digital twinning, and community energy. Shared data from large-scale projects and highlighted the value of integrating research with city planning.
Nottingham Trent University	Provided net zero roadmap and interim targets, focusing on refurbishments, electrification, and sustainable procurement. Shared insights on supporting SMEs and supply chains.
Nottinghamshire Police	Shared plans for fleet electrification and grid constraints. Emphasised collaboration with public sector partners.
Local Authority (wider)	Supported integration of modelling, digital tools, and feedback into LAEP. Emphasised aligning local initiatives with national policy and ongoing engagement to address barriers.

For example, both Nottingham Trent University and the University of Nottingham are committed to achieving net zero by 2040, with clear roadmaps and interim targets. Stakeholders provided valuable information on their decarbonisation strategies, such as action plans, electrification of fleets, building refurbishments, renewable energy projects, and large-scale energy initiatives.

Themes highlighted included challenges and opportunities, particularly relating to electricity grid capacity constraints. These covered limited headroom at primary substations, delays or uncertainty in securing new connections for large non-domestic loads, and concerns that the pace of heat pump and EV charger deployment in some MSOAs could outstrip existing local network capacity without timely reinforcement.

Data on current and projected energy consumption and emissions was shared where available, with some stakeholders offering to provide further information upon request or through direct contact with environmental officers.

5 Assessing Options for the Future

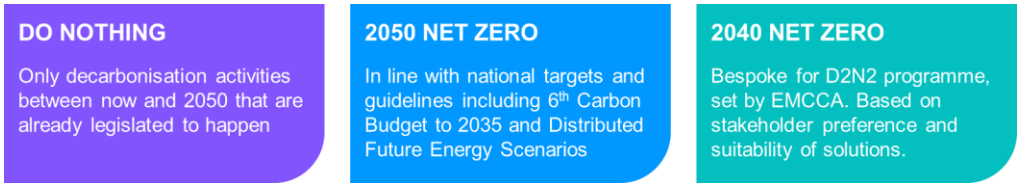
This section sets out the approach and methodology in deciding which interventions underpin the fundamentals of the transition to net zero for Nottingham City.

5.1 Overview of Scenarios

Scenarios are a powerful tool in energy planning, letting us explore different futures, understand the impacts of our choices, and prepare for uncertainties. Three scenarios were proposed as part of this LAEP to explore potential decarbonisation pathways and they are compliant with HM Treasury Green Book[33].

These scenarios reflect varying levels of ambition and policy contexts, from minimal intervention to accelerated decarbonisation aligned with regional targets. To ensure comparability, key economic parameters such as intervention costs, energy prices, and discount rates were held constant across all scenarios. This supports sensitivity analysis and isolates the effects of policy ambition and technology uptake.

Figure 5.1: Scenarios for the LAEP Modelling



5.1.1 Do Nothing

This scenario includes decarbonisation activities between now and 2050 that are already legislated to occur. It represents a baseline case where no additional efforts beyond existing legal mandates are pursued. It aligns with the “Falling Short” pathway from the National Grid/Regen Distributed Future Energy Scenarios (DFES).

The ‘Do Nothing’ scenario represents what will happen without additional policy (beyond what is already legislated) or without additional infrastructure investment identified in this LAEP. In this way, the counterfactual scenario represents the most probable outcome, if nothing additional was done beyond what is already committed to. The counterfactual acts as the baseline, from which carbon reductions and the cost of the LAEP can be calculated.

This could be characterised as a small amount of consumer engagement in decarbonisation in addition to slow system changes. In the counterfactual scenario, the energy system emissions are reduced, but the scenario does not result is reaching Net Zero.

Each intervention area in the subsequent sections, provides specific detailed counterfactual assumptions and exclusions relevant to the technological solution. The overview of Do Nothing assumptions are listed in the following table.

Table 5.1: Do Nothing Modelling Assumptions

Technology Area	Policy Landscape and Market Trends
Heating Decarbonisation	As there is currently no legislated mandate for heat pumps, we have assumed no further uptake of low-carbon technologies and a like-for-like replacement of heating systems at the end of their operational life.

[33] The Green Book: appraisal and evaluation in central government - GOV.UK

Technology Area	Policy Landscape and Market Trends
Building Thermal Energy Efficiency (Fabric Improvements)	We have assumed that all privately rented and social housing currently rated EPC C or below will undergo some form of fabric retrofit in order to meet the MEES target.
Energy Generation	As with air source heat pumps, we have assumed no further uptake of solar PV due to the absence of mandated legislation.

5.1.2 2050 Net-Zero

Aligned with the UK Government's legally binding target, this scenario reflects a pathway to net zero greenhouse gas emissions by 2050. It corresponds with the "Leading the Way" DFES pathway and includes assumptions from the Climate Change Committee (CCC) on retrofit rates and policy impacts. Hydrogen use is considered for industrial clusters, consistent with National Grid's Future Energy Scenarios (FES 2024). This scenario provides a nationally consistent benchmark for evaluating local contributions to UK climate commitments.

5.1.3 2040 Net Zero

This regionally defined scenario targets net zero by 2040, positioned between the national 2050 target and the 7th carbon budget. It allows for bespoke modelling of retrofit rates, hydrogen deployment, and other interventions tailored to local opportunities and constraints. The scenario assesses the feasibility, impacts, and benefits of accelerating the energy transition to meet a 2040 target.

5.2 Scenario Modelling Approach

Scenario modelling for LAEPs typically follows two main approaches:

- **Standardised Scenarios aligned with regional planning (Top-Down):** LAEPs can adopt industry-standard scenarios, such as the DNO's DFES, which are derived from the National Energy System Operator's Future Energy Scenarios Pathways (FESP). This approach ensures consistency with regional and national planning frameworks.
- **Bespoke Local Scenarios informed by stakeholder input (Bottom-Up**): Alternatively, scenarios can be developed through engagement with local stakeholders, reflecting local priorities and ambitions. This includes input from local authorities, large energy users, community organisations, and businesses. Such collaboration helps identify unique local drivers and constraints that may not be captured in standardised scenarios

Following discussions with the steering group, a bottom-up modelling approach was adopted to estimate the uptake of interventions, informed by local stakeholder input and priorities. The projections are based on the UK Climate Change Committee's (CCC) Seventh Carbon Budget, which targets a 75% reduction in UK territorial emissions by 2040.

To model uptake, a logistic growth (S-curve) function was applied. This reflects slow initial growth due to barriers such as upfront costs, followed by acceleration in the mid-phase driven by policy support, and eventual saturation near 100%. Uptake is normalised to 100% of the total required installations by the target year, assuming a low starting point in 2026.

During modelling, curve midpoints and growth rates were anchored to concrete national and regional policy signals. Peak annual delivery was capped at realistic levels to reflect workforce and supply chain ramp-up constraints.

Annual percentages represent the incremental increase in installations for each year, while cumulative uptake reaches 100% by the target year.

- For the **Net Zero by 2050 scenario**, the timeline follows the CCC's Balanced Pathway.

- For the more ambitious **Net Zero by 2040 scenario**, the timeline is compressed by a factor of approximately 1.67 (25 years to 2050 vs. 15 years to 2040). This shifts data points earlier while preserving the S-curve shape, consistent with CCC's "Tailwinds" or "Leading the Way" sensitivities for accelerated decarbonisation.

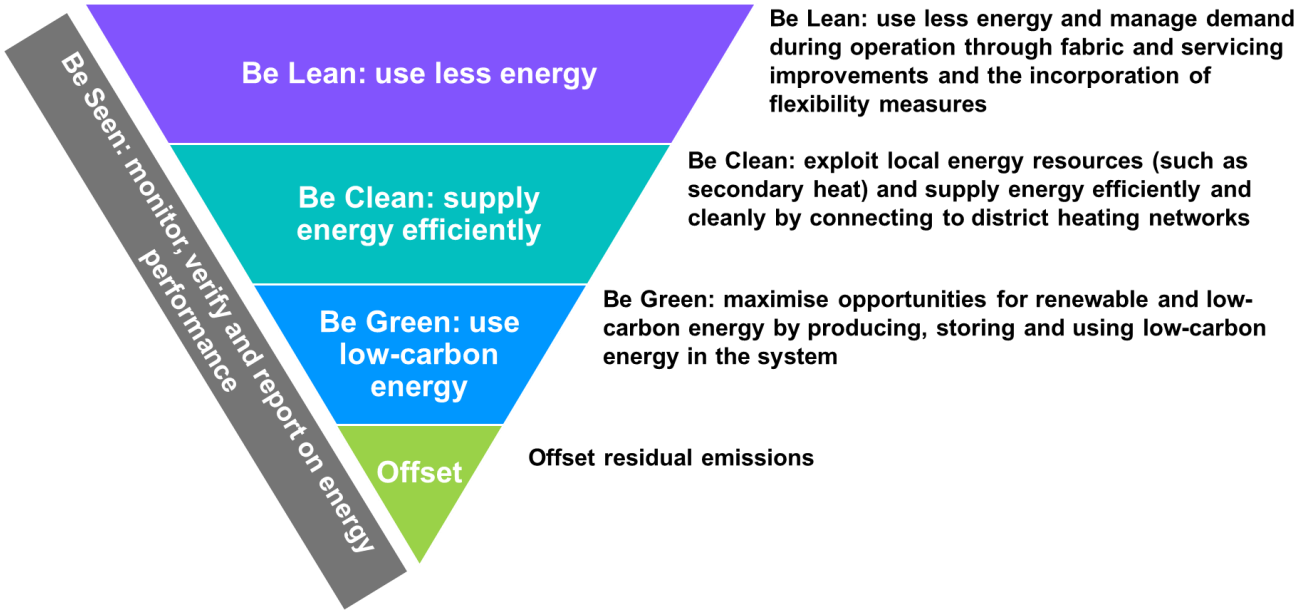
5.3 Intervention Prioritisation Approach

The idealised approach to achieving net zero emissions is to follow the Energy Hierarchy as represented in Figure 5.2. It offers a common-sense, cost-effective, sustainable energy policy that aims to reduce energy use before seeking to meet remaining demand by investing in 'be clean' technologies in advance of 'be green' and offset incentives.

The Energy Hierarchy[34] provides a clear roadmap for sustainable energy policy and decision-making. The Hierarchy offers a practical framework for shaping sustainable energy strategies. It prioritises reducing energy demand, improving efficiency, leveraging local resources, and maximising renewable energy use, while ensuring performance is monitored and reported.

The Interventions identified for Nottingham will therefore follow this hierarchy, starting with energy efficiency measures and then followed by low carbon heating alternatives, then following this with installation of local renewables and battery storage.

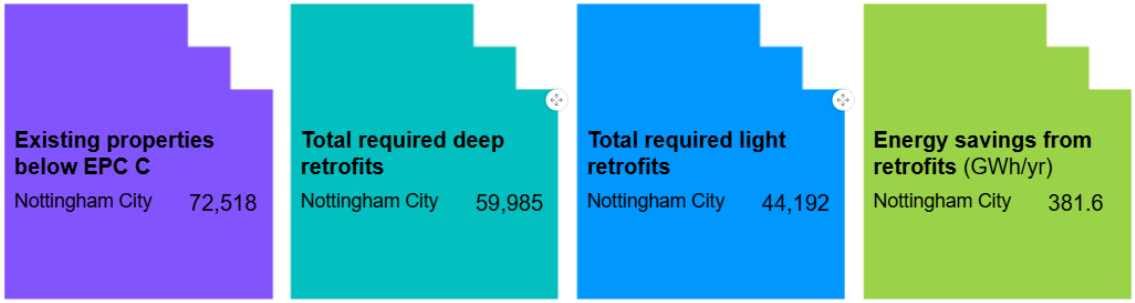
Figure 5.2: The Energy Hierarchy



[34] Comparable methodological principles are reflected in wider engineering literature: IET Energy principles.

6 Energy Efficiency in Buildings

Buildings account for nearly 40% of energy consumption in the UK across all sectors, and this equates to almost a quarter of total emissions UK wide[35]. This section deals with energy efficiency in buildings associated with the upgrade and retrofit of fabric improvement measures. This spans both domestic and non-domestic properties.



The primary focus of building fabric retrofit is to reduce the “U-value”, which measures the rate of heat transfer through building elements. Lower U-values reduce unwanted heat loss in colder conditions and limit heat gain in warmer conditions, improving thermal performance, occupant comfort, and overall energy efficiency across the year. Increased fabric performance and energy efficiency of a buildings can be linked to many direct benefits such as reduced energy bills, reduced fuel poverty, warmer homes and reduced carbon emissions. Energy efficiency and fabric retrofit can also deliver a range of indirect co-benefits, including improved resilience of electricity and gas networks through reduced energy demand across homes and businesses.

Additionally, implementing retrofits will reduce the overall thermal demand of properties. This reduction will be pivotal when transitioning to electric heating systems. This is because it will lower the required heating capacity of properties, which in turn will significantly cut the total capital costs associated. Further details are provided in Section 7.

Building fabric retrofit is crucial to tackling climate change. It also contributes to the growth of local economies through the creation of jobs and is ultimately linked to the increased health and well-being of the population.

6.1 Existing Building Stock

6.1.1 Domestic Housing Stock

Across Nottingham City, domestic housing accounts for 95% of buildings across social housing, private rented and owner-occupied tenure types. With the right information and insights influencing policy decisions a significant impact on the energy transition and carbon impacts can be made through addressing this sector.

Nottingham’s housing stock is a mixture of Victorian terraces, interwar council estates, post-war prefabrications, high-rise blocks, and modern regeneration schemes. Its history reflects broader national housing policies while being shaped by the city’s industrial roots and ongoing efforts to improve energy efficiency and sustainability.

Going forward the majority of these houses will continue to be occupied, highlighting the importance of future proofing these properties. A key aspect of futureproofing is reducing both

[35] The CCC Sixth Carbon Budget

the thermal and electrical demand. This can be achieved by improving fabric performance and implementing other energy efficiency measures, which in turn lowers energy consumption and reduces associated carbon emissions.

Energy efficiency and energy retrofit in buildings is a fundamental for achieving net zero. Through following the first step of the Energy Hierarchy, “Be Lean”, it is possible to bring wider benefits such as creating warmer homes, improving internal air quality and thermal comfort, reducing energy use, all giving occupants more certainty over their energy bills, and a reduction in the risk of fuel poverty.

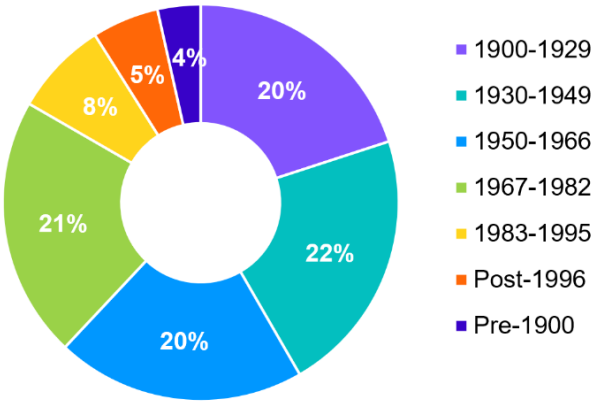
In the context of EMCCA, Nottingham and this LAEP, energy efficiency will play a critical role in demand reduction and heat decarbonisation across the area. The UK’s EPC data provides insight into the thermal efficiency of dwellings across the country. EPC ratings are the most widely used indicator of a building’s energy efficiency level and are based on data points collects across building fabrics (insulation, windows, construction type, age), heating and hot water system and electrical demand (lighting, electric heating and appliances).

To address the energy transition needs of the local area is it pertinent first to understand the emissions context of the area (see Figure 3.1) and the “tools” that the city authority might have at their disposal by way of energy interventions.

An understanding of the scale of retrofitting needed can be indicated by the spread of construction dates for existing housing from the levels of pre-existing energy-efficiency measure in place.

Figure 6.1 displays the breakdown of age bands of properties across Nottingham City. Properties built between 1900-1996, account for the vast majority of all housing, where housing built between 1950-1995 and 1900-1949, makeup 49% and 42%, respectively. Properties of these age bands should therefore be targeted as priority for energy efficiency improvements.

Figure 6.1: Splits of Domestic Buildings by Age Band Across Nottingham



The oldest homes, pre-1900 and 1900–1929, typically feature solid brick or stone walls with lime mortar and no cavity, giving estimated U-values above 2.1 W/m²K, roughly eight times worse than current standards[36]. However, their usual wet plaster finish does offer some airtightness. Although these buildings can be durable and architecturally significant, they normally require more complex retrofit solutions, which is likely dependent on factors such as statutory planning protection (e.g., listings, conservation areas). The technological challenge of applying external or internal wall insulation is a significant technical barrier, while cost and affordability present

[36] Conservation of fuel and power: Approved Document L - GOV.UK

financial barriers. The disruption of the work is also likely to be a major consideration, particularly for internal wall insulation.[37]

The 1930–1949 band marks the architectural transition to cavity wall construction. While these walls offer slightly better conductive performance (typically around 1.5 W/m²K) because of the air gap, they introduced new vulnerabilities. These early cavities were built for moisture prevention rather than thermal retention and were left uninsulated. Additionally, the move to suspended timber floors in this era often makes this cohort significantly prone to higher air infiltration rates compared to their solid-walled predecessors. As a result, these homes tend to have poorer baseline efficiency and higher heat loss without targeted retrofit measures. It should be noted that the EPC data reflects where changes have occurred to the properties since the year built, i.e. the installation of double glazing or addition of loft insulation. This has therefore been captured in our assessment.

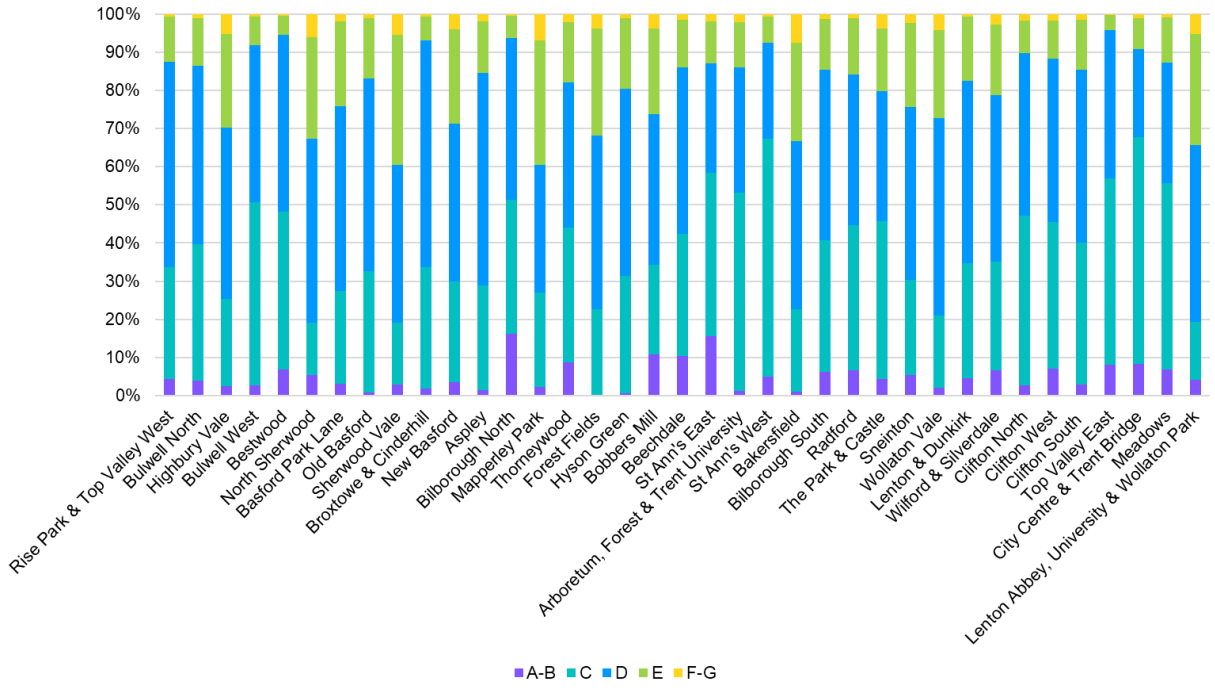
The 1983–1995 and post-1996 segments, coincides with the introduction and progressive tightening of Approved Document L within the Building Regulations. First introduced in 1985 and updated significantly in 1995, 2002, and 2006, these regulations mandated strict limits on air permeability, thermal bridging, and U-values. The ~10% of stock built post-1996 likely benefits from mandatory double glazing, floor insulation, and high-performance loft insulation, achieving an EPC rating of C or higher by design. While these newer properties require minimal fabric intervention, they represent a small share of the domestic housing stock. This implies that to achieve area-wide decarbonisation, the primary focus must remain on the 67% of buildings in Nottingham City that were constructed before 1983, where the gap between original performance and modern standards is widest.

Homes constructed post-2000 may only require minimal upgrades to reach EPC rating C and above, if they aren’t already achieving these levels based on as built and installed fabrics and systems. It may, however, be difficult to achieve EPC rating C for the Nottingham’s older properties given the increased complexity in delivering full fabric and energy retrofit improvements, as well as the high costs associated with deep retrofit.

Figure 6.2 presents the EPC rating distribution across Nottingham’s domestic building stock.

[37] Retrofit Internal Wall Insulation: guide to best practice

Figure 6.2: Nottingham EPC Rating per MSOA



Given Nottingham's large proportion of pre 1996 buildings, it is unsurprising to see a substantial proportion of Nottingham's homes falling below the UK Government's current recommended EPC rating of C. 66% of homes are rated D or lower, indicating high energy demand and poor insulation. This further raises the importance of fabric retrofit and energy efficiency as a priority in the area.

It is likely that this challenge will continue to influence the level of fuel poverty experienced in Nottingham. The current proportion of households in fuel poverty across the city sits at 15.2%, which is high when compared to the East Midlands average of 11.7% and the national average of 11.4%.

The proportion of fuel-poor households in Nottingham is significantly higher than both the national and East Midlands averages, as illustrated in Figure 6.3. This measure of fuel poverty is based on the condition of the housing fabric, identifying homes that require more energy to maintain comfortable living conditions. Consequently, it can be inferred that the average energy efficiency of Nottingham's housing stock is below the national standard, reinforcing the need for targeted retrofit interventions to improve overall energy performance.

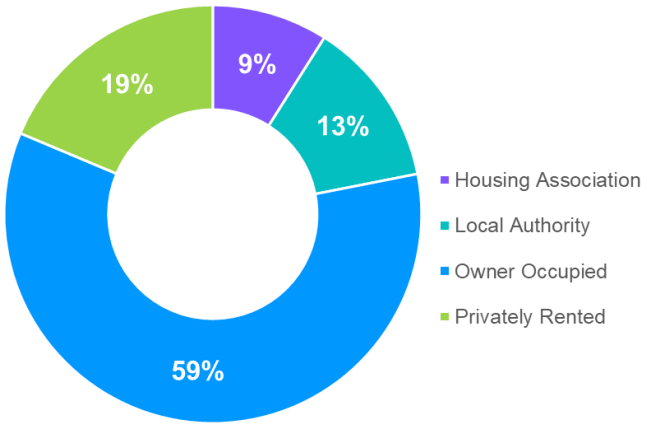
Figure 6.3: Proportion of Fuel Poor Households in Nottingham



Source: Sub-regional Fuel Poverty in England, 2023

Addressing the below-average efficiency, indicated by the EPC distribution, requires an understanding not only of the housing fabric but also of who owns and manages these homes, since tenure strongly influences the feasibility of retrofit interventions. Figure 6.4 shows the tenure breakdown across each local authority. Of the homes within Nottingham City, most are owner occupied, indicating a strong level of control of occupiers over the implementation of building fabric changes.

Figure 6.4: Proportion of Tenure Types across Nottingham MSOAs



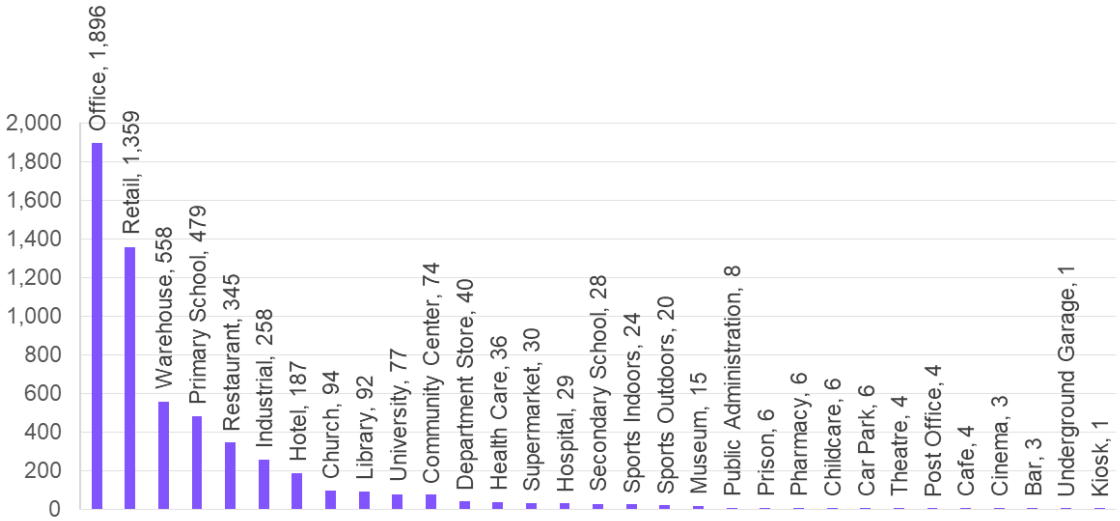
Source: EST Home Analytics

6.1.2 Non-Domestic and Commercial Building Stock

The non-domestic sector account for 5% of the buildings across Nottingham. These buildings span the public and commercial sectors and are utilised for a variety of primary uses, as listed in Figure 6.5. Detailed in this figure is the total number of non-domestic building split by primary use case varying from Churches to Retail stores. Currently, the non-domestic building stock is

predominantly made up of commercial buildings, with office and retail buildings accounting for the majority.

Figure 6.5: Total Non-Domestic Buildings, split by Primary Use



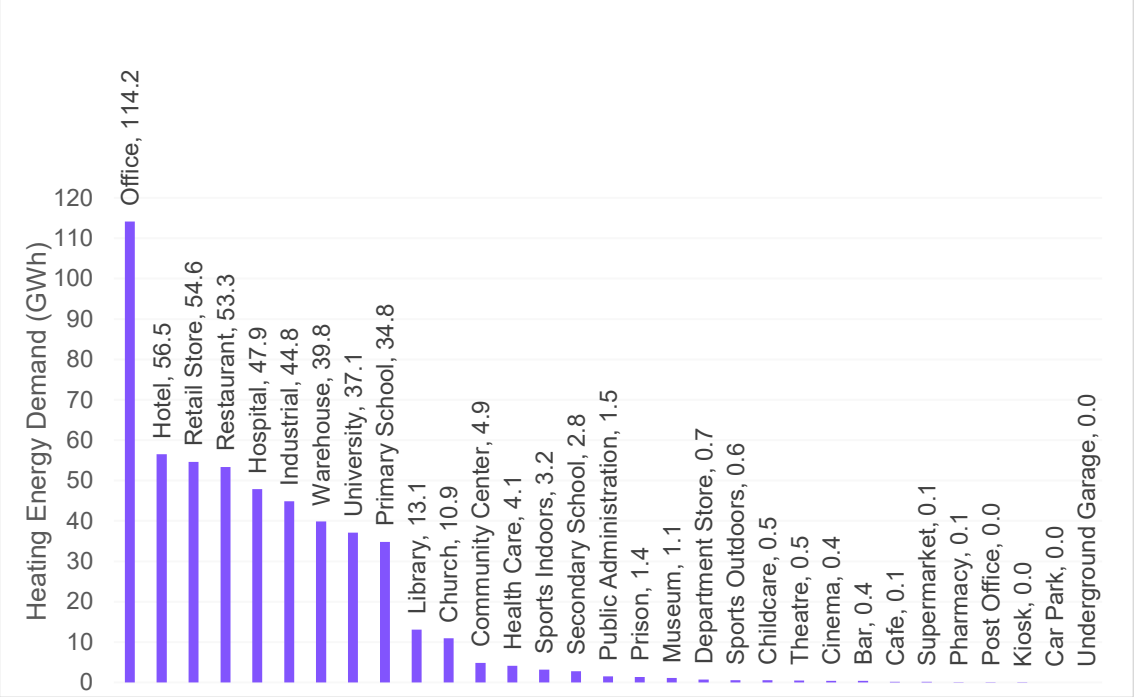
While the EPC values of non-domestic properties are evaluated to identify priority areas across the region, a significant proportion of the non-domestic building stock in Nottingham lacks surveyed EPC data, meaning that the ratings of many properties are not captured. This data gap reflects broader issues with the methodology for undertaking and reporting non-domestic EPCs, where the current policy landscape has less strict drivers regarding the uptake of ongoing energy assessments. Currently, one of the only policies in place in this sector is all rented commercial properties in the UK must have a minimum EPC rating of E. To progress energy efficiency in non-domestic building stock requires further energy studies on non-domestic buildings to provide more available data to aid in identifying and implementing energy efficiency measures across the properties.

The total simulated thermal demand of non-domestic buildings was also assessed, as shown in Figure 6.6. The office and primary school properties exhibit significantly higher thermal demand than the other building types, primarily due to the large volume of the properties across Nottingham city, identifying these building types as a priority to retrofit. Nottingham also had significant demand from industrial buildings and warehouses.

Office buildings tend to share similar characteristics, such as building envelopes, room layouts, and energy systems, presenting an opportunity for standardised retrofit approaches. Implementing retrofits at scale across these properties is likely to be more straightforward compared to other non-domestic building types, which tend to be more varied in design and function. For these building types, more bespoke retrofit approaches may need to be undertaken, which could incur additional complexity and costs

One challenge within the commercial buildings sector however is the commercial ownership and rental model, where large office or retail buildings are owned by large commercial asset owners and rented to those utilising the spaces. This means that the ability of the local business or organisation within the space to effect energy efficiency change within their environment is relatively minimal compared to the domestic sector. However, by the same principle, increased energy efficiency and fabric standards applied to commercial buildings could impact those large asset owners encouraging their engagement in retrofitting their assets prior to rental or sale.

Figure 6.6: Total Thermal Demand of Non-Domestic Properties by Use



Within the scope of this LAEP, the opportunity to accurately represent the decarbonisation the non-domestic sector, depends on the available data / the fabric and energy efficiency measures most appropriate for each non-domestic building will depend heavily on the primary use of the building. Different uses like offices and industrial building will have significantly different building fabrics, equipment type and profiles, and occupancy patterns which will affect which measures are most suitable for each building.

Different primary uses also have varying funding mechanisms for how to implement improvements; public sector buildings are more likely to receive more UK Government grant funding than private office buildings, the Public Sector Decarbonisation Scheme (PSDS) is a good example of this type of funding support, although it is now closed to new applications, with funding continuing only for previously awarded projects. In the absence of available funding for commercials buildings, it is important other incentives or regulations for private building be developed by the UK Government to support the implementation of energy efficiency and fabric upgrade measures.

During the LAEP development and through the stakeholder engagement with non-domestic stakeholders and estate managers, ongoing retrofit programmes amongst non-domestic buildings, such as schools, colleges and the NHS, where highlighted. All programmes mentioned were following fabric first approaches despite funding limitations. To ensure continued operation of such buildings out of hours periods (e.g. end of term) were being used to implement such measures or complete upgrades.

6.2 Intervention Methodology

6.2.1 Energy Interventions

To meet the legally binding decarbonisation targets for the UK, significant levels of energy efficiency improvements need to be undertaken across the country. For Nottingham's diverse domestic and non-domestic sectors to reach the levels of uptake needed for net zero compliance the two chosen scenarios - a 2040 and 2050 net zero scenario, as well as a

counterfactual “Do Nothing” scenario – have been modelled following two energy efficiency approaches.

The specific fabric upgrades that were modelled into Nottingham’s LAEP were split into the following Retrofit categories shown in Table 6.1.

Table 6.1: Light and Deep Retrofit Definitions

Light Retrofit Criteria	Deep Retrofit Criteria
Cavity Wall Insulation: Applied to properties identified as having cavity frame walls that are currently uninsulated (excluding timber frame construction to avoid damp and moisture).	**Window Upgrades**: All single-glazed windows being proposed to be upgraded them to double glazing.
Full Loft Insulation: Targeted to properties where the predicted loft insulation depth is between 0–50mm, effectively meaning they have no insulation.	**Solid Wall Insulation**: Applied to properties with solid brick or stone walls that are currently uninsulated.
Loft Top-Up Insulation: Applied to homes with an existing insulation depth of 50–150mm, where we topped up with an additional 200mm of insulation.	**Floor Insulation**: Based on Home Analytics data, we targeted buildings with either suspended floors or those with an unheated space below, provided these floors were not already insulated.

Where a property is eligible for retrofit measures, it may be classified as requiring a light retrofit, a deep retrofit, or a combination of both, depending on the measures applicable to that dwelling.

There are approximately 74,615 buildings requiring some degree of retrofit across these light and deep retrofit categories in order to meet MEES compliance as a minimum.

Due to limitations in the available data on fabric conditions and construction types of non-domestic properties, the modelled retrofit upgrades are limited to domestic properties and do not include non-domestic stock.

6.2.2 Building Fabric – Do Nothing

This scenario takes into account the current pathway, based on currently mandated legislation at the time of completion of this LAEP. It assumes that all existing national legislation is implemented in relation to energy efficiency, which includes the following policies:

The UK Governments Minimum Energy Efficiency Standards (**MEES**) **regulations**[38], which applies to private-rented properties not owner-occupied, currently states that a property cannot be rented unless it has an EPC rating of E or higher. This is anticipated to increase to EPC C or higher by 2030.

The Future Homes and Buildings Standard (2025) is assumed to be implemented and will mandate that all new builds are constructed as ‘net zero ready’, future proofed for low carbon heating and with ‘world leading’ levels of energy efficiency. This bill aims to have all new builds at an EPC rating of C or higher, however 85% of new build properties in England are already achieving a minimum EPC rating of B. We therefore assume that all houses constructed after 2025 will be to an EPC B or higher and will not require fabric retrofit intervention.

[38] Improving the energy performance of privately rented homes: 2025 update

The UK Government is encouraging the improvement of housing stock via these policies and incentives, the impact of which have been incorporated into our modelling of the “Do Nothing” scenario.

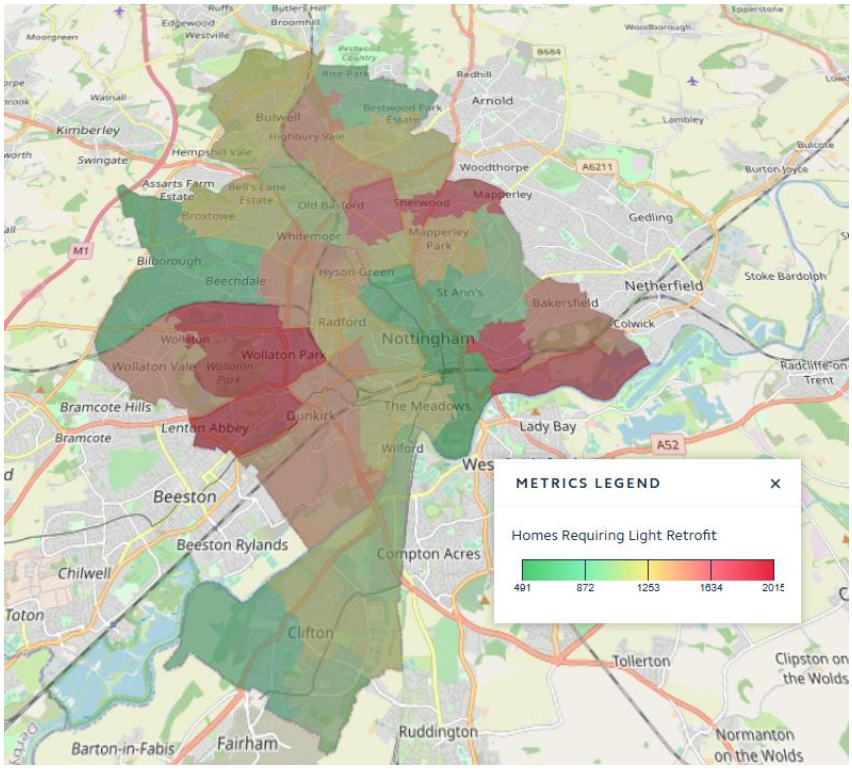
6.3 Light Retrofit

The light retrofit option represents the cheaper retrofit option, focusing on less intrusive insulation improvements. This option is targeted for homes requiring less significant thermal efficiency improvements.

Light retrofit measures such as cavity wall insulation and loft insulation are lower cost than internal and external solid wall insulation and have been identified to have a significantly reduced payback compared with deep retrofit approaches. To find which homes require light retrofits, the existing fabric levels are analysed to find where improvements are needed. The extent of the improvements required is compared against the criteria for light and deep retrofit, described in Table 6.1, to identify which level of retrofit is required. With this analysis across the region, it is then possible to quantify the extent of light retrofit needed across Nottingham city.

Figure 6.7 visualises the light retrofit installations required across Nottingham city.

Figure 6.7: Number of Homes Requiring Light Retrofit, by MSOA



Source: IES Digital Twin

The 2040 and 2050 scenario uptake rates are informed by mandated national and regional policies, including the UK Government’s Warm Homes Plan, which seeks to front-load retrofit measures with a particular emphasis on social housing[39]. Uptake rates are also aligned with the CCC’s Seventh Carbon Budget net zero pathway, which prioritises the rapid deployment of

[39] Warm Homes: Local Grant policy guidance

energy efficiency measures ahead of low-carbon heating installations[40]. The uptake rates for the Net Zero scenarios are set out in Figure 6.8.

Additionally, the uptake profile assumes a slower rate of delivery between 2025 and 2030, reflecting current workforce and supply chain capacity. From 2030 onwards, however, retrofit demand is expected to drive significant growth in both workforce skills and supply chain capability, enabling a sharper acceleration in uptake.

Figure 6.8: Annual Light Retrofit Installations for Preferred Scenario

Year	2050 Scenario		2040 Scenario	
	Annual % Uptake	Annual Uptake	Annual % Uptake	Annual Uptake
2025	0%	-	0%	-
2026	1%	309	1%	530
2027	1%	354	2%	751
2028	2%	751	4%	1,547
2029	3%	1,326	6%	2,740
2030	**5%**	2,033	**10%**	4,508
2031	7%	3,093	15%	6,496
2032	10%	4,242	18%	7,866
2033	12%	5,126	17%	7,468
2034	12%	5,347	13%	5,701
2035	**11%**	4,861	**8%**	3,580
2036	9%	3,977	4%	1,856
2037	7%	3,093	2%	884
2038	5%	2,210	0%	177
2039	4%	1,723	0%	88
2040	3%	1,326	**0%**	-
2041	3%	1,193		
2042	3%	1,149		
2043	2%	663		
2044	1%	486		
2045	**1%**	398		
2046	1%	221		
2047	0%	177		
2048	0%	88		
2049	0%	44		
2050	**0%**	-		

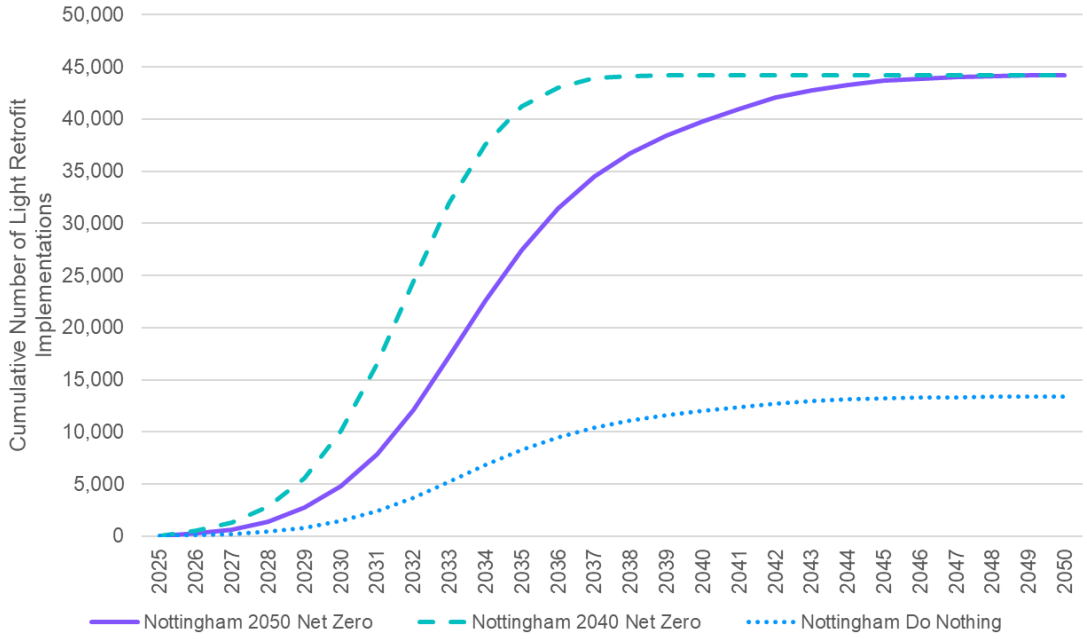
Figure 6.8 outlines the required year on year uptake light retrofit uptake rate for the 2050, 2040 and Do Nothing scenarios. The Do Nothing represents the counterfactual scenario, considering the expected retrofit of private rented properties as part of MEES regulations and follows similar update trajectory.

In both the 2040 and 2050 scenarios, a total of around 44,192 homes are required to have light retrofit upgrades, representing 40% of the total housing.

However, to meet the pathway targets of the local area in each scenario, light retrofit upgrades are not sufficient on their own. For some properties further thermal efficiency is required in order to meet the heat grade provided by a heat pump or district heating, so deep retrofit has also been modelled within the LAEP.

[40] The Seventh Carbon Budget - Climate Change Committee

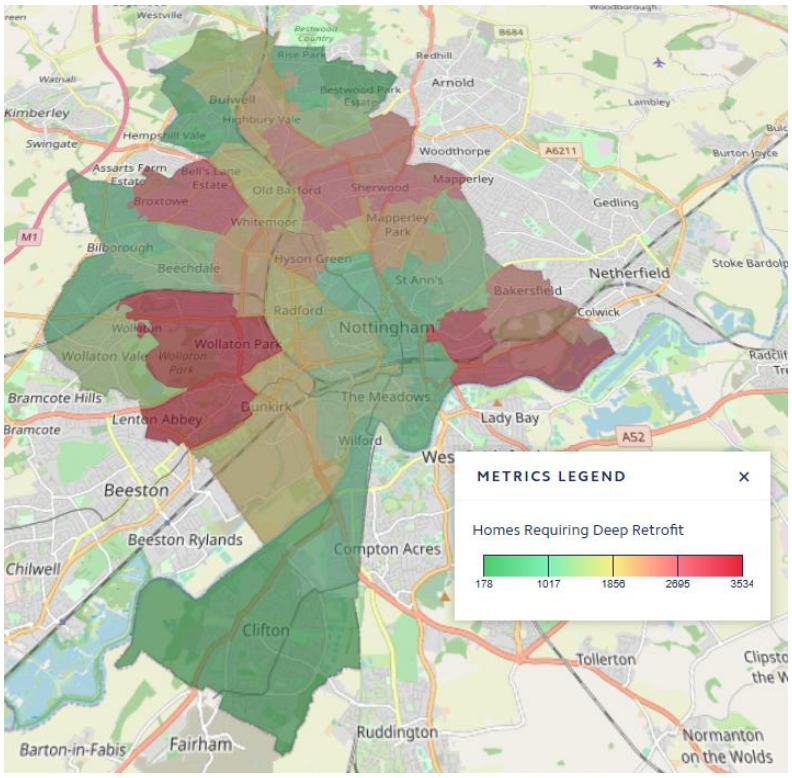
Figure 6.9: Annual Uptake of Light Retrofit Required per Scenario



6.4 Deep Retrofit

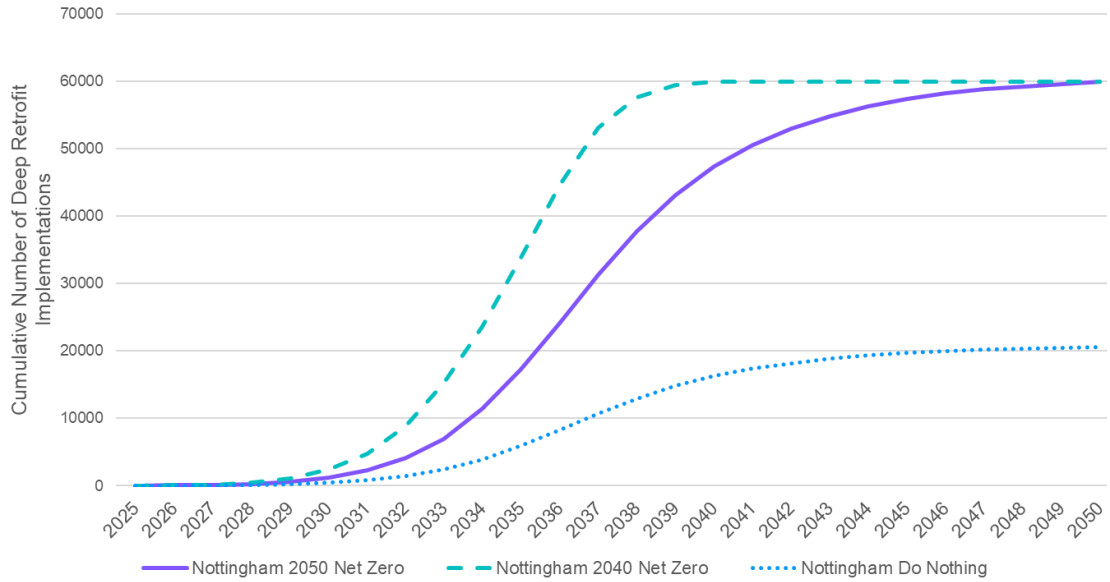
The deep retrofit option represents the more expensive approach, requiring more intrusive insulation improvements. It is intended for homes that need significant enhancements in thermal efficiency. As described in Table 6.1, the deep retrofit encompasses fabric upgrades for solid wall insulation, glazing upgrades and floor insulation. These retrofit measures are tailored to older housing stock, which often feature building envelopes that benefit most from these fabric upgrades, such as solid stone walls, single glazing and suspended floors.

Figure 6.10: Homes Requiring Deep Retrofit by MSOA



Source: IES Digital Twin

Figure 6.11: Annual Uptake Projection of Deep Retrofit



Year	2050 Scenario		2040 Scenario	
	Annual % Uptake	Annual Installations	Annual % Uptake	Annual Installations
2025	0%	0	0%	0
2026	0%	60	0%	60
2027	0%	60	0%	120
2028	0%	180	1%	300
2029	1%	360	1%	660
2030	**1%**	600	**2%**	1,260
2031	2%	1,080	4%	2,399
2032	3%	1,800	7%	4,139
2033	5%	2,819	10%	6,238
2034	7%	4,439	14%	8,518
2035	**10%**	5,879	**17%**	10,197
2036	12%	6,898	18%	10,737
2037	12%	7,138	14%	8,458
2038	11%	6,478	8%	4,499
2039	9%	5,399	3%	1,860
2040	7%	4,259	**1%**	540
2041	5%	3,179		
2042	4%	2,399		
2043	3%	1,860		
2044	2%	1,440		
2045	**2%**	1,080		
2046	1%	840		
2047	1%	600		
2048	1%	420		
2049	1%	360		
2050	**1%**	360		

Figure 6.12: Annual Deep Retrofit Installations for Preferred Scenario

Similarly to the light retrofit, the home analytics dataset within the digital twin of Nottingham was used to identify where deep retrofit measures would be suitable for each property, based on building fabric and construction type. The aim of this approach was to ensure that every property achieved adequate insulation levels, with a dual purpose of reducing the risk of fuel poverty and enabling the efficient installation and operation of a low-carbon heat source. This is discussed further in Section 7.

Figure 6.10 emphasises where in Nottingham is most in need of deep retrofit. These areas are concentrated around the inner city. The zones of Nottingham, including Wollaton Park and Wollaton, Lenton Abbey, parts of Radford and Hyson Green, Mapperley Park and Bakersfield show the highest concentration of deep retrofit demand.

It vital to target older building types as they will be most at risk of poor thermal comfort levels as health risks such as mould. Deep retrofit measures in these properties will provide additional benefits of remove risks of condensation, damp, and mould caused by excess cold air.

Figure 6.12 underlines the required annual uptake deep retrofit uptake rate for the 2050, 2040 and Do Nothing scenarios. The Do Nothing represents the expected retrofit of private rented properties as part of MEES regulations. Similar to light retrofits, the 2040 and 2050 scenario uptake growth rates were informed by mandated national and regional policies alongside considering the growth of the supply chain to limit the uptake to realistic levels. However, the rates have been slightly reduced to account for the increased scope and costs associated with deep retrofit upgrades, in comparison to light retrofits.

In both the 2040 and 2050 scenarios, a total of 59,985 homes are required to have deep retrofit upgrades, representing 54% of the total housing.

6.5 Impacts

Displayed in Figure 6.13, is the total number of retrofit installations required across Nottingham, specifying the number of properties requiring either light, deep or no retrofit. Additionally, there is a separate category for the housing stock requiring both light and deep retrofits. The breakdown of retrofits across the EPC ratings can be seen in Figure 6.14

Retrofit installations are expected to be widespread across the region, necessitating installations across all tenure types. This will require coordinated engagement from both the public and private sectors, including the development of incentives and potential funding mechanisms to support the transition. As the capital expenditure will be the main hurdle for the implementation of retrofits, these funding mechanisms would aid in ensuring the retrofit upgrades are accessible to all properties.

Households with lower income levels will be the least likely to undertake and pay for the high cost of deep retrofit measures, so appropriate support must be given in such circumstances to ensure a just transition towards net zero by 2040 or 2050. Retrofit programmes must be designed with support mechanisms for landlords and incentives for low-income households.

Additional targeting may be required in areas of high fuel poverty that have a large proportion of privately rented homes. Owner-occupied homes may have greater autonomy to invest in upgrades, while rented properties particularly in the private sector, face challenges due to split incentives and regulatory constraints.

Refer to Section 12 for further analysis and in depth technoeconomic discussion on costs of each intervention across each net zero scenario.

Figure 6.13: Number of Properties Requiring Fabric Retrofit, per MSOA

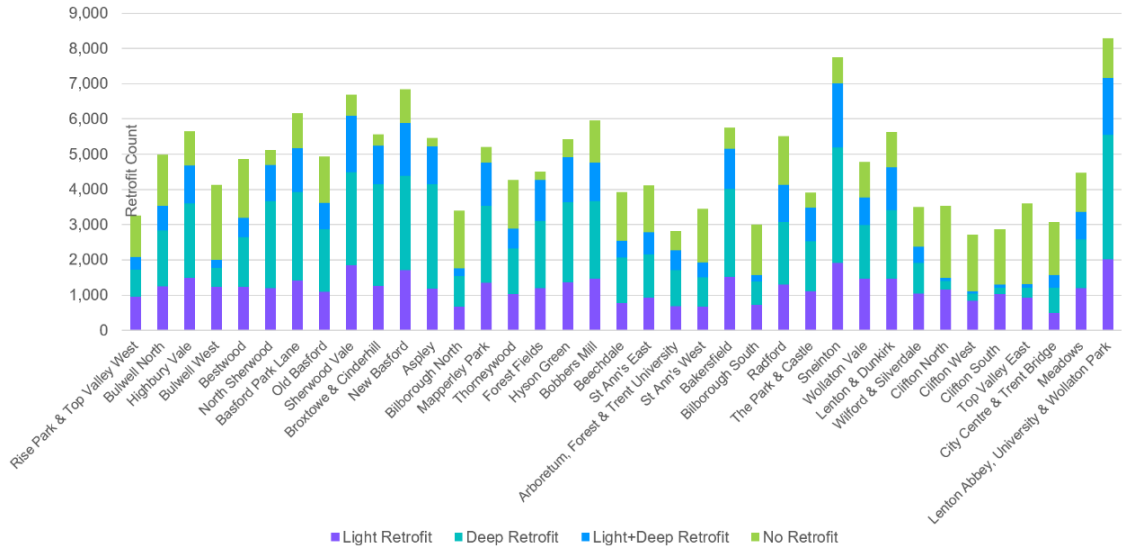
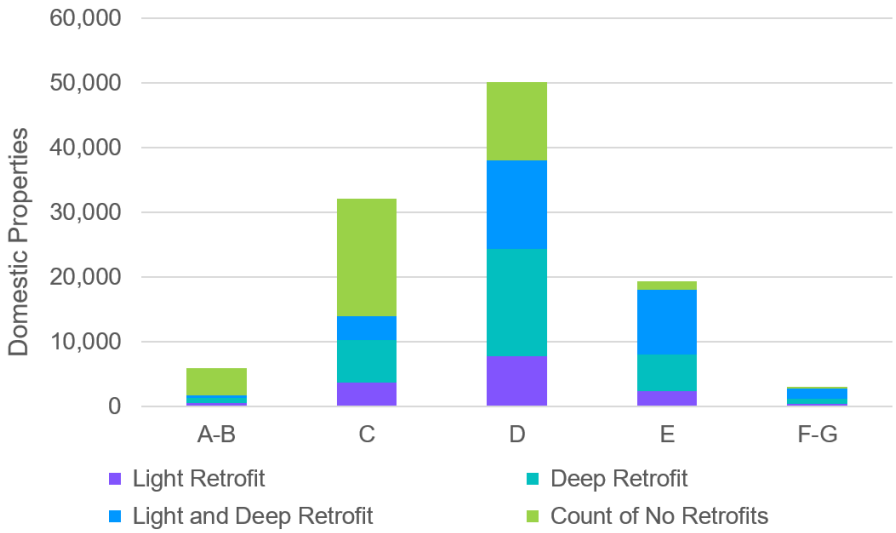


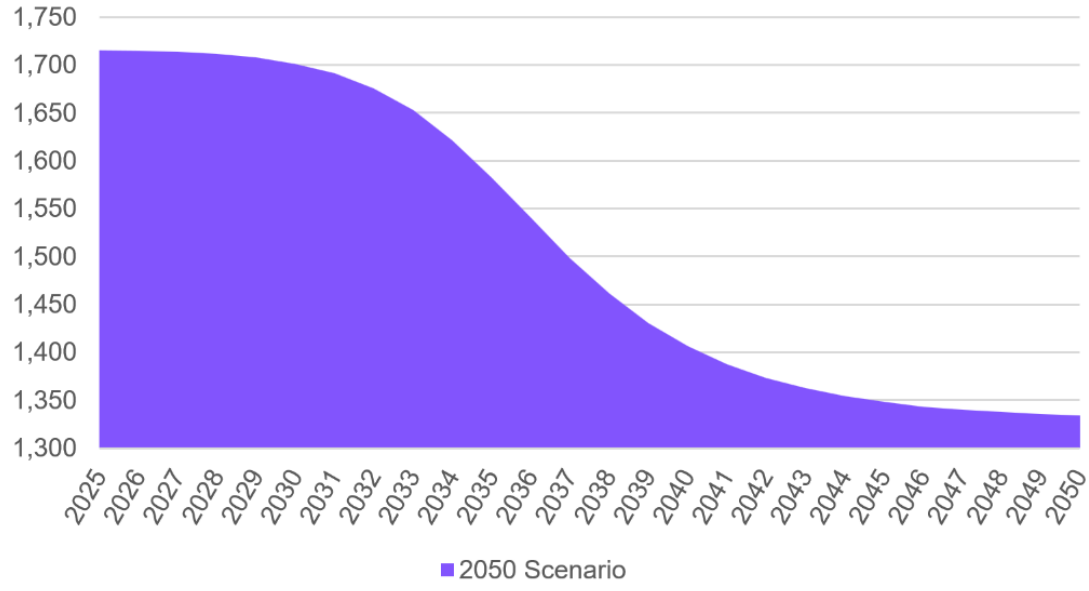
Figure 6.14: Retrofit Measures Across EPC Bands



The successful implementation of these retrofits will introduce significant energy savings across the region while satisfying thermal comfort levels within each property. Figure 6.15 displays the projected reduction in energy demand from domestic retrofits, driven by the reduced heat demand resulting from fabric upgrades. This identifies the significant increase in energy efficiency of homes, resulting from light and deep retrofits.

The energy demand reduction will provide vast benefits both to residents and Nottingham City Council, providing cost and carbon savings leading to a host of other benefits. These include alleviating fuel poverty, as households that were previously thermally inefficient would be able to heat their homes affordably.

Figure 6.15: Annual Combined Energy Demand Reduction from Fabric Retrofits



Additionally, these benefits will be extended as and when low-carbon heating technologies are deployed. As, the retrofit measures will act as a foundational step allowing the LCTs to efficiently operate, allowing for further savings.

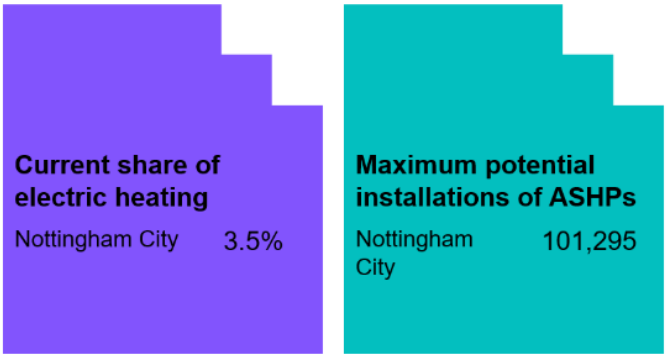
This not only lead to immediate energy savings and lower utility bills for residents but also contributes to the reduction of carbon emissions associated with gas use. In addition, the resulting decrease in thermal demand will help mitigate the anticipated strain on the local grid as the region transitions to electrified heating systems in the future.

For more information on the impacts of the installation of low carbon heating systems, please refer to Section 7.

7 Low Carbon Heating

This section analyses how low carbon space heating technologies can be implemented to support Nottingham City Council achieve net zero carbon emissions. Currently, the majority of domestic and non-domestic properties rely on fossil fuels to meet their space heating and hot water demands, presenting a significant challenge and substantial proportion of emissions. To decarbonise heat consumption, most properties will need to transition to low-carbon technologies, primarily those powered by electricity, which overtime will be supplied by an entirely green electricity grid.

7.1 Domestic Sector



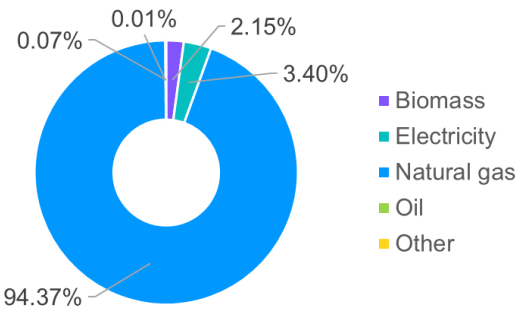
7.1.1 Existing System

Natural gas is the predominant fuel type used in Nottingham as shown in Figure 7.1. Approximately 94.4% of homes use a gas-powered boiler for space heating and hot water. Around 3.4% of homes use electricity for heating which includes both electric heat pumps and resistive electric heating. These homes can already be considered to have low-carbon heating systems, as their emissions will continue to decrease as the national grid decarbonises. In addition, around 2.2% of households use biomass heating, most commonly in the form of wood pellets, which is also recognised as a low-carbon option.

Nottingham City has a small number of homes (0.1%), liquefied petroleum gas (LPG), grouped under the ‘other’ category. To meet net zero targets, all homes in this category will need to transition to a low-carbon heat source.

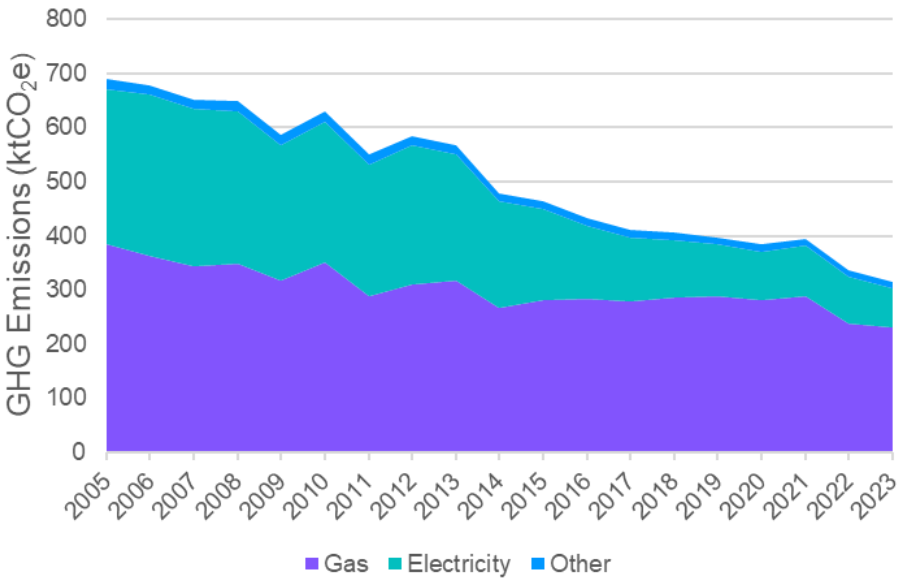
In order for Nottingham City to achieve its net-zero goals, the uptake of low-carbon heating technologies across its domestic sector is key in order to decarbonise emissions associated with space heating.

Figure 7.1: Domestic Heating split by Fuel Type for Nottingham (%)



Source: IES Modelling

Figure 7.2: Domestic Historical Carbon Emissions Breakdown in Nottingham ($ktCO_2e$)



Source: UK local authority and regional greenhouse gas emissions statistics - GOV.UK

Figure 7.2 outlines the historical carbon emissions associated with domestic fuel types. Buildings using natural gas contribute up to 230 ktCO2e of emissions, followed by 73.5 ktCO2e from electricity. There have been significant emissions reductions across all fuel types since 2005, predominantly from electricity use. This is in large part due to the decarbonisation of the grid as well as efficiency measures. Local retrofit programmes such as the Home Upgrade Grant (HUG) and Sustainable Warmth schemes have supported these reductions, particularly in hard-to-heat homes.

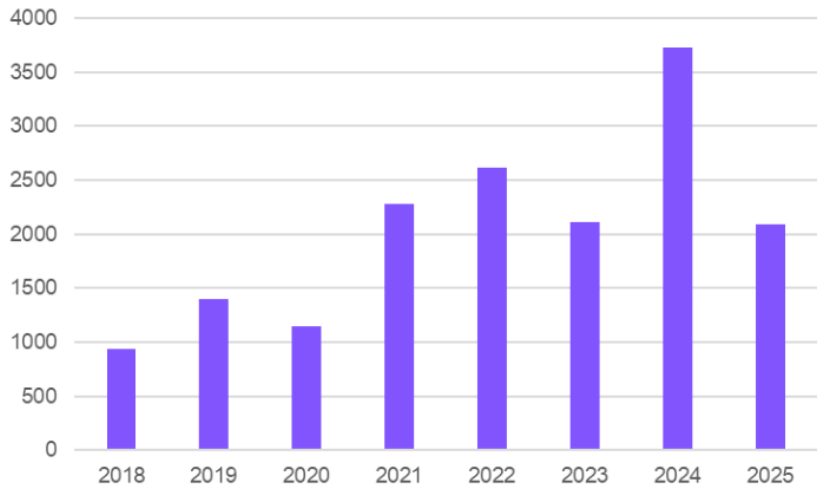
7.1.2 Low-carbon Heating System Installations

Across the D2N2 programme modelling approach, air source heat pumps (ASHPs) are the primary alternative to natural gas heating systems to meet its net zero goals. Across the East Midlands area historic heat pump uptake has increased overall since 2018, as seen on Figure 7.3.

The UK Government publishes quarterly data on heat pump deployment by region. As shown in Figure 7.3, there is a steadily growing uptake year on year of heat pumps since 2018 in the East Midlands. Over 3,700 installations were recorded in 2024 and projections for 2025 are on track

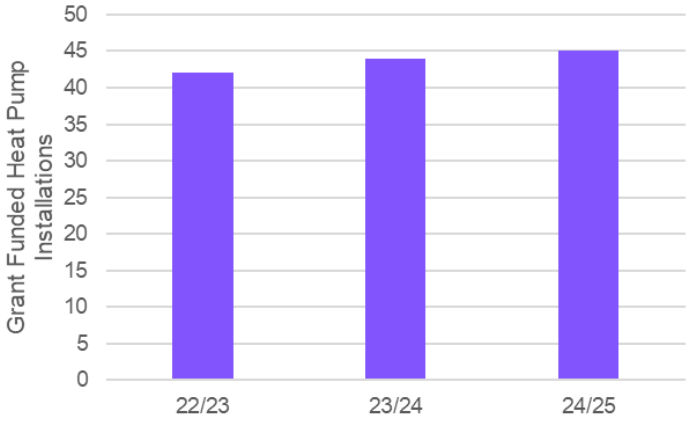
to exceed this. While this upward trend is encouraging, heat pumps still represent a small fraction of space heating compared to the total housing stock.

Figure 7.3: East Midlands historical heat pump uptake



Source: Heat pump deployment statistics: June 2025 - GOV.UK

Figure 7.4: Nottingham Boiler Upgrade Scheme Heat Pump Installations



Source: Boiler Upgrade Scheme statistics: August 2025 - GOV.UK

Focusing on Nottingham City specifically, Government data also tracks heat pump installations at the local authority level through the Boiler Upgrade Scheme. Figure 7.4 shows that Nottingham City does not follow the regional trend, with only a slight increase in installations year-on-year.

In the 2024/25 financial year, Nottingham recorded 45 heat pump installations through the scheme. With over 80,000 homes using natural gas and an average boiler lifespan of 15 years, Nottingham City would roughly see 5,400 gas boiler replacements each year. However, less than 1% of these replacements are currently switching to heat pumps due to ongoing high upfront costs of installations, perceived installation complexity and requirements for additional insulation before installations go ahead. Further information is covered in Section 6.

To decarbonise domestic heating in Nottingham, the installation of heat pumps must rise sharply. Even if boiler replacements are banned in the 2030s, proactive measures are needed

now to accelerate uptake in the short term. See Section 13.5 for enabling actions to accelerate the uptake of LCTs.

7.1.3 Do Nothing

The Do Nothing scenario here assumes minimal policy requirements for heat decarbonisation. The only assumed policy intervention in this area is a ban on fossil fuel heating in new builds from 2030[41], with no policy implemented regarding the removal of fossil fuel heating systems from existing buildings.

While there is noticeable growth in heat pumps, most of these installations are assumed to be from the fossil fuel boiler ban in new builds, with only a small percentage occurring from existing gas boilers changing systems. Heat pump uptake is expected to be very low due to the lack of policy incentives and grant funding available. However, after 2035, gas boiler to heat pump conversions are expected to pick up slightly as per the planned phase-out of fossil fuel boilers.

7.1.4 Intervention Methodology

We have considered feasible installation of heat pumps in all building types that are currently using any fuel type other than electricity or biomass.

The digital twin has been used to model the changes in energy use and carbon emissions from the switching of fossil fuel boiler systems to heat pumps. The additional peak electrical demand and annual electricity consumption has been built into the projected modelling for carbon emissions reduction and impacts of the local grid. Therefore, the buildings' new total electricity consumption, post heat electrification, equals their electricity consumption post retrofit, plus the demand of the ASHP.

For buildings already with an electrical heat source, it has been assumed that this will stay the same.

While ASHP are the main heat decarbonisation vector for Nottingham City[42], Section 7.3 outlines the council-identified district heating focus zones, where the deployment of district heating can reduce the scale of individual heat pump installations.

7.1.5 Scenarios Overview

The two net zero compliant scenarios developed as part of this LAEP anticipate significantly more installations to take place compared to the Do Nothing, by assuming all homes will have a net zero heating system by 2040 or 2050.

[41] Note that the new Future Homes Standard, summarised in Section 2.1.9 now legislates for no fossil fuel heating in new builds from 2025, at the time of the DFES publication this date was still set to be 2030

[42] Approach consistent across the D2N2 programme.

Figure 7.5: 2050 Scenario Domestic Heat Pump Uptake Projection

Year	2050 Scenario		2040 Scenario	
	Annual % Uptake	Annual Installations (units)	Annual % Uptake	Annual Installations (units)
2025	0%	-	0%	-
2026	0%	223	1%	699
2027	0%	324	1%	1,074
2028	0%	456	2%	1,641
2029	1%	638	2%	2,482
2030	1%	891	4%	3,667
2031	1%	1,236	5%	5,267
2032	2%	1,702	7%	7,263
2033	2%	2,320	9%	9,431
2034	3%	3,110	11%	11,365
2035	4%	4,082	12%	12,540
2036	5%	5,227	12%	12,642
2037	6%	6,442	11%	11,274
2038	8%	7,617	9%	9,420
2039	8%	8,559	7%	7,263
2040	9%	9,086	5%	5,267
2041	9%	9,086		
2042	8%	8,559		
2043	8%	7,617		
2044	6%	6,442		
2045	5%	5,065		
2046	4%	4,244		
2047	3%	3,110		
2048	2%	2,320		
2049	2%	1,702		
2050	1%	1,236		

The projected annual uptake rates and annual installations for the domestic heat pump for Net Zero scenarios is outlined in Figure 7.5, alongside the cumulative comparison between the 2040 and 2050 scenarios. Both scenarios assume a full electrification of space heating, with no hybrid heat pump installations. The uptake rate assumes a relatively consistent, steady uptake of heat pumps, which accelerates in the mid-2030s. The growth in installation reflects introduction of incentives, such as the Boiler Upgrade Scheme and its £7,500 grants used to improve near-term uptake economics.

All new builds are assumed to have a low carbon heating system, as per the Future Homes Standard, however the challenges lie with existing housing due to space constraints and the need for fabric upgrades in older housing stock as discussed in Section 6. The impact on electrical networks is covered in Chapter 11, given that heating in new builds will now be fully electric.

Heat pumps operate less efficiently in older properties as they incur higher heat losses and may struggle to maintain thermal comfort in cold weather conditions. Therefore, it is important that fabric retrofit improvements are undertaken in such properties as soon as possible to reduce the costs incurred by running them as well as achieving the necessary COP level for adequate thermal comfort.

Space constraints in existing housing, particularly flats and terraced houses, present challenges to heat pump installation due to the required hot water cylinder to go alongside it. Social housing providers may be able to install heat pumps alongside the necessary insulation upgrades.

The current level of thermal demand per MSOA for domestic housing in Nottingham City is shown in Figure 7.6 below. The MSOAs of Bestwood and Basford Park Lane record the highest peak heat demand which can be attributed a number of non-domestic and commercial building in the area.

Figure 7.6: Thermal Demand by MSOA

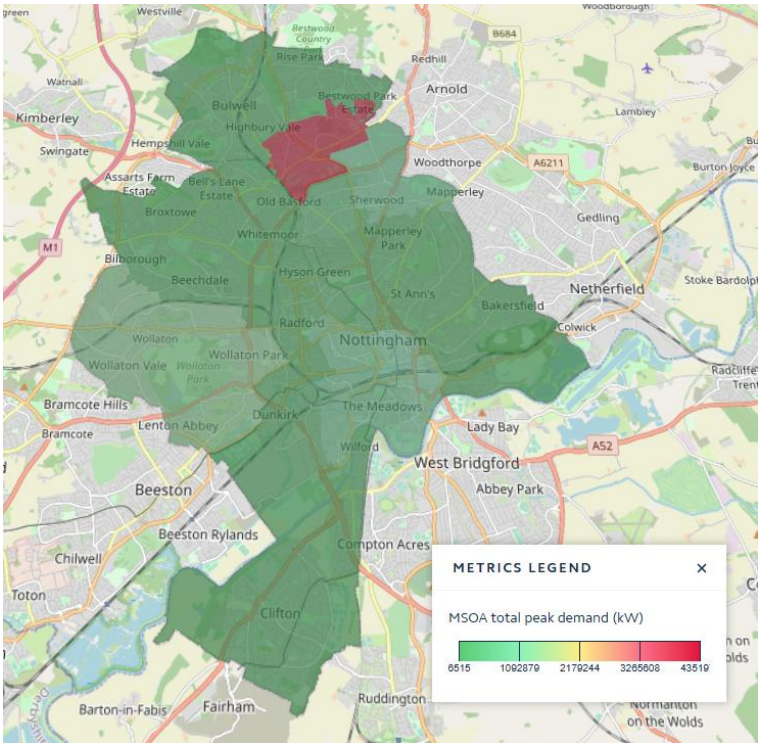


Figure 7.7: 2050 and 2040 Scenario Domestic Heat Pump Uptake

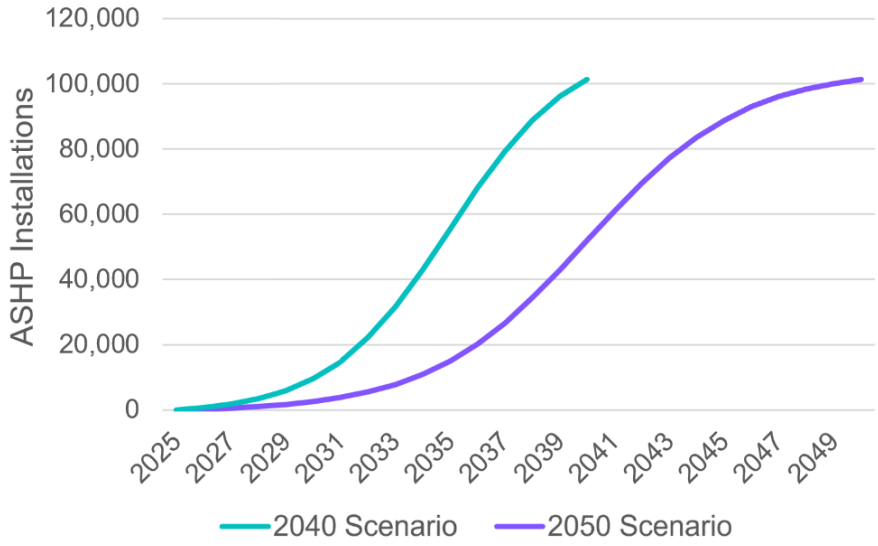


Figure 7.8: 2050 and 2040 Scenarios Domestic Gas Consumption Reduction from Domestic Heat Pump Uptake

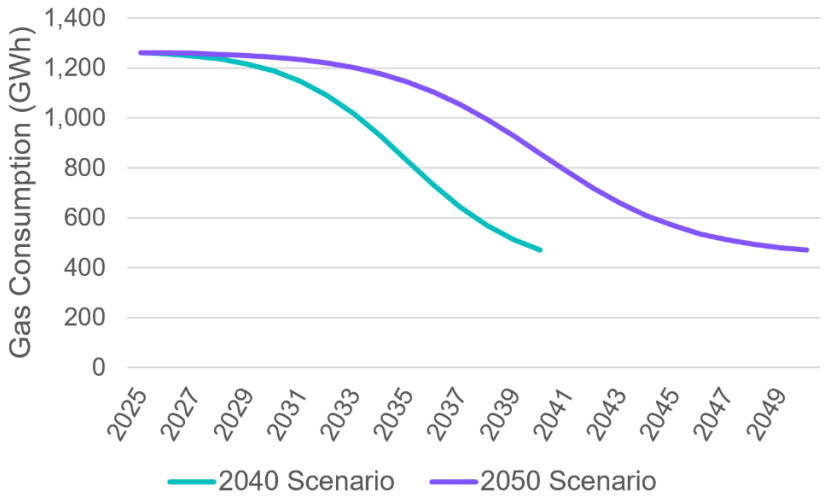


Figure 7.8 illustrates the projected uptake of domestic heat pumps, and Figure 7.7 illustrates the reduction in gas consumption projected from domestic heat pump uptake. As savings are directly proportional to the technology uptake, they follow the same s-curve profile, with accelerated growth expected in the mid-2030s. The associated carbon reductions will be substantial, driving a major shift in the sector, though the scale of impact will ultimately depend on the pace of grid electricity decarbonisation.

Regulatory changes to permitted development rights for ASHPs remove barriers like the 1-meter boundary rule for ASHP, which also make installations easier for more homes and can be expected to boost uptake significantly alongside the planned phase-out of fossil fuel boilers by 2035.

7.1.6 Modelled Interventions

The technologies considered for heating decarbonisation are set out in Table 7.1. Of these, ASHPs are the most viable and economical option going forward due to grid decarbonisation and their high efficiencies, providing heat for the building while meeting the Net Zero targets.

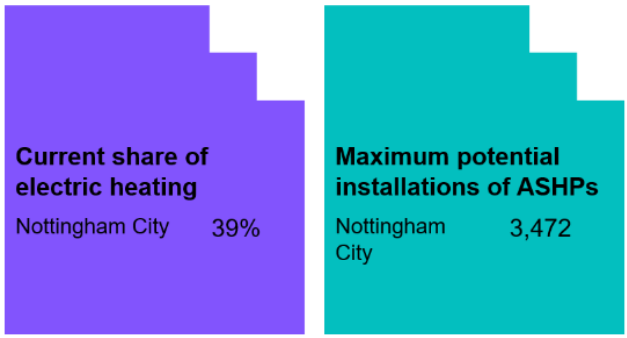
In comparison, GSHPs offer slightly higher efficiencies than ASHPs but come with higher upfront costs and require sufficient outdoor space for ground loops. Direct electric heating, though simple to install, is far less efficient and results in higher running costs and electricity demand. Finally, district heat networks can provide low-carbon heat in dense urban areas or large developments but are generally less cost-effective or practical for dispersed and rural housing.

ASHPs are electrically powered and use refrigerant to extract low grade heat from the air, which is then upgraded using compression. The resulting heat is then transferred to a wet central heating system through a plate heat exchange. The efficiency of a heat pump is known as Coefficient of Performance (COP) and measures the heat output in kWh of heat produced per kWh of electricity used (i.e., a system that produces 3kWh of heat per kWh of electricity has a COP of 3). In our modelling, anticipated demand for ASPs was represented by the building's new electrical consumption for space heating and DHW, with an assumed COP of 2.7.

Table 7.1: Heating Technologies

Technology	Description
Fossil Fuel Boiler	Heating technology that combusts fossil fuels to heat water for space heating and DHW demands. Most of these installations currently in the County use natural gas as the fuel source, although there are some using LPG and Oil in the off-gas grid postcodes. This is the most common heating system for domestic properties in Nottingham City.
Direct Electric	This category of heating technologies includes electric boiler, electric storage heaters, electric heat batteries and other direct electric technologies. They are typically cheaper to install than heat pumps, but more costly to run due to their lower efficiency. Any home currently with this technology is assumed to keep it in all scenarios. Some homeowners and landlords may opt to install one of these technologies instead of a heat pump.
Air Source Heat Pump (ASHP)	Electrical heating system that takes heat from the ambient air outside and delivers it internally, consuming electricity. This technology typically has significantly higher efficiencies compared to direct electric or fossil fuel boilers, of between 2.5 and 3.0. All heat pump uptake is assumed to be air source, unless otherwise specified.
District Heat Network Connection	Some properties in Nottingham will likely be able to decarbonise their heat supply through connecting to a district heat network, instead of installing their own low carbon heating system. District heat networks supply heat to properties via hot water in underground pipes, from a centralised plant. See Section 7.3 for more details.
Hydrogen Boilers	Similar to a fossil fuel boiler but provides heat through burning hydrogen. If this hydrogen is considered 'green' (created via renewables) or 'blue' (created via carbon capture and storage of fossil fuel combustion) then it can be considered low carbon. This heating technology has not been considered for the Nottingham City LAEP, due to hydrogen for space heating not being considered viable as part of this programme, however it should be noted that potential industrial clusters that have been identified as having hydrogen as a possible alternative fuel source.

7.2 Non-Domestic Sector

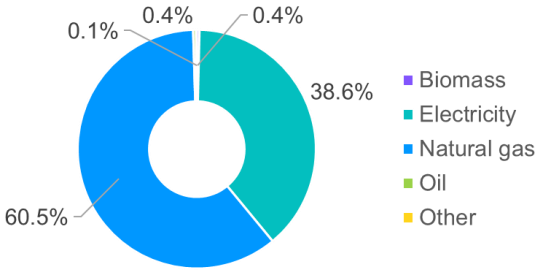


7.2.1 Existing System

Alongside the domestic sector, the non-domestic will require the uptake of low-carbon heating technologies to decarbonise emissions associated with space heating across Nottingham.

In comparison to the domestic sector, there is a split between the heating fuels types in place, as shown in Figure 7.9. Approximately 61% of properties utilise natural gas for space heating and hot water, with 39% of properties use electricity for heating. The electrically heated properties are considered to have low carbon heating systems, identifying 61% of the non-domestic properties require replacement of their heating systems.

Figure 7.9: Non-Domestic Heating Split by Fuel Type (%)



7.2.2 Scenarios Overview

For the non-domestic sector, two net-zero compliant scenarios were developed by assuming all homes will have a net zero heating system by 2040 or 2050. The scenarios developed followed the methodology as described in Section 7.1.5. Whereby, the carbon and energy savings from removing all low carbon heat sources were modelled using a digital twin.

Figure 7.10: 2050 & 2040 Scenario Non-Domestic Heat Pump Uptake Projection

	2050 Scenario		2040 Scenario	
Year	Annual % Uptake	Annual Installations (units)	Annual % Uptake	Annual Installations (units)
2025	0%	-	0%	-
2026	0%	8	1%	24
2027	0%	11	1%	37
2028	0%	16	2%	56
2029	1%	22	2%	85
2030	1%	31	4%	126
2031	1%	42	5%	181
2032	2%	58	7%	249
2033	2%	80	9%	323
2034	3%	107	11%	390
2035	4%	140	12%	430
2036	5%	179	12%	433
2037	6%	221	11%	386
2038	8%	261	9%	323
2039	8%	293	7%	249
2040	9%	311	5%	181
2041	9%	311		
2042	8%	293		
2043	8%	261		
2044	6%	221		
2045	5%	174		
2046	4%	145		
2047	3%	107		
2048	2%	80		
2049	2%	58		
2050	1%	42		

The 2040 and 2050 scenarios also assume a reduction in the total number of non-domestic properties using other types of electric heating, assuming that many will transition to heat pumps as the technology matures and funding becomes available.

This is based on the replacement rate of boilers with a 15-20 year life span, using historic ASHP installation data to inform the rate at which heat pumps would be installed. Efficiency Assumption is 85% for gas boilers and overall CAPEX for boilers is £2–5k, and ASHPs (£10–15k).

As heat pump technology improves and installation costs fall, larger scale heat pumps will become more accessible and cost effective which some non-domestic users and businesses may be suited in communal form.

Figure 7.11: 2050 and 2040 Scenario Non-domestic Heat Pump Uptake

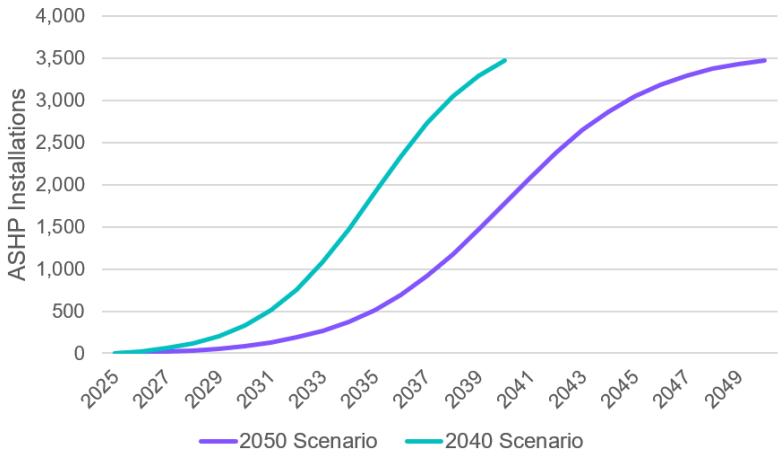


Figure 7.12: 2050 and 2040 Scenarios Non-Domestic Gas Consumption Reduction from Non-domestic Heat Pump Uptake

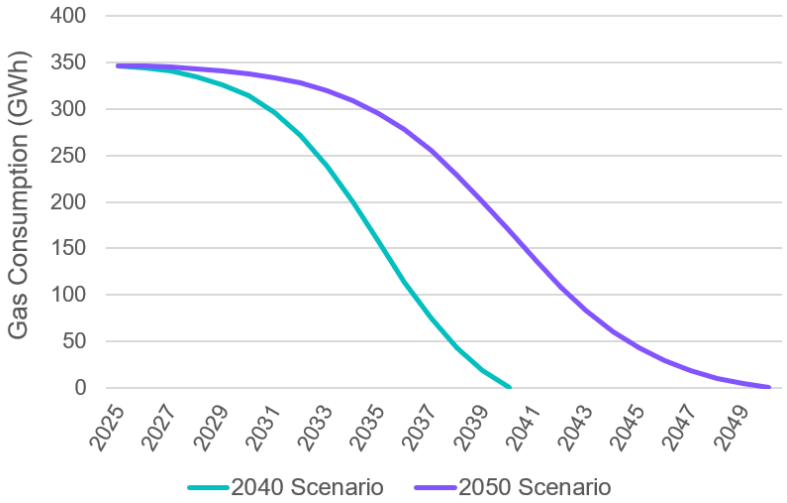
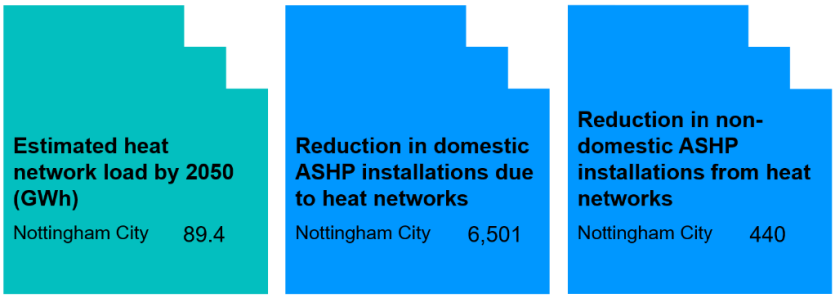


Figure 7.11 illustrates the projected uptake of domestic heat pumps, and Figure 7.12 illustrates the reduction in gas consumption projected from domestic heat pump uptake.

It is critical financial support is available for more non-domestic properties which already have good capability for heat pump use, to enable these properties to upgrade their fabric to be able to quickly adopt heat pump technology.

7.3 District Heating



7.3.1 Existing Network

Nottingham has one of the oldest and largest heat Networks in the UK, Enviroenergy, that supplies over 5,000 homes and over 100 non-domestic properties through an extensive system of insulated pipes. The network is owned and operated by Nottingham City Council, primarily fuelled by steam from the Eastcroft waste plant and supplemented by gas boilers. This infrastructure forms the backbone of the city's efforts to decarbonise heating and supports key sites such as hospitals, universities, and council offices.

Reliance on decentralised fossil fuel heating remains a key driver of local carbon emissions and contributes to fuel cost volatility**.** Heat networks are an important part of securing energy independence for the UK through local, low carbon heat sources in densely populated areas. Heat networks could provide 20% of total heat by 2050, where currently only 3% of total heat is provided by heat networks.

7.3.2 Heat Network Zoning Opportunity Pilot Programme

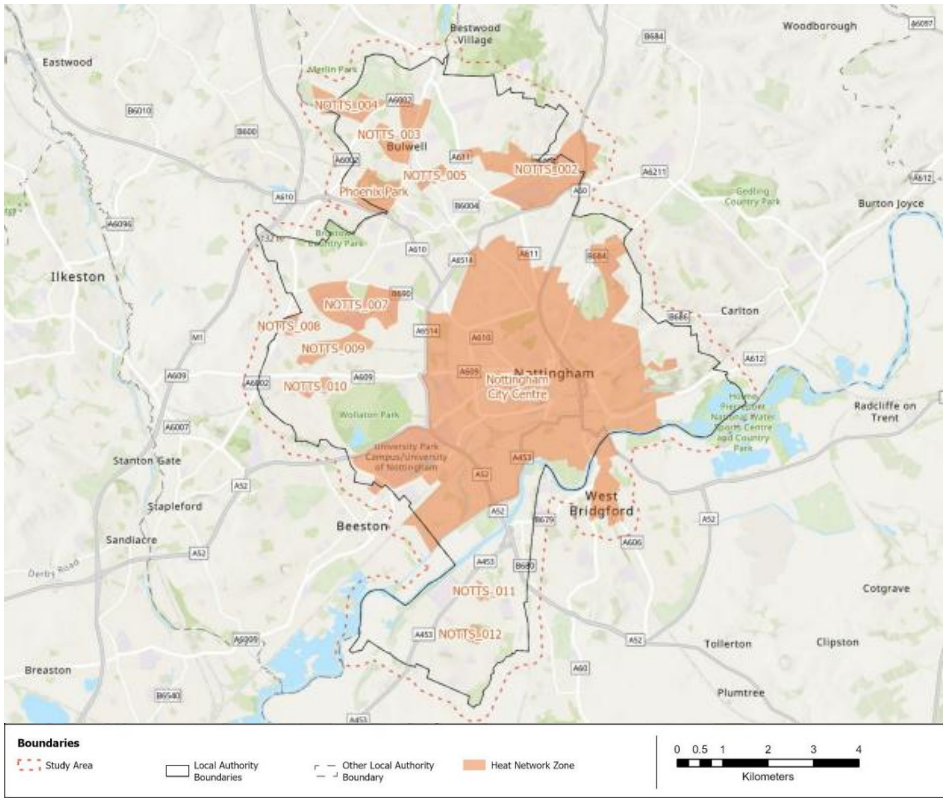
The Heat Network Zoning Opportunity Pilot Programme is a government-led initiative designed to support the development of heat networks across the country. It does so by identifying areas with strong potential for these systems, highlighting suitable locations for heat network zones, investment opportunities, and priority areas for development.

As part of the programme, 23 cities in England were identified as suitable for advanced zoning pilots, including Nottingham. However, the Nottingham Heat Network Zoning Pilot Programme was undertaken before the formal Heat Network Zoning policy was available, and therefore the technical content of the report is expected to change.

The city has identified twelve zones for the heat network comprising of two strategic areas: Nottingham City and Phoenix Park, mapped to target a total annual heat demand of 650GWh. Planned expansions focus on connecting new developments, hospital sites, and university campuses, with future heat sources including expanded energy-from-waste, water source heat pumps, mine water heat, and air source heat pumps. The estimated capital investment required for all zones is around £1.9 billion.

The initial development opportunities are projected to deliver annual carbon savings exceeding 35ktCO_2e, supporting Nottingham's ambition to achieve carbon neutrality by 2028. Beyond environmental benefits, the programme is expected to create thousands of jobs, lower heating costs, and improve energy security for residents and businesses. However, technical challenges such as crossing tramlines, railways, and canals will need to be addressed as the network expands and integrates with new developments.

Figure 7.13: Nottingham Heat Network Zoning Map



Source: Heat Network Zoning Opportunity Report: Nottingham

Figure 7.13 above provides an overview of the heat network zones in Nottingham. The network already supplies many anchor loads including Victoria Baths, National Ice Arean, Nottingham Trent University's Newton Building, Bio City and NCC offices. The city's zoning methodology has integrated Queen's Medical Centre, university campuses and major public properties as key connection targets to underpin the viability of each zone. Table 7.2 below shows the heat demand split by building category across all initial zone opportunities in Strategic Heat Network Zones.

Table 7.2: Heat Demand by Building Category across Strategic HNZ Zones

Building category	Number of properties required to connect	Annual Heat Demand across IZOs (MWh)
Domestic	11	3,950
Education (schools & higher education)	15	9,550
Entertainment	14	9,950
Hospitals and residential / nursing homes	8	2,450
Hotels	11	5,500
Industrial properties	99	36,650
Offices	138	42,800
Public properties	15	7,250
Retail	129	43,500
Sports and recreation	7	4,500
New Developments	14	70,450
Totals	**461**	**236,550**

New and re-developments, such as Boots campus and Island Quarter, are planned future anchor loads. Network routing and energy centre locations have been designed to facilitate their connection.

The report highlights ongoing engagement with anchor load stakeholders (e.g., NHS Trusts, universities, developers) to ensure their needs are integrated into network design and delivery. Planned projects (such as the Queen's Medical Centre ground source heat network and university campus networks) are developed in partnership with anchor load owners.

Table 7.3 identifies the new proposed key off takers from the heat network zone as well as their proportion of heat demand from the network. Overall, these key off takes will take up most of the demand accounting for over 70% of the total network demand. The private sector accounts for the most demand with 29%, where this proportion is predominantly made up of commercial and retail properties.

Table 7.3: Proposed Key Off takers

Anchor Load	% of Total Network Heat Demand
Nottingham City University Hospital	12%
University of Nottingham	17%
Nottingham City Council	18%
Nottingham City College	5%
Private Sector	29%
Total	**71%**

7.3.3 Modelled Networks Validation

Following completion of the Heat Network Zoning Opportunity study for Nottingham, NCC compared heat demand in the strategic zones with its own modelled data. This exercise aimed to validate DESNZ's dataset against Nottingham's figures as well as against separate IES modelling performed during this LAEP development. This was done to further assess potential energy and carbon savings across the proposed network zones.

The Heat Zoning study only covers 50% of the NCC geography and therefore a significant portion of residential units are outside the zone mapping areas will decarbonise with alternative technologies, such as heat pumps and electric heating.

Table 7.4 presents the heat zone demand and heat decarbonisation vector for the zones.

Table 7.4: DESNZ Heat Network Zoning Validation

DHZ (District Heating Zone)	Zone Heating Demand (GWh/annum)	Heat Decarbonisation Vector
City Centre	832	Heat pump and potential for heat network deployment
City Hospital	80	Heat pump deployment
Bulwell	25	Heat pump deployment
Blenheim IE	7	Heat pump deployment
Western Zone	44	Heat pump and potential for heat network deployment
Southern Zone	7	Heat pump deployment

The locations have been assessed against key feasibility criteria, including the presence of low-carbon heat sources, suitable anchor loads, and geographic constraints. The city centre heat zone, which would expand on the existing network, presents the most significant annual heat demand. This area contains a large concentration of commercial and other non-domestic

properties, offering strong anchor loads and manageable constraints, making it well-suited for initial exploration.

Through stakeholder feedback and consultations with the council, there are two major zones that are focus areas for district heat network deployment:

- City Centre: Focus area with extended zones around commercial activity and property. DHZ assumes 50% penetration of heat network.
- Western Zone: Focus area with high heat network penetration of 80%.

Table 7.5 displays the estimated heat networks load by 2050 across identified DHZs and their associated MSOAs, alongside the corresponding potential reduction in both domestic and non-domestic ASHP installations resulting from heat network deployment.

Table 7.5: Heat Network Demand and Resulting Reductions in ASHP Installations

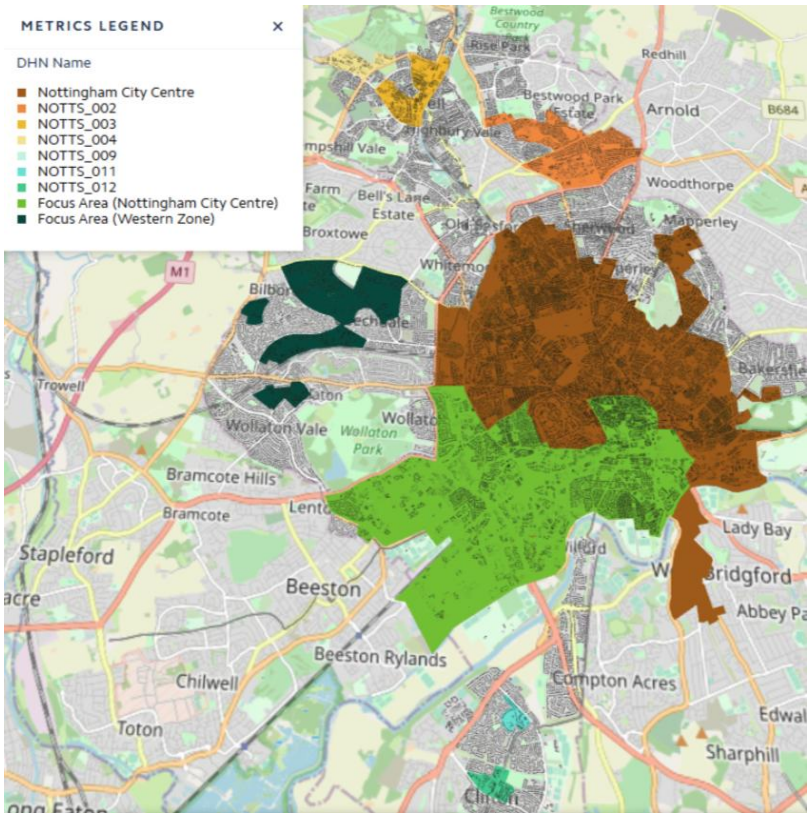
DHZ	MSOAs	Estimated Heat Network Load by 2050 (GWh)	Reduction in domestic ASHP installations	Reduction in non-domestic ASHP installations
City Centre	Lenton & Dunkirk City Centre & Trent Bridge Meadows Lenton Abbey, University & Wollaton Park	47	4,009	378
Western Zone	Bilborough North Beechdale Bilborough South Wollaton Vale	42	2,491	63
Total		89	6,500	441

Other areas are more likely to support smaller-scale communal heating systems, which could be investigated on a case-by-case basis.

IES produced visualisation of DHN, presenting all district heating zones within a single map view. Individual zones are interactive and can be selected to display high-level summary data. The visualisations include a set of interactive DHN scenes, including time-phased heat supply views, focus-zone analyses with MSOA-level aggregation, and a flexible Western Zone visualisation that can be viewed as a single area or disaggregated into component zones. See Figure 7.14 for visualisation of DHN zones.

Together, these visualisations provide a clear, flexible spatial overview of district heating networks, supporting exploration of network extent, focus areas, and phased heat supply development, and enabling consistent interpretation of results across stakeholders.

Figure 7.14: Nottingham DHN Zones Visualisation



The viability of district heating within the zones is further strengthened through major anchor loads and stakeholder engagement in supporting DHN. NHS facilities within Nottingham are currently delivering significant PSDS-funded heat decarbonisation projects, including transitions to low-temperature heat networks and large-scale heat pump installations. These investments substantially reduce gas demand in the medium term and may, over time, create opportunities for wider network connectivity. The University of Nottingham's net-zero ambitions are also recognised within the LAEP, although district heating integration remains at an exploratory stage.

Planning policy plays a critical enabling role in translating strategic potential into delivery. Nottingham's local planning framework already prioritises district heating connections for larger developments where commercially viable, creating a mechanism to secure future connections and reinforce network growth in priority areas. In this context, incremental expansion around existing pipework and generation assets is considered more realistic and lower risk than large, speculative network extensions.

IES developed a suite of interactive district heating network visualisations (as seen above) that provide a spatial overview of identified zones, incorporating MSOA-level aggregation, time-phased heat supply scenarios, and the ability to view zones either individually or in combination. Together, these tools support transparent interpretation of results, allow stakeholders to explore different deployment pathways, and provide a clear evidence base to support coordinated decision-making across the council and its partners.

7.3.4 Policy and Market Drivers

The forthcoming UK Heat Network Zoning (HNZ) Regulations[43], set for rollout in 2025 under the Energy Act 2023, will be a key catalyst for local heat network delivery across Nottingham. HNZ will define areas where heat networks represent the lowest-cost decarbonisation pathway, and within these zones certain building types, such as large public, commercial, and multi-residential developments, will be required or strongly encouraged to connect.

NCC's Local Plan Policy CC2 explicitly supports decentralised energy and heat networks, requiring new developments to consider connection to low-carbon and renewable energy sources.

For Nottingham, zoning provides clear spatial and policy signals about where networks are technically and economically viable. Embedding this framework allows the council to align heat-demand mapping, anchor-load identification, and spatial planning policy with designated zones. This integration helps to:

- Direct investment and development activity toward areas with strongest heat network potential
- Secure anchor connections from public-estate or regeneration sites
- De-risk private-sector investment by demonstrating long-term demand certainty
- Strengthen funding bids to programmes such as the GHNF.

Alongside the introduction of national consumer-protection and technical-performance standards, Heat Network Zoning will create a more stable and transparent market for heat network projects. By incorporating these policy mechanisms, Nottingham can ensure that heat networks are developed as part of a coordinated, place-based energy and planning strategy, supporting net-zero targets while enabling predictable, low-carbon heat for communities and businesses.

Heat Network Zoning was authorised to be implemented in the Energy Act 2023. The pilot programme was made to test and refine the zoning methodology, with lessons learnt being used to inform the development of Heat Network Zoning Policy.

7.3.5 Next Steps

Key policy instruments underpinning zoning have been delayed. The Heat Network consultation response and the Warm Homes Plan, originally expected in spring 2025, were postponed to Autumn 2025. Similarly, the National Modelling Maps, which will provide a standardised view of zoning potential across England, remain in draft, with official publication expected in early 2026. These delays have created uncertainty for local planning and hindered the ability to move from high-level opportunity identification to detailed zone design.

In the absence of national guidance, Nottingham's LEAP team can only incorporate zoning at a strategic level. Current work focuses on replicating the zones identified in the Opportunities Report and shortlisted by the Council. The LEAP's digital twin can show the areas and the aggregating heat demand. However, detailed building-level zoning and mandatory connection planning cannot proceed until regulations and data standards are finalized.

To fully realise this opportunity, coordinated action will be essential across stakeholders. Key priorities include supporting zoning implementation, securing anchor load commitments, and aligning local planning and development policies with heat network rollout. As networks expand, they are expected to become a cornerstone of sustainable infrastructure in Nottingham City,

[43] Heat network zoning - GOV.UK

enabling future connections and integration of additional renewable and low-carbon technologies.

8 Industrial Decarbonisation

This section examines the current industrial process loads across the city and models the expected changes in energy sources required to achieve full decarbonisation. Data from Cadent Gas has been used to map existing process loads. The analysis assumes that most low-temperature process loads will transition to electrification, while the majority of high-temperature process loads will require a shift to hydrogen.

8.1 Methodology

To analyse the industrial process loads currently operating in Nottingham, data from Cadent gas was obtained. This provided information on the gas consumption of each connection to the gas network from a non-domestic building.

The primary use of each connection was determined from their SIC code, which is an internal numbering system used by Cadent gas to assign the use of each commercial and industrial connection. A description of the primary uses matched to each code was also provided by Cadent to facilitate this process. Each industrial SIC code primary use that was present in Nottingham was then assigned as either low temperature, or high temperature, based on information gathered directly from stakeholders or site owners during one-on-one engagements with high energy users or industrial operators. Where such stakeholder input was unavailable, we made an informed assessment of the degree of heat required for the majority of process loads for that specific industry.

From the above process, the existing low and high temperature process loads throughout the City could be modelled and mapped at MSOA. These were then used to calculate the projected requirements for additional electricity and hydrogen demand, required to decarbonise low temperature and high temperature process loads respectively, through phasing out industrial fossil fuel use.

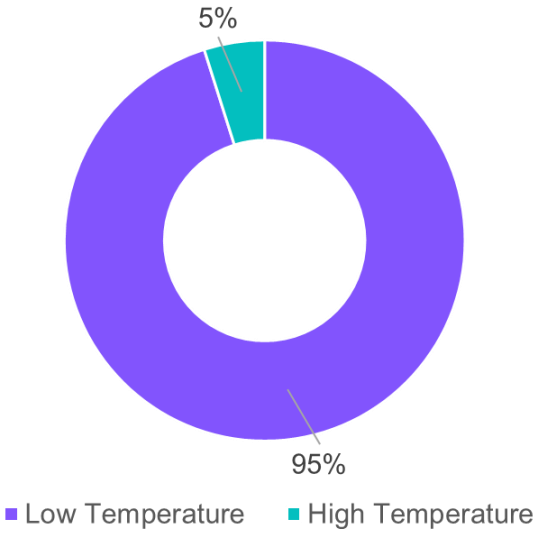
8.2 Overview of Key Industrial Sectors

Nottingham's industrial base includes sectors with significant heat requirements, which could drive future hydrogen demand. The food and drink manufacturing sector is one of the largest in the region, employing around 17,750 people and forming part of the UK's biggest manufacturing industry.

The city is recognised for its Creative and Digital industries and Life Sciences, supported by strong university research and innovation hubs. These sectors are complemented by a well-established financial and business services presence and a vibrant visitor economy. Advanced manufacturing also plays a significant role, with recent investments such as Davenham Switchgear's new 100,000 ft² global manufacturing site at Fairham Business Park, which will create over 100 jobs and strengthen Nottingham's position in high-value engineering and technology supply chains. Logistics and distribution remain important due to Nottingham's strategic location in the East Midlands, supporting e-commerce and supply chain operations.

8.3 Existing System

Figure 8.1: Breakdown of Process Loads by Energy Demand



Source: Mott MacDonald Analysis of Cadent Gas Data

Figure 8.1 above illustrates the current natural gas consumption for industrial process loads in Nottingham, segmented into low-temperature and high-temperature categories. Notably, low-temperature processes dominate, accounting for 95 % of total industrial gas use, while high-temperature processes make up the remaining 5%.

An aggregated summary of the top non-domestic gas-consuming sites, including annual consumption and associated carbon emissions, is provided in Appendix F.

Given this context, the path to decarbonisation must be tailored to the nature of the thermal demand. High-temperature processes, due to their intensity and technical requirements, are less amenable to electrification and will likely require low-carbon hydrogen as a viable alternative. In contrast, low-temperature processes, which generally involve heating below 100 degrees Celsius are more suitable for electrification, especially with the increasing availability of renewable electricity. This distinction is crucial for developing targeted strategies to reduce industrial emissions in Nottingham.

8.4 Decarbonisation Requirements

To model the projected changes in energy consumption and the associated carbon emissions for industrial process loads, the analysis assumes that all low-temperature process loads will transition to electrification, while all high-temperature process loads will convert to hydrogen. It is important to note that the low-temperature category includes certain industries that do not currently have cost effective technology available on the market to electrify but likely will within the next ten years or so. The high-temperature category generally refers to processes requiring heat in the range higher than 150°C.

Year	Hydrogen		Electricity	
	2050 Scenario		2050 Scenario	
	Annual % conversion	Annual conversion	Annual % conversion	Annual conversion
2025	0%	-	0%	-
2026	0%	-	1%	4,815
2027	0%	-	1%	4,815
2028	0%	-	2%	9,631
2029	0%	-	2%	9,630
2030	0%	-	4%	19,261
2031	2%	494	6%	28,891
2032	2%	494	6%	28,892
2033	2%	495	6%	28,891
2034	4%	988	8%	38,522
2035	4%	989	8%	38,521
2036	4%	988	8%	38,522
2037	8%	1,977	8%	38,522
2038	8%	1,977	8%	38,521
2039	8%	1,977	8%	38,522
2040	8%	1,977	4%	19,261
2041	8%	1,977	4%	19,261
2042	8%	1,977	4%	19,261
2043	8%	1,976	4%	19,260
2044	6%	1,483	2%	9,631
2045	6%	1,483	2%	9,630
2046	6%	1,483	2%	9,631
2047	4%	988	2%	9,630
2048	4%	988	0%	-
2049	0%	-	0%	-
2050	0%	-	0%	-

Figure 8.2: Electricity and Hydrogen Uptake Rates

A profile to project the rate of uptake of fuel switching for process loads was developed using the projections in the UK Government's 7th Carbon Budget, scaled down appropriately to Nottingham. This profile included a reduction in the total energy required for process loads due to energy efficiency, of around 6%. Efficiency improvements of electrical systems compared to fossil fuel boilers were also included in the consumption projections for low temperature loads.

The industrial decarbonisation projection from the 7th Carbon Budget included contributions from Carbon Capture and Storage. However, this technology was ruled out for Nottingham, as it is generally only suitable for extremely large industrial sites of national level importance infrastructurally. Based on the data available, there did not appear to be any suitable sites within the city.

Figure 8.3: Process Load Energy Consumption Projection

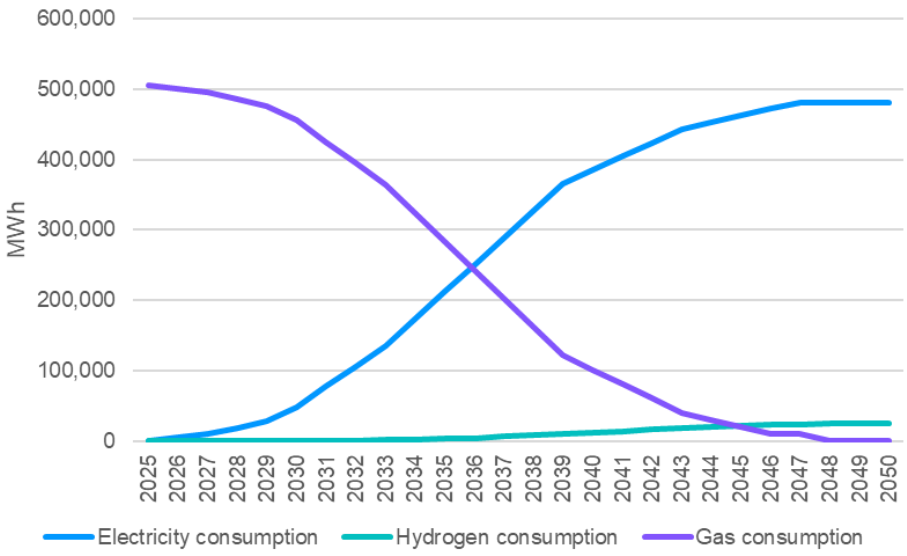


Figure 8.3 above shows the projected consumption of gas, electricity and hydrogen for process loads. This follows the previously outlined assumptions. The ratio of hydrogen consumption to

electricity consumption in 2050 is higher than the current ratio of high temperature to low temperature process loads, due to the system efficiency improvements when electrifying burners and other processes that previously combusted fuel.

Table 8.1: Summary of Process Load Emission Post Fuel Switch

Gas Consumption for Process Use (MWh)	Current Process Load Emissions (tCO2e)	Electrical Emissions Post Fuel Switch (tCO2e)	Hydrogen Emissions Post Fuel Switch (tCO2e)	Total Process Load Emissions Post Fuel Switch (tCO2e)	Emissions Reduction (%)
506,233	92,590	3,371	1,779	5,150	94%

Figure 8.4: Process Load Emissions

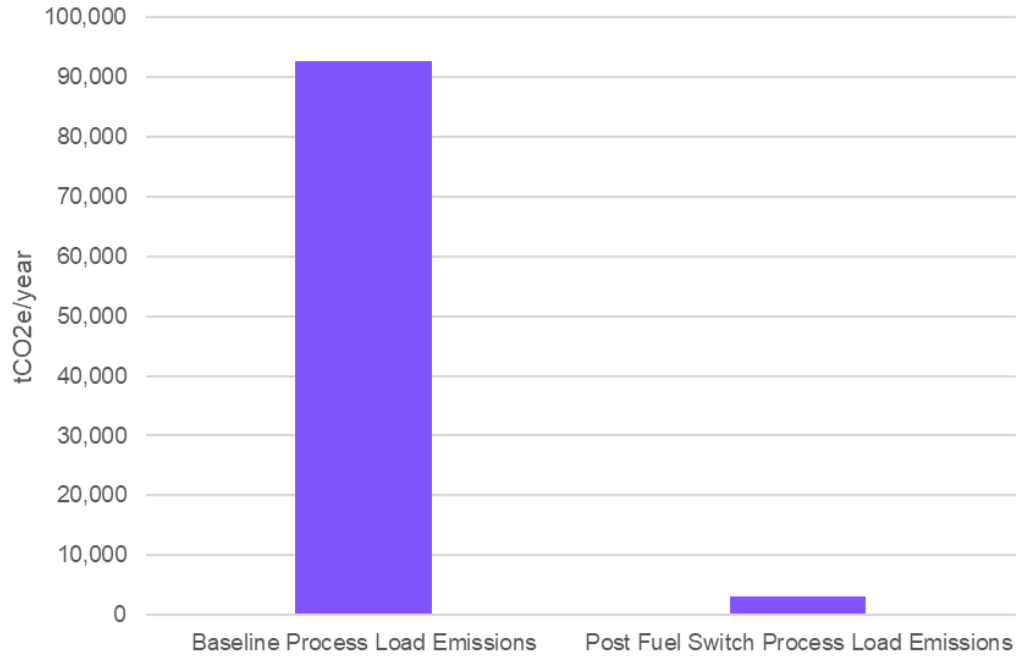
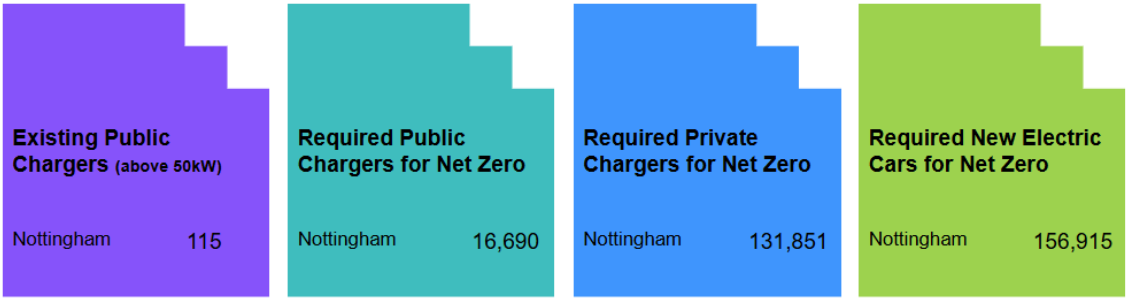


Figure 8.4 provides a breakdown of carbon emissions from process loads after the removal of fossil fuels, showing the respective contributions of electricity and hydrogen consumption. Electrifying process loads wherever feasible is essential because electricity generally has a lower carbon intensity than green hydrogen.

To ensure a structured and timely transition, all industrial companies in Nottingham should develop comprehensive decarbonisation plans. These plans should clearly specify when each fossil-fuel-based process will be phased out and identify which alternative energy source, electricity or hydrogen, will replace it. Such planning is critical for achieving cost-effective, reliable, and sustainable industrial decarbonisation.

9 Electrification of Private Transport

This section outlines the current state of transport emissions in Nottingham and the role electrified transport plays in reducing these. This section details the interventions modelled in the net-zero aligned scenarios to achieve decarbonisation of private vehicles.



9.1 Existing System

Transportation accounted for 33% of Nottingham's emissions[1] in 2023, so supporting the decarbonisation of this sector is crucial to enable net zero achievement.

The scope of this LAEP (set out in Section 1.3) does not include transport planning, therefore this chapter focuses on the uptake of private electric vehicles only, as a key part of the transport sector decarbonisation challenge.

As of Q2 2025, the total number of licenced vehicles in Nottingham is 122,200[2], 95% of which are petrol or diesel internal combustion engine (ICE) vehicles. Of these vehicles, 79% were privately-owned cars. The number of licensed vehicles is expected to remain similar to current day volumes. Despite population growth increasing the total number of people who could have a vehicle, it is expected that future modal shifts will reduce the likelihood that an individual will own a vehicle, resulting in no material net change in overall volume.

Electric Vehicles (EVs) produce zero tailpipe emissions, which contributes to improved local air quality by not contributing to the levels of nitrogen oxides and particulate matter typically emitted by internal combustion engine vehicles. Therefore, expanding the current proportion of EVs to beyond its current value of less than 5% is key to reducing the emissions from private transport.

9.2 Local Context

As of October 2025 are 318 publicly available chargepoints in Nottingham, with just over a third (115 units) being rapid[44] chargepoints.[45] This equates to 96.8 public chargepoints per 100,000 people in Nottingham, higher than the East Midlands average of 78.2, but lower than the England average of 129.8 chargepoints per 100,000. However, the number of rapid chargepoints per 100,000 people in Nottingham is 35.0 which is higher than both the East Midlands and England averages of 27.7 and 25.1, showing good progress has been made on these.

[44] A rapid chargepoint delivers high-power DC charging, typically between 50-149 kW, allowing most EVs to recharge to 80% in about 20-40 minutes.

[45] Electric vehicle public charging infrastructure statistics: October 2025 - GOV.UK

Nottingham City Council has an operational partnership alongside the rest of the D2N2 region with BP pulse to cover costs not supported by central government grants, with over 700 chargepoints installed across the region so far.

Using the governments Transforming Cities Fund, Nottingham City Council has distributed more than half a million pounds to businesses to add cycling or electric vehicle infrastructure. The council fleet has also been undergoing the transition to EVs rapidly over the past 4 years, now reaching 42% electric vehicles including street sweepers, bin lorries, and school mini busses. Forty-five of the city's taxis have also transitioned to electric vehicles, helped by a council vehicle borrowing scheme and specific hackney cab chargepoints. Alongside a V2G demonstrator started in 2023, the city has demonstrated several successful schemes to increase EV ownership.

Alongside low access to public chargepoints, another barrier to EV adoption is practicality of private charging, specifically if a household only has access to on street parking. 93% of current EV owners in the East Midlands have off street parking, whereas only 68% of all East Midlands households have this access to easier private charging.[4] This means a considerable amount of work will be necessary to enable cross pavement charging or other solutions, to encourage all households to adopt EVs.

According to Midlands Connect the Midlands could have over 2 million electric vehicles (EVs) on the roads by 2030, with 32.5% of all vehicles expected to be electric. To support this growth, 58,997 new public EV charging points will need to be installed across the region by the end of the decade. This translates to 27 new charging points per day, 194 per week, and 9,832 each year until 2030.

9.3 Do Nothing

The Do Nothing scenario represents the best estimate of outcomes before the LAEP is implemented. In terms of modal shift (people switching to more sustainable modes of travel), this scenario assumes uptake is influenced solely by current mandated policies. As of 2025, these policies in the UK include the ban on the sale of new internal combustion engine (ICE) vehicles from 2030, as well as the Zero Emission Vehicle (ZEV) mandate, which requires vehicle manufacturers to sell an increasing proportion of zero-emission vehicles each year[46].

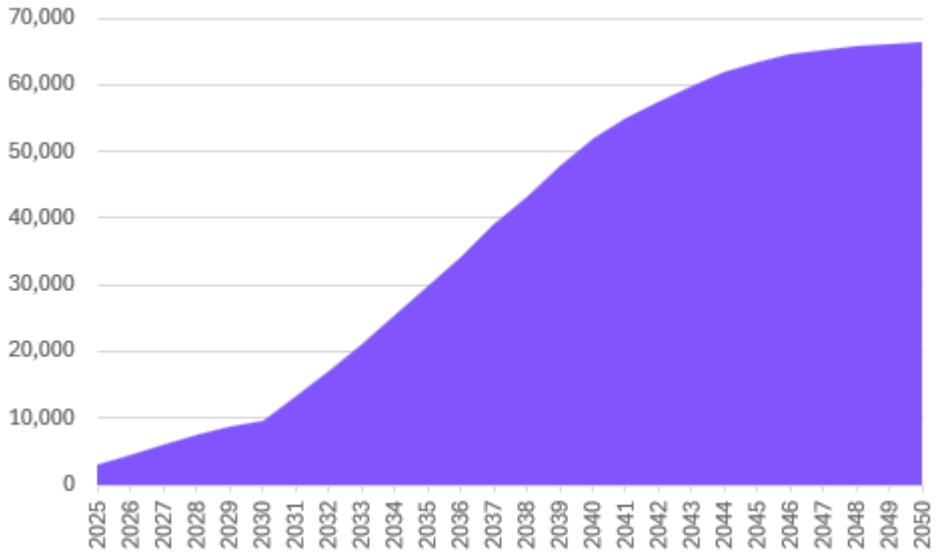
Whilst these existing policies would lead to the continued growth in trends of EV ownership, the insufficient charging infrastructure and lacking policy support would lead to limited progress towards decarbonisation. This highlights a significant scale of action would be required to shift the region away from reliance on petrol and diesel vehicles.

To evaluate this scale of intervention required, Midlands Connect conducted modelling to examine a business-as-usual scenario (BAU) through to 2050, as illustrated below.[47]

[46] Phasing out sales of new petrol and diesel cars from 2030 and supporting the ZEV transition - GOV.UK

[47] STB EV Charging Infrastructure Visualiser

Figure 9.1:Do Nothing EV Uptake Scenario



Source: Mott MacDonald analysis based on Midlands Connect Business-as-Usual and Accelerated EV uptake projections

The Do Nothing estimates that 45,913 electric vehicles will be adopted by 2050 in Nottingham, representing 27% of currently licensed vehicles. Demonstrating that under existing policy conditions, the region is likely to fall considerably short of transitioning its entire vehicle fleet to zero-emission alternatives.

The Midlands Connect BAU scenario reflects projections based on current government policies that are confirmed and funded, as well as exogenous factors influencing adoption rates. This scenario anticipates that growth in the electric vehicle market will largely be shaped by factors such as national legislation and the natural turnover of the vehicle fleet. As this BAU scenario aligns with the criteria of the Do-nothing scenario within this LAEP, it has been adopted as the modelled Do-nothing scenario.

For this LAEP, net zero is a requirement under different timescales, and this will mean an EV uptake in line with net zero targets. Therefore, to represent this, separate modelling was undertaken to forecast EV uptake in Nottingham by 2040 and 2050, in line with the Climate Change Committee's Seventh Carbon Budget.

9.4 Modelling Methodology

The modelling approach drew on 2021 ONS population data for Nottingham's MSOAs to determine the existing number of cars per area using a cars per capita assumption derived from midlands data.[48] By apportioning this national projection according to the region's population, the analysis provides locally specific estimates of EV uptake.

The uptake trends were modelled using the Climate Change Committees seventh carbon budget[49]. The CCC pathway is slightly more ambitious than the EV mandate, citing reductions in EV costs as making this achievable. This pathway results in 97.5% of cars being battery electric

[48] Middle layer Super Output Area population estimates (supporting information) - Office for National Statistics

[49] https://www.theccc.org.uk/wp-content/uploads/2025/02/The-Seventh-Carbon-Budget.pdf

by 2050. A large portion of the remaining cars are covered by other zero emission vehicle types including hydrogen fuel cell and biofuels. The remainder covers 1% of current transport emissions (made up of antique cars and 15-year-old ICE cars still in operation in 2050) and is covered by nationally engineered removals like carbon capture.

To estimate the number of public EV chargers needed, a ratio of public chargers to EVs was taken from Midlands Connect 'Supercharging the Midlands' report[50] which cites 1-in-10, suitable for the urban make up of Nottingham. As chargers are seen as a necessary precursor to mass EV adoption, the uptake curve of public chargers matches the uptake in EVs. Keeping the pace of charging infrastructure roll-out in line with growth in EVs is fundamental to growing public confidence in the viability of EV ownership and therefore achieving the emissions reductions required in private transport.

Similarly, private charger projections were derived using the EV uptake and an EV to private charger ratio based on Zapmap data and an assumption that development in cross pavement charging will enable the percentage of private charger installations to remain the same at 79%, even as uptake spreads further beyond households with off-street parking. Further details of the assumptions used within the modelling are detailed in Appendix D.

For the 2040 scenario (2040), the same uptake curve has been used accelerating from 2032, reaching the same final total volume as the 2050 scenario, ten years earlier. The total abated emissions differ from the 2050 scenario due to the changing grid emission intensity factor, across the transition timeline.

For the Do Nothing scenario (DN) the uptake curve has utilised the Midlands Connect BAU data. The annual percentage vehicle uptake in BAU compared to their accelerated uptake, is applied to our 2050 scenario uptake. For example, for the year 2050 the BAU scenario only has 40% of the volume of EVs in the accelerated uptake scenario, thus a factor of 40% is applied to the 2050 volume of EVs in our 2050 scenario to obtain the Do Nothing 2050 uptake value.

9.5 Results

Required EV uptake for Nottingham is 166,900. These uptakes represent a significant proportion of the region's current fleet of vehicles, with the 2040 scenario requiring over 82% of the current fleet of vehicles to be replaced by 2035, and 59% in the 2050 scenario. To provide a sense of scale a quick calculation based on SMMT[51] and government[52] data shows that there are nearly 2 million cars registered a year and ~34 million cars licensed, resulting in an expected renewal rate to 2035 of 57% of the total car fleet. As this uptake will take place before the ban of the sale of new ICE vehicles, it will require significant additional coordinated policy interventions, incentives, and investment in supporting infrastructure to reduce the amount of fossil-fuel lock-in during this period.

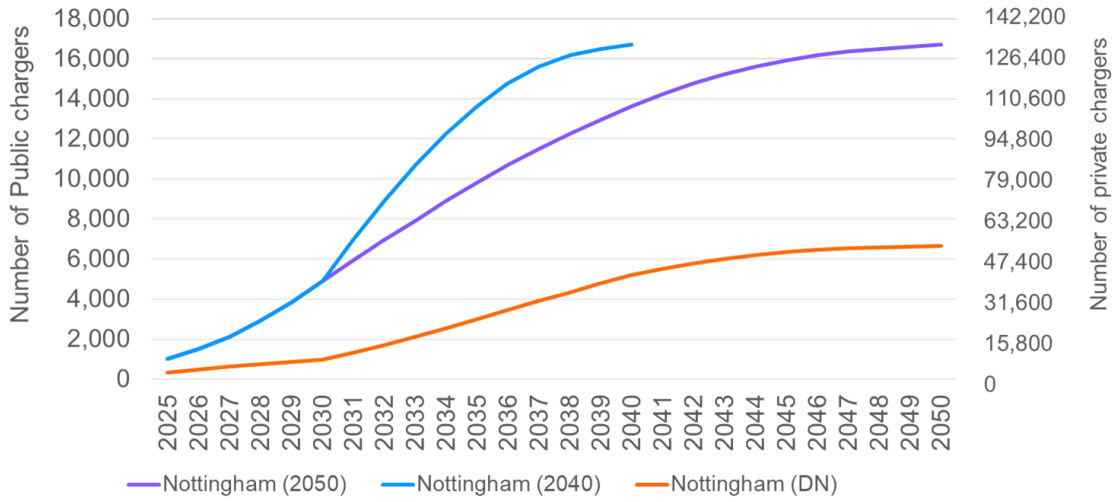
Figures 9.2 shows the number of public and private EV chargers required in Nottingham under the modelled scenarios to support EV uptake.

[50] https://www.midlandsconnect.uk/media/i1spcsr1/mc-supercharging-the-midlands-document.pdf

[51] 2024 (Full Year) Britain: New Car Market Overview and Analysis - Car Sales Statistics

[52] Vehicle licensing statistics, United Kingdom: 2024 - GOV.UK

Figure 9.2: Required Number of Public and Private Chargers



As described in Section 9.4, this figure was derived from the 2025 ratio of EVs to private chargers, with the assumption that this proportion remains constant through to 2050. This reflects the expectation that many EV owners will prefer to have access to their own charger to ensure reliable charging.[53]

Alongside private chargers, public chargers play an important role in ensuring that charging points are accessible to all road users and giving drivers confidence in undertaking longer journeys. The LAEP pathway highlights that the rollout of public charging infrastructure must keep pace with the uptake of electric vehicles

A total of 131,851 private and 16,690 public chargers were modelled for Nottingham to support the EV uptake for the 2040 and 2050 scenarios. This indicates a vast and comprehensive charging infrastructure would be required, with a broad distribution of chargers throughout the region to meet necessary charging needs. Charging points should be placed across the region so that they are accessible within a short distance, with placement decisions based on anticipated demand.

9.6 Impacts

9.6.1 Grid Impact of EV Infrastructure

Nottingham will require more electricity to power these new EVs. It is key to determine which areas should take prioritisation when selecting the areas for continued EV charge point growth. Areas with high population densities, large coverage of flats and terraced housing, correlating with low percentages of off-street parking should take priority.

It will be crucial to work collaboratively and openly with the local Grid to ensure the region's grid is equipped to incorporate the extra demand increase EV use will bring, as well as the opportunities in Vehicle-to-Grid electricity storage flexibility. Please refer to Section 11 to find more information regarding impacts to the grid infrastructure.

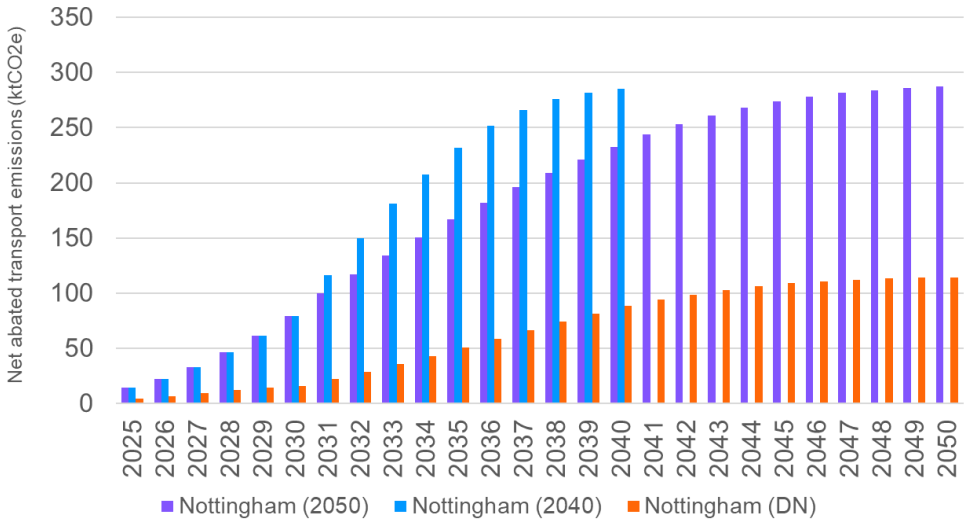
9.6.2 Carbon Impact of EV Infrastructure

Figure 9.3 illustrates the net abated carbon emissions resulting from the transition away from ICE vehicles across both scenarios. It presents the total carbon savings achieved through this

[53] Electric vehicle (EV) driver behaviours and attitudes tracker - GOV.UK

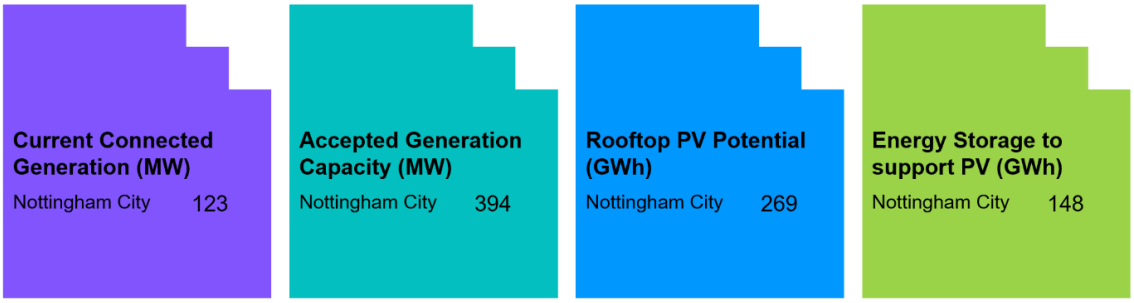
transition factoring in both reduced ICE emissions and a change in emissions from electricity usage.

Figure 9.3: Total Abated Emissions from the transition away from Internal Combustion Engines ($ktCO_2e$/year)



The data shows the abated emissions from the region's vehicle fleet, influenced by two main factors: increased use of EVs and the ongoing decarbonisation of the electricity grid. In the 2040 and 2050 scenarios the final average emissions per vehicle are expected to be 59 and 46 $kgCO_2$/year, respectively, down from 1,641 $kgCO_2$/year in 2025 (the larger value in 2040 for the 2040 scenario is accounted to a higher average grid intensity factor than in 2050).

10 Local Generation



This section outlines the opportunity to deploy local generation to support the net zero scenarios for Nottingham City. Overall, the generation considered in the LAEP is that likely to have local impacts, such as behind-the-meter solar PV and community energy schemes where the output is consumed locally. Utility-scale generation, which contributes to overall electricity grid decarbonisation is not considered within this LAEP.

10.1 Existing System

While electricity demand in Nottingham is primarily met through the UK national electricity grid, heat demand is largely supplied by the national gas grid. According to the Non-Gas Map, approximately 25% of properties across the city are off the gas grid, relying instead on alternative heating sources such as oil, LPG, or electricity.[54]

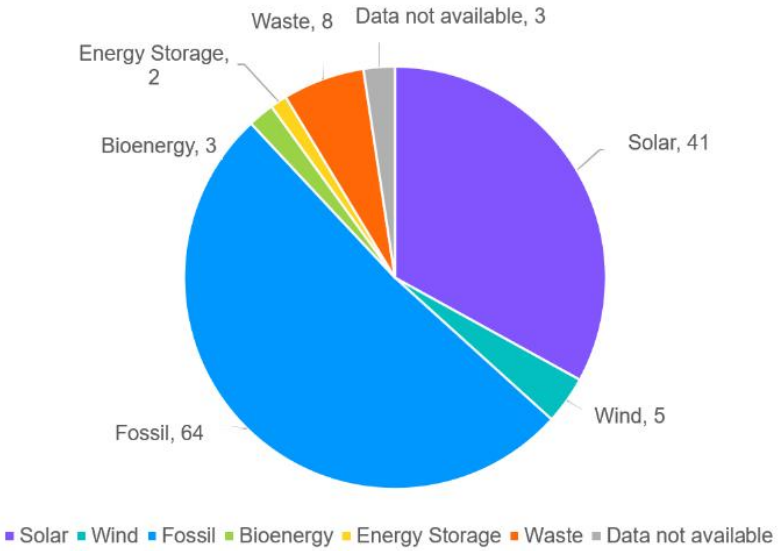
Figure 10.1 shows the current split of connected generation types in Nottingham. According to the National Grid's embedded capacity register, the city has 123 MW of total generation capacity. Fossil fuels, specifically natural gas, still account for the majority, with 64 MW. Although natural gas is cleaner than other fossil fuel options, Nottingham's reliance on it highlights the need for further progress to meet local decarbonisation goals.

Solar PV is the second most abundant generation type, with 41 MW of capacity. Given the city's dense urban landscape, this is likely dominated by rooftop installations rather than ground-mounted systems. Figure 10.2 breaks down the existing solar capacity per MSOA, identifying there is increased capacity in the city centre and Bulwell.

Representing roughly a third of Nottingham's total capacity, solar PV demonstrates that steps have already been taken to decarbonise electricity supply. However, further expansion will be essential, and roof-mounted solar is expected to remain the most practical option for the local grid.

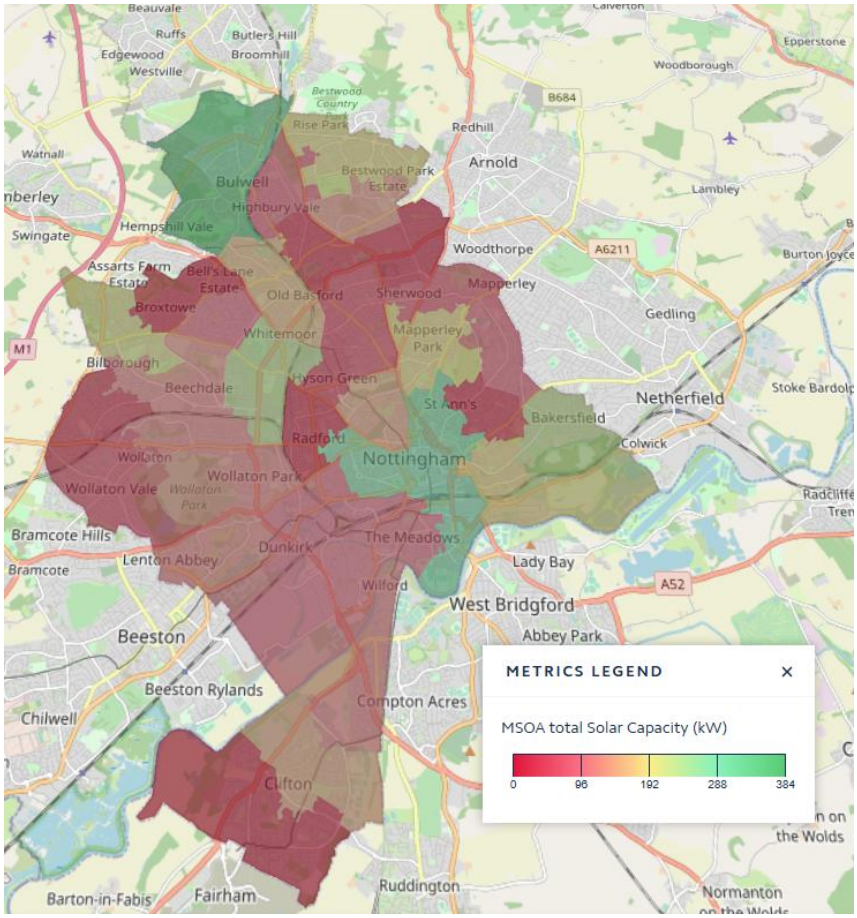
[54] Non-gas map

Figure 10.1: Current Connected Generation Capacity in Nottingham, MW



Source: National Grid - Embedded capacity register. Complete list of sites can be found in Appendix H.

Figure 10.2: Existing Solar Capacity in Nottingham, by MSOA (kW)



Source: IES Digital Twin

In recent years, Nottingham City Council has deployed rooftop solar across its commercial assets, including schools, leisure centres, and recreational facilities. While some sites are now fully utilised, others still offer scope for additional installations. The pace of rollout has largely depended on funding availability, underscoring the importance of sustained investment to unlock further capacity.

The primary focus has been on roof-mounted PV systems, although some ground-mounted installations have also been delivered, notably the 67kWp solar carport canopy installed at the Harvey Hadden Sports Village.[55]

While there is no statutory requirement for rooftop solar installation, uptake has been increasing, driven by falling costs, energy security concerns, and local authority support.

10.2 Do Nothing

The “Do Nothing” scenario assumes no additional local action beyond existing national legislation. Opportunities for large-scale distributed generation connected at the Grid Supply Point (GSP) level are excluded from this LAEP, as these assets contribute to national supply and are accounted for in carbon intensity factors.

As stated in Section 1, opportunities from large-scale distributed generation connected at the Grid Supply Point (GSP) level have been excluded from this LAEP analysis, as these assets contribute to national energy supply and their associated emissions are already captured within the carbon intensity factors used for electricity consumption. This LAEP focuses on distribution-connected and locally influenced generation, such as rooftop solar and community-scale renewables. A review of the National Grid Opportunity Map shows no major schemes with significant capacity contracted to connect in the near term.

10.3 Context

Future energy scenarios for Nottingham predict rising demand between 2022 and 2040, driven by population growth, housing expansion, and increased commercial and industrial activity. Meeting this demand will require significant expansion of local generation capacity across the region.

Table 10.1 presents Nottingham’s current connected generation capacity alongside the accepted capacity scheduled for future implementation. The data illustrates a significant shift towards renewable energy, with large additions of solar and energy storage projects planned. Notably, no fossil fuel capacity has been accepted, with the only other approved sources are water and waste. This trend suggests the potential phase-out of fossil fuel generation in the region.

Table 10.1: Connected and Accepted Generation Capacity in Nottingham

Energy Technology	Total Connected Capacity (MW)	Total Accepted Capacity (MW)
Solar	41	373
Wind	5	0
Water	0	2
Fossil	64	0
Bioenergy	3	0
Energy Storage	2	861
Waste	8	19

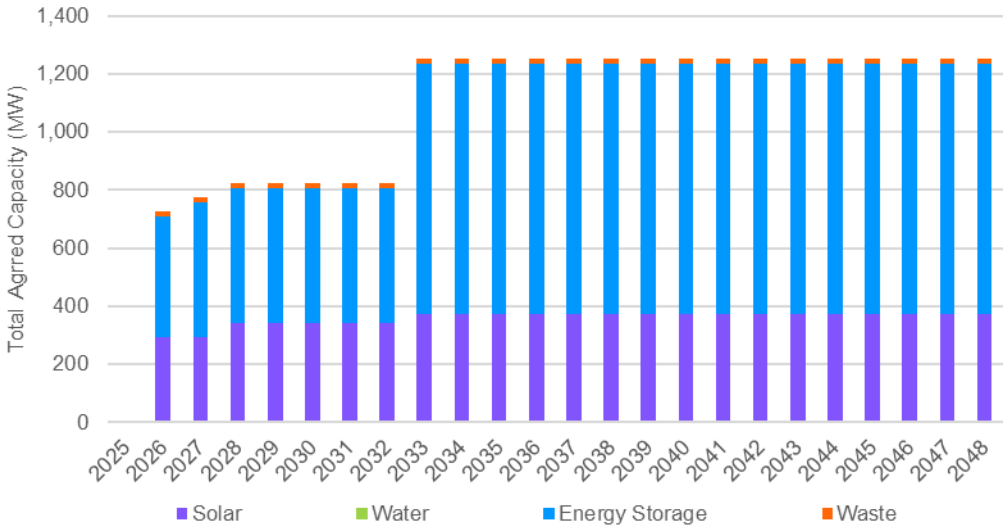
[55] Harvey Hadden Solar Carport Case Study | EvoEnergy

Energy Technology	Total Connected Capacity (MW)	Total Accepted Capacity (MW)
Data not available	3	0
Source: National Grid - Embedded capacity register		

Figure 10.3 illustrates the timeline of accepted capacity in Nottingham over the coming years. Notable projects include 291 MW of solar capacity expected in 2026, alongside major battery storage deployments of 412 MW in 2026 and 399 MW in 2033. These additions highlight the scale of investment planned to support the city's transition and ensure resilience in its future energy system.

While these figures indicate the potential scale of future investment, they should be interpreted with caution. Acceptances within the grid connection queue do not guarantee project delivery, as schemes must also progress through planning approval, financing, supply-chain constraints, and final investment decisions. In practice, a substantial proportion of projects within the connection queue do not ultimately materialise, meaning these capacities cannot be fully relied upon to be delivered as currently stated.

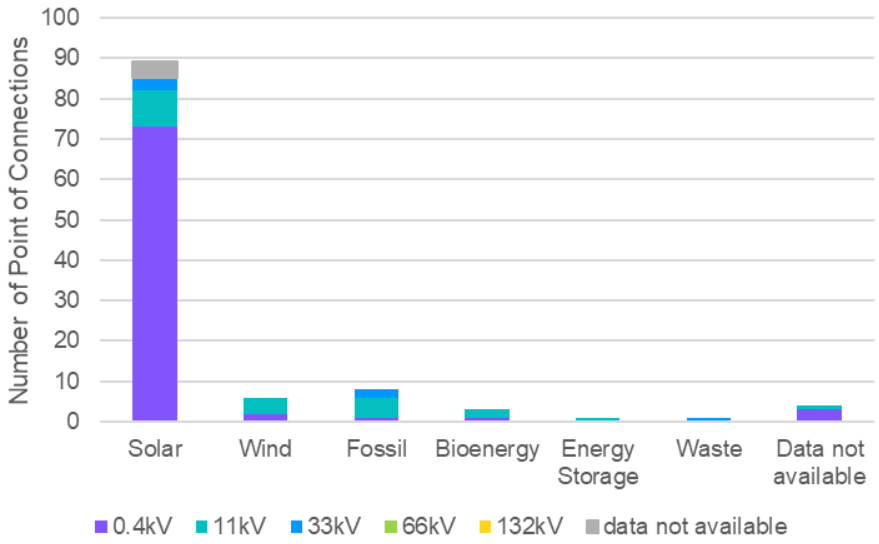
Figure 10.3: Timeline of Accepted Electrical Capacity (MW)



Source: National Grid - Embedded capacity register

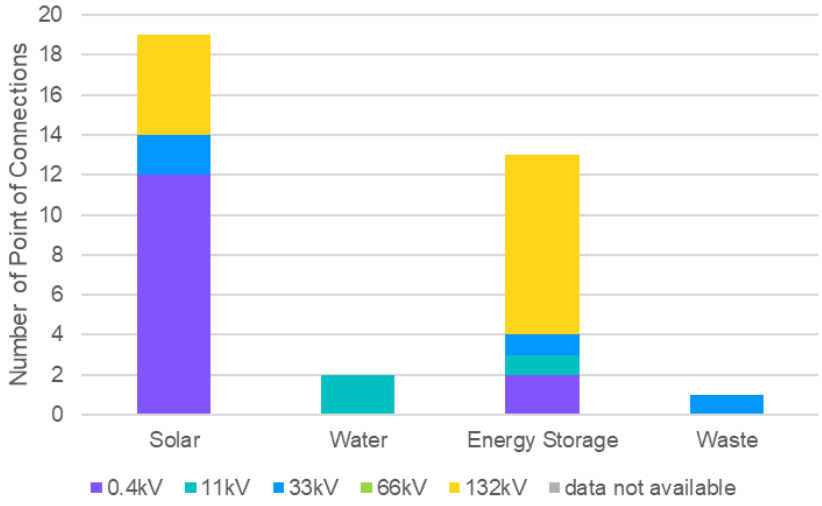
Examining voltage output provides insight into how future systems will interact with the electrical grid: low voltage (LV) connections feed into local distribution, medium voltage (MV) into regional networks, and high voltage (HV) into transmission. Figure 10.4 and Figure 10.5 display the number of connected and accepted generation sites by voltage output.

Figure 10.4: Number of Connected Generation Sites by Voltage Output



Source: National Grid - Embedded capacity register

Figure 10.5: Number of Accepted Generation Sites by Voltage Output



Source: National Grid - Embedded capacity register

Solar PV accounts for the largest number of connected generation points, with most of these connections at a lower voltage of 0.4 kV. These are typically smaller rooftop installations feeding into the local distribution network.

For accepted generation points, solar PV again represents the majority, though a significant share are at a higher voltage of 132 kV. Energy storage also shows a notable number of accepted connections, which are predominantly at 132 kV, indicating both of these are larger-scale installations supplying directly to transmission.[56]

Looking ahead, Nottingham must build on initiatives like this by significantly scaling up the deployment of local low-carbon energy solutions. By expanding rooftop solar PV across

[56] Agenda item - Harvey Hadden Sports Village solar PV project - Nottingham City Council

domestic and non-domestic sectors and integrating battery energy storage systems, Nottingham can accelerate the decarbonisation of their local energy systems, supporting both regional and national net zero targets.

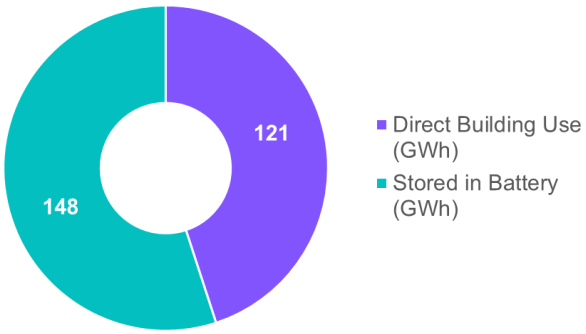
10.4 Intervention Methodology

The methodology applied in this model considered only the installation of solar PV on all south, south-east, and south-west facing rooftops across domestic and non-domestic properties without pre-existing panels. Based on these criteria, the maximum potential for rooftop solar installations across Nottingham was estimated at 268.9GWh per year, see Figure 10.6.[57]

However, to find where installations would be more feasible and cost effective, a suitability assessment was conducted using rooftop area and orientation data. It assumes optimal solar PV installation on 100% of feasible South, South-East, and South-West facing rooftops across domestic and non-domestic properties. Suitability was determined based on roof orientation, size, and shading constraints, with architectural features like hipped/gabled roofs, chimneys and skylights reducing viability.

Under these assumptions, rooftop PV could enable up to 181 GWh of generation from domestic properties and 88 GWh from non-domestic properties annually. Solar panel efficiency was modelled at 18%. Battery storage was estimated using a 45/55% split, 45% of generated electricity consumed on-site and 55% stored for later use. Ground-mounted solar was excluded due to limited suitable council-owned land.

Figure 10.6: Maximum Solar Potential Generation



10.5 Scenarios

Figure 10.7 illustrates the projected uptake of rooftop solar PV installations across domestic and non-domestic sectors for the 2040 and 2050 scenarios.

[57] Distribution Future Energy Scenarios (DFES) - Dataset - Connected Data Portal | National Grid

Figure 10.7: Rooftop PV Annual Uptake across Net Zero Scenarios

Domestic Solar PV				
Year	2050 Scenario		2040 Scenario	
	Annual % Uptake	Annual Generation (kWh)	Annual % Uptake	Annual Generation (kWh)
2025	0%	0	0%	0
2026	1%	1,805,046	1%	1,805,046
2027	2%	3,610,092	2%	3,610,092
2028	4%	7,220,183	4%	7,220,183
2029	9%	16,245,413	9%	16,245,413
2030	18%	32,490,826	18%	32,490,826
2031	25%	45,126,147	25%	45,126,147
2032	18%	32,490,826	18%	32,490,826
2033	13%	23,465,596	13%	23,465,596
2034	10%	18,050,459	10%	18,050,459
2035	0%	0	0%	0
2036	0%	0	0%	0
2037	0%	0	0%	0
2038	0%	0	0%	0
2039	0%	0	0%	0
2040	0%	0	0%	0
2041	0%	0		
2042	0%	0		
2043	0%	0		
2044	0%	0		
2045	0%	0		
2046	0%	0		
2047	0%	0		
2048	0%	0		
2049	0%	0		
2050	0%	0		

Non-Domestic Solar PV				
Year	2050 Scenario		2040 Scenario	
	Annual % Uptake	Annual Generation (kWh)	Annual % Uptake	Annual Generation (kWh)
2025	0%	0	0%	0
2026	1%	884,110	1%	884,110
2027	2%	1,768,220	2%	1,768,220
2028	4%	3,536,440	4%	3,536,440
2029	9%	7,956,990	9%	7,956,990
2030	18%	15,913,981	18%	15,913,981
2031	25%	22,102,751	25%	22,102,751
2032	18%	15,913,981	18%	15,913,981
2033	13%	11,493,430	13%	11,493,430
2034	10%	8,841,100	10%	8,841,100
2035	0%	0	0%	0
2036	0%	0	0%	0
2037	0%	0	0%	0
2038	0%	0	0%	0
2039	0%	0	0%	0
2040	0%	0	0%	0
2041	0%	0		
2042	0%	0		
2043	0%	0		
2044	0%	0		
2045	0%	0		
2046	0%	0		
2047	0%	0		
2048	0%	0		
2049	0%	0		
2050	0%	0		

Reflecting outcomes from stakeholder engagement, the uptake curves are shaped to reflect the optimal timing for carbon savings from rooftop PV installations. Where uptake rates are based on CCC projections, with the majority of installations occurring before grid decarbonisation.[58] Since the carbon intensity of the electricity grid is expected to decline significantly by 2035, the greatest carbon benefit from rooftop PV occurs when installations happen before full grid decarbonisation. Beyond this point, the marginal carbon savings from additional rooftop PV diminish. Therefore, the uptake is projected to be fully realised by 2035 and 2040 for the 2040 and 2050 scenarios, aligning with the UK's anticipated grid decarbonisation and maximising the carbon reduction potential of rooftop solar generation.

Nonetheless, local expansion of embedded generation and grid capacity can continue to bring system-level benefits, but it does not automatically increase available network capacity and in many cases requires targeted network reinforcement to accommodate new connections and altered power flows. Peak demand periods will still require the electricity network to respond to consumer demand, particularly as electrification of space heating and EV charging accelerates. When coordinated with appropriate reinforcement, local storage, and smart controls, embedded generation can enhance demand-side response resilience and help manage peaks more effectively.

Energy generation schemes should be prioritised in locations where there is existing capacity on the electricity network, with early engagement undertaken to confirm constraints and connection requirements. Where significant network reinforcement is required, the associated costs and

[58] A reliable, secure and decarbonised power system by 2035 is possible – but not at this pace of delivery - Climate Change Committee

delivery timescales should be identified at an early stage and incorporated into project planning and milestones.

Recent market analysis indicate that the cost of solar PV panels and battery storage systems continues to decline, driven by technological innovation, economies of scale, and supportive policy frameworks. For example, capital expenditure for battery energy storage in the UK has fallen by approximately 30% since 2022, with further reductions expected over the next five years. Global forecasts suggest battery storage costs could drop by up to 40% by 2030,[59] making solar-plus-storage systems increasingly competitive with conventional energy sources.

In the context of this LAEP modelling, these cost trends support the assumption that solar PV and battery systems may become cost-effective for a majority of households within the next 5–7 years. This assumption directly influences the uptake trajectory in net zero scenarios, where widespread adoption is essential to meet carbon reduction targets.

The affordability of solar PV and battery storage technologies is a key enabler for achieving Nottingham's net zero ambitions, particularly within the residential sector. However, there is currently no direct funding available from the UK Government for domestic solar PV installations. This presents a significant barrier to uptake, not only for fuel-poor households, but also for middle-income families who may struggle with the upfront capital costs. Without financial support, the pace of adoption required to meet local and national carbon reduction targets may be hindered.

To address this, there is scope to encourage more widespread adoption through community-owned renewable schemes. These initiatives allow groups of homeowners and landlords to collectively purchase solar PV systems for their street or neighbourhood, reducing costs through economies of scale. Such schemes have the potential to lower upfront costs and energy bills for residents, while also fostering local engagement and ownership of the energy transition.

There is scope to encourage more widespread adoption of solar PV in the short term through two distinct approaches. First, community-owned renewable energy schemes can enable groups of residents to collectively own and benefit from shared solar PV installations (for example, through cooperatives or community energy organisations). These models can be particularly valuable where shared ownership and long-term community benefit are a priority. Second, group purchasing or bulk-buy schemes can be used to support homeowners and landlords to install rooftop solar PV by coordinating joint procurement at street or neighbourhood scale. These schemes do not involve shared ownership of the assets, but can reduce costs through economies of scale and help lower upfront investment and energy bills for participants.

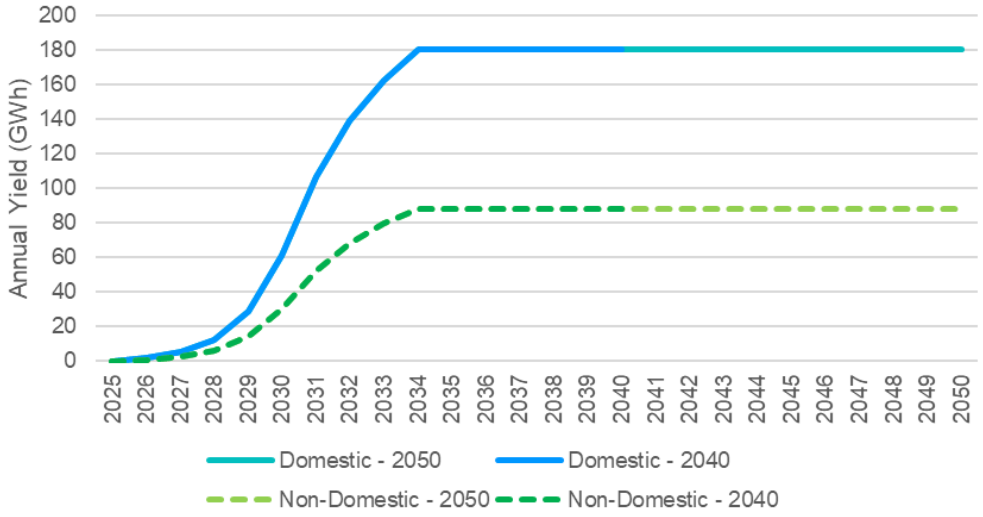
10.6 Results

Figure 10.8 below presents the projected annual solar PV yield for the domestic and non-domestic sectors in Nottingham. The domestic sector is expected to generate over 181 GWh per year, while the non-domestic sector is projected to produce approximately 88 GWh annually. Combined, these sectors could deliver more than 266 GWh of renewable electricity each year, representing a substantial contribution to the local energy supply in Nottingham.

This level of generation would significantly reduce reliance on grid-supplied electricity, helping to lower carbon emissions and support the districts' transition to net zero. The increased availability of locally generated renewable energy enhances energy resilience by reducing exposure to national energy price fluctuations and supply disruptions. Additionally, the deployment of solar PV systems across domestic and commercial properties can stimulate local economic activity through job creation in installation and maintenance.

[59] Outlook for battery demand and supply – Batteries and Secure Energy Transitions – Analysis - IEA

Figure 10.8: Rooftop solar annual yield projections in Nottingham



11 Networks, Storage and Flexibility

This chapter explores the current state of the network, planned infrastructure upgrades, impact of LCTs on the local network planning in Nottingham. The associated shift to electric vehicles and heat pumps means the capacity and resilience of the local electricity network must evolve rapidly to meet future needs.

11.1 Existing Network Constraints

Nottingham City's electricity distribution is operated by National Grid Electricity Distribution (NGED) as part of its East Midlands licence area. NGED is the DNO responsible for maintaining and operating the local electricity network.

The local distribution grid connects to the National Grid Transmission System via Grid Supply Points (GSPs), which step down voltage from 400 kV/275 kV to 132 kV. From these GSPs, Bulk Supply Points (BSPs) (typically 132/33 kV) feed primary substations (usually 33 kV/11 kV), which then distribute electricity to homes, businesses, and industrial users across Nottingham and surrounding areas.

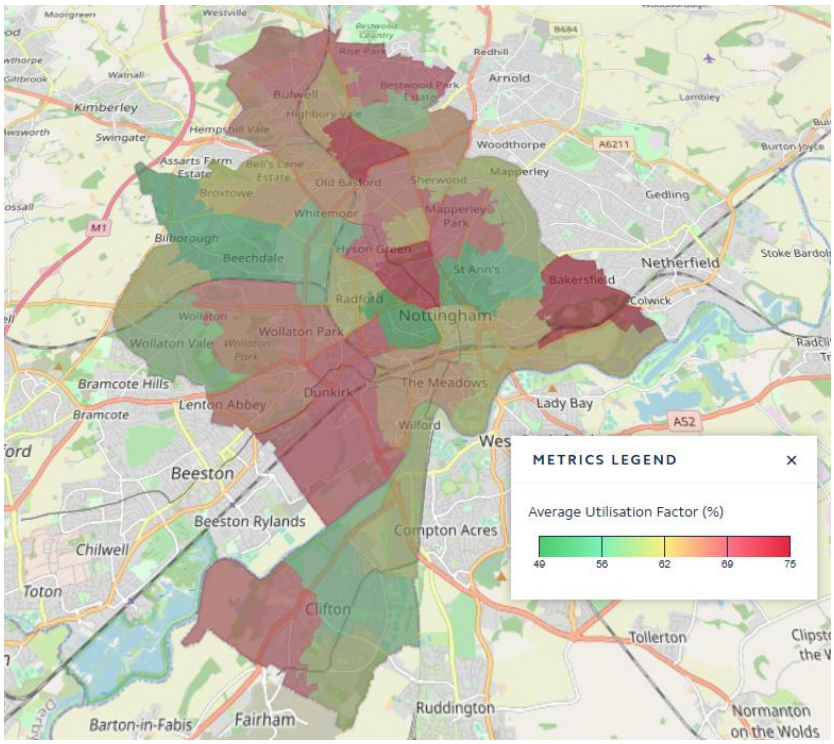
The East Midlands licence area has 14 GSPs, of which the following are most relevant to Nottingham and its hinterland:

- Stoke Bardolph GSP: Located east of Nottingham, this is a key node serving the city and surrounding areas.
- Ratcliffe GSP: Associated with the Ratcliffe-on-Soar power station site, providing resilience and capacity for Nottingham and the wider region.

These GSPs are critical nodes in the regional network and are referenced in NGED's DFES for planning reinforcement and flexibility interventions. Nottingham's DFES projections anticipate significant growth in low-carbon technologies such as electric vehicles, heat pumps, and distributed generation, requiring targeted upgrades and flexibility services to meet Net Zero targets.

The LAEP provides a spatially and temporally explicit view of future growth of LCTs, which can directly inform the DFES and emerging Regional Energy Strategic Plans (RESPs). By translating local decarbonisation ambitions into quantified demand and generation projections, the LAEP supports proactive network reinforcement and investment, reducing the risk of connection delays and inefficient, reactive upgrades. Integrating LAEP data into the DFES will help identify areas where network reinforcement is required and support the delivery of LAEP-identified LCTs. For near-term projects (within the next five years), the DSO can facilitate connection clinics with the DNO to identify locations where LCTs can be connected within existing network capacity and technical constraints.

Figure 11.1: Average Utilisation Factor (%)



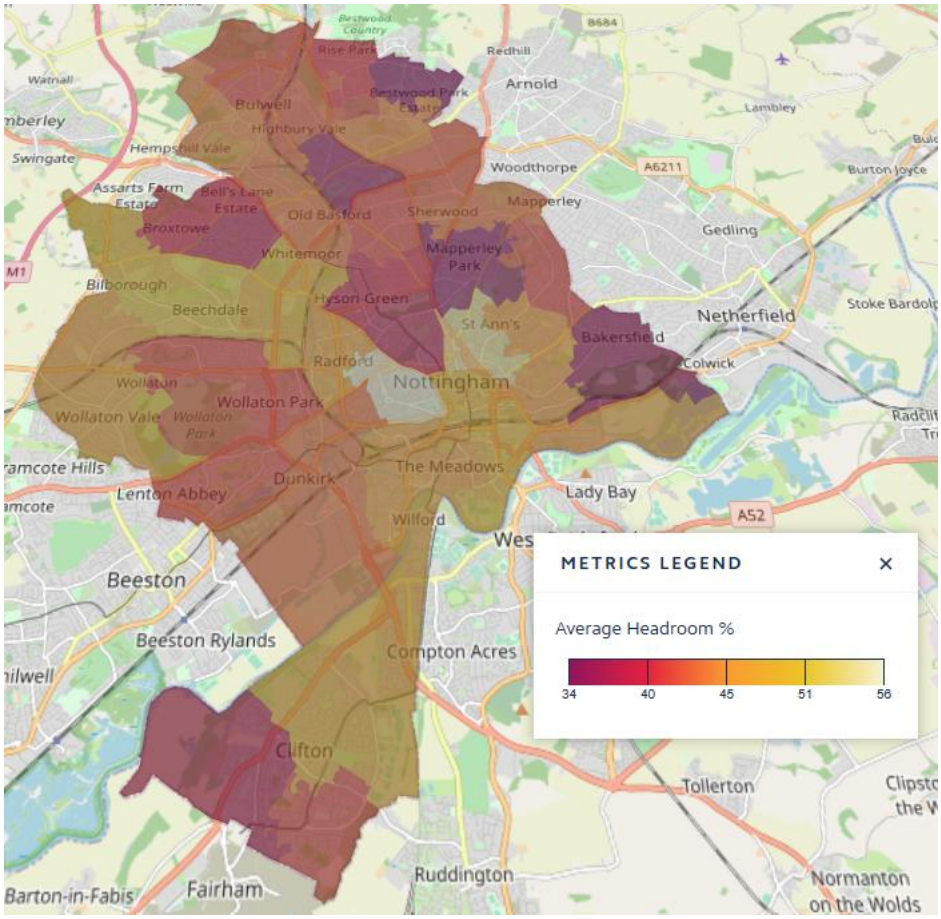
Source: IES Digital Twin, data from NGED

Figure 11.1 above illustrates the average grid utilisation factor across each MSOA in Nottingham. The utilisation factor is defined as the ratio of maximum demand to the installed (rated) grid capacity. Secondary substation data were overlaid with MSOA boundaries and aggregated to produce MSOA-level utilisation and headroom. The network data is subject to regular change over time, reflecting new and amended applications for network connections and evolving patterns of demand.

Nottingham has a utilisation factor of 63%, with Basford Park Lane and Arboretum, Forest & Trent University showing higher utilisation levels at 75% each. In contrast, The Park & Castle records a significantly lower utilisation of 49%.

This variation highlights important opportunities for strategic sequencing of low-carbon deployment. Areas of lower utilisation can support early electrification and distributed energy schemes, while higher utilisation zones will require close collaboration with NGED to plan for reinforcement, flexibility services, or demand-side management. Coordinating these actions will be critical to ensure network readiness for the scale of electrification required to achieve net zero across Nottingham City.

Figure 11.2: Average Demand Headroom (%)



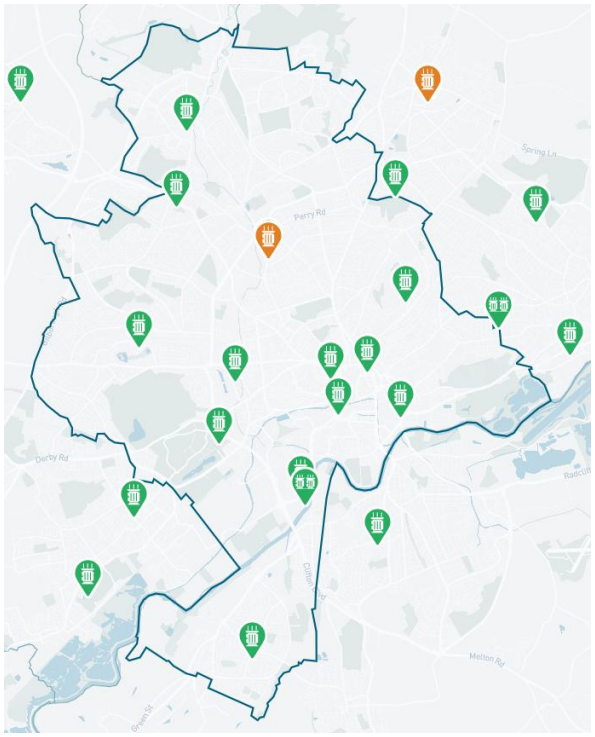
Source: IES Digital Twin, data from NGED

Figure 11.2 above also presents the average demand headroom across Nottingham's MSOAs.

Headroom represents the percentage of unused grid capacity under typical operating conditions, indicating the available spare capacity. On average, Nottingham has a headroom of 43%, with Top Valley East and Mapperley Park having the lowest at just 34%. Notably, at least 10 out of the 41 MSOAs in Nottingham have an average headroom below 40%, while The Park & Castle and St Ann's West have the highest headroom at 56% and 54% respectively.

Substations with more headroom will be able to accommodate large amounts of heat pumps, direct electric heating systems and EV chargers before requiring an upgrade. The substations with lower headroom percentages such as those in Top Valley East or Mapperley Park may require upgrades within the next few years.

Figure 11.3: Primary Demand Headroom Map



Source: National Grid Network Opportunity Map

Figure 11.3 illustrates contracted demand headroom across primary substations in Nottingham. The pins on the map correspond to these substations, giving an indication of the possible demand that may be connected at a substation, excluding upstream constraints, without triggering reinforcement.

Each substation is colour-coded using the standard RAG rating:

- **Green** indicates more than 5% spare capacity,
- **Amber** represents a positive headroom of less than 5%, and
- **Red** signifies negative headroom, where demand exceeds available capacity (none displayed in the image above).

The figure highlights existing network pinch points, underscoring areas where the infrastructure is already constrained. This reinforces the need for targeted reinforcement to support future demand and enable low-carbon technology deployment.

Nottingham is projected to experience significant growth in energy demand driven by planned housing developments, population increases, and expansion of commercial and industrial activity through to 2040. The transition to low-carbon technologies will substantially raise electricity consumption and peak loads. This shift places pressure on the capacity and resilience of the local electricity network. To meet future needs, targeted reinforcement, flexibility solutions, and smart energy management will be essential to enable decarbonisation and maintain security of supply.

11.2 Network Impact

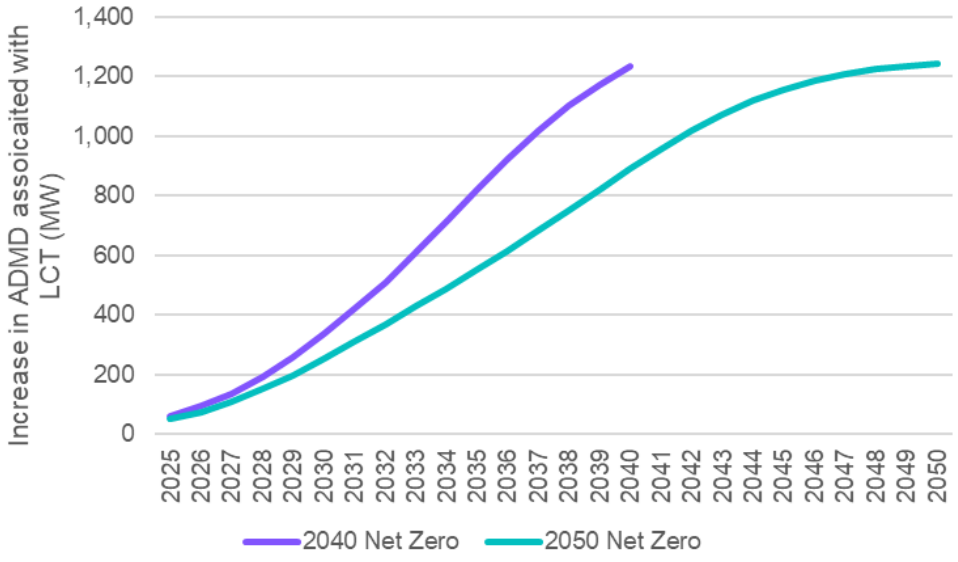
After Diversity Maximum Demand (ADMD) represents the maximum expected electrical demand, adjusted to reflect the fact that not all homes and businesses will use their peak load simultaneously. This diversity of usage - where appliances and systems are not all operating at full capacity at the same time - allows network planners to design infrastructure more efficiently, avoiding unnecessary oversizing while still ensuring reliability. ADMD plays a crucial role in assessing the total connected capacity required at substations. By applying the ADMD value to the number of dwellings or technologies modelled, planners can estimate the aggregate peak demand that the substation must be capable of handling. This informs decisions about transformer sizing, cable ratings, and switchgear specifications.

We have modelled the ADMD for LCT adoption across Nottingham, focusing on ASHP and electric vehicle (EV) charging demand. This includes heat pumps for both domestic and non-domestic users, as well as public and private EV charging infrastructure. The modelling approach uses scenario-based uptake rates for EVs and heat pumps, applying diversity factors of 0.7 for Private EV chargers and 0.3 for Public Chargers, 0.8 for non-domestic ASHPs, and 0.65 for domestic ASHPs.

Table 11.1: Estimated increase in ADMD across Nottingham Attributable to Adoption of LCTs (EV charging and ASHPs)

Scenario	2030	2035	2040	2050	Annualised Growth (MW)
2040 Net Zero	336	819	1,236		82
2050 Net Zero	255	551	891	1,245	49

Figure 11.4: Nottingham Aggregated ADMD Increases (MW)



This model presents a strong case for proactive investment in distribution network upgrades, as any net zero-compliant scenario is expected to add an additional 1,245 MW of ADMD which would exceed the capacity of the current infrastructure.

11.2.1 Planned Development Impact on Network ADMD

Alongside the anticipated impact of LCTs on the grid, there are significant planned developments across both the domestic and non-domestic sectors that will influence network

demand. These developments are expected to add an additional 50.9 MW of ADMD to the network. Of this total, the domestic sector accounts for 9.3%, with the most notable impact concentrated in Bestwood and Clifton West. In contrast, the non-domestic sector represents 90.7 per cent of the additional ADMD, with the greatest effect projected in City Centre & Trent Bridge, Lenton & Dunkirk and Bulwell West. This increase, particularly from non-domestic developments, underscores the need for careful consideration in network planning and reinforcement strategies to ensure sufficient capacity and resilience for future growth.

Table 11.2: Planned Development Impact on Network (MW)

	Year not provided	2025	2026	2027	2028	2029
New Greenfield Developments (Domestic)		1.3	1.2	1.2	0.6	0.2
New Developments (Non-Domestic)	46.2					

11.2.2 Impact of Negative Headroom on Net Zero

As shown in the previous section, any net zero compliant scenario will result in ‘negative headroom’. Negative headroom indicates that the projected ADMD exceeds the available network capacity at the substation level. Identifying and responding to such capacity constraints is a core function of the Distribution System Operator (DSO), which is responsible for planning, operating and developing the local electricity network to ensure it can meet future demand safely and reliably. In other words, the infrastructure is no longer sufficient to accommodate the expected load. This breach signals the need for reinforcement measures such as substation upgrades, or deployment of flexibility solutions to avoid constraints, maintain reliability, and support continued connections to the network.

Network constraints have direct consequences for how quickly and affordably new connections can be made to the electricity network. When substations are operating beyond their capacity, new connection requests, whether for new or existing domestic, new industrial or commercial connections, or LCT installations, may be delayed or queued until reinforcement works are completed. This can slow down the pace of electrification, decarbonisation and urban expansion, particularly in areas with high growth or ambitious Net Zero targets.

Financially, a breach of headroom at a substation can trigger the need for infrastructure upgrades, such as installing new transformers, expanding substation capacity, or reinforcing feeder circuits. Under the current regulatory framework, new customers are only liable for the costs at the point of connection. Any upstream reinforcement costs, such as those at higher voltage levels are now covered by the DNO and ultimately recovered through fixed daily charges applied to all consumers. For example, if a large industrial site applies for additional electrical capacity to decarbonise its operations, and this request causes a breach at the primary substation, the customer would only be responsible for the direct connection costs. The DNO would manage and fund any upstream upgrades, which may still result in delays depending on network availability and planning timelines.

In areas with persistent constraints, alternative approaches such as flexibility services, energy storage, or demand-side management may be considered to defer or reduce the need for capital investment. However, these solutions require coordination, digital infrastructure, and regulatory support to be effective. The results shown in this LAEP, should be reviewed in detail by NGED and NESO, so that network improvements can be planned proactively and at a system level. This would reduce the risk that individual customers need to bear disproportionate costs or experience time delays, as electrical network infrastructure can stay ahead of decarbonisation and growth within the area.

11.3 Storage and Demand Side Response

Demand Side Response (DSR) refers to the strategic adjustment of electricity consumption patterns by end users in response to signals from the network operator. These signals may include price incentives, time-of-use tariffs, or direct requests to reduce or shift demand during peak periods. DSR enables the electricity system to operate more flexibly by aligning demand with available supply, particularly during times of network stress or limited capacity.

The implementation of DSR alongside stationary energy storage, particularly when integrated with PV systems, offers a powerful mechanism for managing grid constraints and enhancing local energy resilience. Solar PV enables sites to generate their own electricity, while battery storage captures surplus generation for later use. This stored energy can then be discharged during peak demand periods, aligning on-site consumption with grid needs and reducing pressure on the network.

This coordinated flexibility helps lower peak demand during periods of increased consumption, mitigating breaches of headroom and deferring the need for costly infrastructure upgrades. By enabling the generation and use of low-carbon, locally produced energy, the combined use of DSR and storage supports a more affordable, secure, and sustainable energy system, aligning with national energy goals.

In the context of Nottingham's Net Zero ambitions, DSR paired with stationary storage presents a significant opportunity to enhance local energy flexibility and resilience. While the financial benefits of DSR and storage will vary depending on market conditions, technology costs, and consumer participation, their coordinated use could help reduce peak demand, defer infrastructure upgrades, and unlock new value streams for energy users. The scale and feasibility of this opportunity in Nottingham will depend on factors such as digital infrastructure readiness, regulatory support, and close collaboration between DNOs, aggregators, and end users.[60]

[60] Energy Institute. Introduction to Demand Side Response.

12 Economics

12.1 Overview of the Economic Assessment

The high-level assessment of costs and benefits for decarbonising the area under the two transition scenarios, 2040 and 2050, indicates that investment in the local energy transition could deliver significant benefits relative to the 'Do Nothing' scenario. Although the required investment is substantial and the pace of transition will depend on sustained policy and grant support, it is expected to generate benefits through lower energy bills, carbon reduction, improved air quality, and employment stimulation in the local economy.

This analysis estimates indicative capital expenditure (capex) and cash and non-cash costs and benefits[61] for the interventions within scope. This reflects the strategic, early-stage nature of the LAEP and aligns with other LAEPs developed across the UK. If this capex is spent, then significant benefits can be realised, summarised in Table 12.1 for both scenarios.

- **Total estimated capex to 2050 in both scenarios is £5.4 billion in 2025 values, before the impact of discounting.** This is the gross cost without considering the contribution from government subsidy programmes, therefore the cost of investment to the local economy is likely to be significantly lower given existing grant support and national government commitment enshrined in law to achieve Net Zero by 2050. The success of the transition under current market conditions is dependent on sustained grant support, which will strongly influence the scale and pace of action.
- **Deep fabric retrofit and domestic and non-domestic air source heat pumps account for 75% of the total investment (£4.1 billion**). This investment is expected to be funded through a combination of public sector support and household/organisation contributions.

Benefit estimates from deploying technologies in the two net zero scenarios include:

- **Carbon savings:** £1.5 billion for 2040 and £1.1 billion for 2050 (discounted) in carbon reduction driven primarily driven by the installation of domestic air source heat pumps.
- **Air quality improvements:** £23 million for 2040 and £16 million for 2050 (discounted) of benefits to human health, productivity, wellbeing, and the environment due to improvements in air quality.
- **Impact on bills:** £560 million for 2040 and £590 million for 2050 (discounted) of savings from utility bills which are a result of self-generation (rooftop solar), fuel switching to lower-cost technologies, and reduced energy demand through retrofit measures. Sensitivity analysis suggestions this could vary to savings of £397 million and £948 million under the 2050 scenario, depending on energy price trends.
- **Substantial economic activity could be generated from the transition.** Assuming installation and fitting of these technologies are carried out by workers, the average economic contribution per year could be £82 million to £87 million, with an aggregate impact of £2.2 billion to 2050.
- **Transition to EVs enabled by charging infrastructure could generate significantly greater benefits,** most notably additional £837 million - £979 million of carbon reduction benefits. These enabled benefits are always shown separately in the subsequent analysis.

[61] Cash benefits reduce actual expenditure or release cash that can be reallocated elsewhere such as direct financial savings, revenue generation, and avoided costs. Non-cash benefits do not result in direct financial savings but still contribute to public or social value, for example carbon savings.

Table 12.1: Estimated Capex and Associated Benefits, vs Do Nothing, £' m

£m (2025)	2040 (£' m)	2050 (£' m)
Discounted values		
Capex (discounted)	4,100	3,610
Carbon savings	1,463	1,123
Air quality improvements	23	16
Impact on bills (ex VAT)	560	590
Capex (financial)	5,413	5,413
Average annual economic contribution (GVA)	87	82
Aggregated economic contribution (GVA) to 2050	2,250	2,144

Source: Mott MacDonald

12.2 Approach to Analysis and Key Considerations

For the two transition scenarios (2040 and 2050), costs and benefits from the scenarios are estimated. These cover capital expenditure (both undiscounted and discounted) and welfare enhancing benefits and economic contribution, which are derived from the following core inputs:

- Modelled installation volumes for net-zero technologies
- Modelled changes in gas and electricity consumption
- Unit costs for technology purchase and installation, based on published sources (e.g., DESNZ), as well as internal data from Mott MacDonald cost consultants.
- Published assumptions on carbon appraisal values, air quality damage costs, and the economic value of net zero transition activities.

This assessment quantifies and presents capital expenditure (CAPEX) to 2050 - both discounted and undiscounted - for net zero technologies deployed under two scenarios: delivery by 2040 and delivery 2050, each assessed relative to a 'do minimum' counterfactual.

Undiscounted CAPEX is provided to show the total financial outlay required to 2050, in 2025 prices, without adjustments for risk, inflation or the time value of money.

Discounted CAPEX is presented to show the adjusted CAPEX value reflecting the time value of money, for economic analysis and in line with HM Treasury Green Book best practice. This applies the Green Book social time preference of money.

In addition to capital costs, the analysis considers associated cash and noncash benefits, including carbon savings, air quality improvements. In addition, a high-level estimate of economic contribution from employment associated with capex is presented.



CAPEX (cash)



Valuation of carbon impacts (non-cash)



Impact on bills (cash)



Improvement in air quality (non-cash)



Valuation of economic contribution (non-cash)

When interpreting the analysis, several key considerations should be considered around:

- The scope of analysis
- Price base, discounting and appraisal period
- Cost base assumptions
- Bill impacts
- Benefits associated with EV charger deployment
- Assumptions and sources.

12.2.1 Scope of the Analysis

While we have estimated capex and outlined indicative benefits that might result from investment, some costs and benefits fall outside the scope of this exercise (e.g., operational expenditure). Accordingly, this is not a full Cost Benefit Analysis (CBA) and the analysis is not presented as an aggregate Net Present Social Value (NPSV).

However, the analysis provides a clear foundation for understanding capital investment requirements and associated benefits. A comprehensive assessment capturing operating expenditure and wider societal benefits to derive a Net Present Social Value would be a valuable next step.

12.2.2 Price Base, Discounting and Time Horizon

All costs and benefits are presented in constant 2025 prices (real terms). Historic and nominal inputs are converted to 2025 using the Office for Budget Responsibility (OBR) GDP deflator. Discounting follows the HM Treasury Green Book (2026) social discounting schedule to convert future streams into present values, reflecting time preference. To capture the full operational lifespan of all assets, the model extends beyond 2050 by the longest asset life.

12.2.3 Cost Base Assumptions

Capital costs in this assessment are based on unit costs derived from Mott MacDonald's internal cost benchmarking, supplemented by published sources such as DESNZ and other relevant industry data. To reflect uncertainty at this stage of appraisal, the Association for the Advancement of Cost Engineering (AACE) Class 4 accuracy ranges (–20% to +50%) are applied to show possible ranges, which are appropriate for early-stage, high-level estimates. This approach ensures the cost base is robust, transparent, and aligned with best practice for strategic economic assessment.

12.2.4 Bill Impacts

Bill impacts reflect changes in energy consumption gas and grid electricity, only. Household expenditure on maintenance, servicing, or replacement is excluded. Bill impacts are presented in economic appraisal terms (net of tax, and discounted).

12.2.5 Benefits Associated with EV ChargePoint Investment

EV charge points have the potential to generate benefits through enabling the displacement of Internal Combustion Engine (ICE) vehicles, thereby generating reductions in carbon emissions, improvements in air quality, and lower energy bills. However, the extent to which the provision

of charge points directly drives EV uptake is highly uncertain. As a result, the potential benefits associated with enabling EV adoption are not included in the core assessment.

12.2.6 Treatment of Gross Value Added (GVA)

High level estimates of the potential economic contribution from the direct creation of jobs associated with fitting and installation of decarbonisation measures is estimated based on publicly sourced type 1 multipliers[62], assuming that there is no leakage i.e. those employed to support the transition are locally employed. This is a high level estimate of Gross Value Added (GVA).

12.2.7 Scenarios

Three scenarios are modelled in this appraisal: the Do Nothing, 2040, and 2050. The results are presented with the 2040 and 2050 in comparison to the Do Nothing to show the relative costs and benefits versus a minimum/baseline scenario.

12.3 Assumptions

12.3.1 Use of Published Sources

Where available, assumptions from HM Treasury's Green Book (2026) have been applied including for the discount rate, forecast energy retail price movements, and carbon emission factors. All inputs are set to 2025 prices using the Office for Budget Responsibility's (OBR) GDP Deflator[63], to reflect the 2025 base year of the model for benefits and costs. All benefits and costs are measured in millions of pounds (£m). Key assumptions used in this analysis are set out in the next section.

12.3.2 Key Assumptions

Table 12.2 lists the key assumptions used in the Economic appraisal.

Table 12.2: Key Assumptions used in the Economic Appraisal

Assumption	Description
Discount rate	A social time preference discount rate of 3.5% and a health discount rate of 1.5% per the HM Treasury's Green Book (2026).
Carbon price	The HM Treasury's Green Book (2026) 'Medium' carbon price profile escalated to 2025 values using OBR's GDP deflator.
Domestic utility prices (electric, gas)	Ofgem energy price cap with future prices aligned to HM Treasury's Green Book (2026) price forecast escalated to 2025 values using OBR's GDP deflator.
Non-domestic utility prices (electric, gas)	HM Treasury's Green Book (2026) long run variable cost (LRVC) price forecast escalated to 2025 values using OBR's GDP deflator.
Road fuel prices	The HM Treasury's Green Book (2026) 'Medium' road fuel price Long Run Variable Cost profile escalated to 2025 values using OBR's GDP deflator.
Carbon emission factors	The HM Treasury's Green Book (2026) long run marginal carbon emission factors.
Gross value added (GVA)	**Output per job figure for the construction industry provided by ONS escalated to 2025 values using OBR's GDP deflator.**

Source: UK GOV, Ofgem, ONS, OBR

[62] Sustainable Transition Effects on Labor Market, Sustainable Development Solutions Network, Available at: https://www.jstor.org/stable/pdf/resrep29195.3.pdf

12.4 Detailed Results

12.4.1 Capital Expenditure

Capital expenditure (capex) is presented in two ways:

- Undiscounted capex is provided to show the total financial outlay required to 2050 in today's prices, without adjustments for risk or the time value of money.
- **Discounted capex is presented to show the adjusted capex value reflecting the time value of money**, for economic analysis and in line with HM Treasury Green Book best practice. This applies the Green Book social time preference of money discount rate.

All capex is presented as the additional spend above the Do Nothing scenario, which assumes minimum building fabric improvements to achieve MEES EPC compliance and minimal levels of electric vehicle uptake.

12.4.2 Undiscounted Capex

Undiscounted capex informs how much might be needed to be invested in today's prices, without reducing future spend for the time value of money (discounting) or increasing for inflation. These values are referenced in the Funding and Finance section below. Table 12.3 below shows the total undiscounted capex, which is identical between the two scenarios.

- **£5.4 bn in today's prices is required** to deliver both net-zero scenarios.
- All capex figures are shown as incremental to the Do Nothing scenario, representing the additional investment required over and above a baseline.
- **The only difference between the two scenarios is the timing of the installations:** while the total number of installations remains the same, the 2040 scenario assumes significantly earlier installations. This will require rapid scale up of supply chains, high levels of consumer adoption and ongoing policy support.
- **The largest areas of expenditure are deep fabric retrofit and air source heat pumps:** These account for 75% of total capital expenditure. To achieve this level of investment the benefits of these measures must be clearly articulated and supported by continued government grants.

Table 12.3: Undiscounted Capex vs Do Nothing, £' m (2025, Undiscounted)

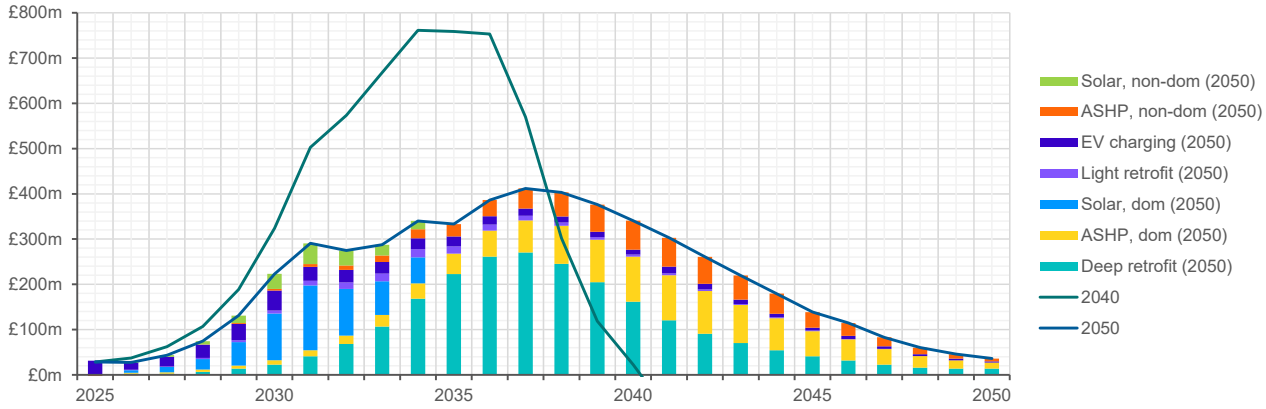
	2040 (£' m)	2050 (£' m)	% of total (2050)
Light fabric retrofit	147	147	**3%**
Deep fabric retrofit	2,274	2,274	**42%**
Domestic solar PV	572	572	**11%**
Non-domestic solar PV	183	183	**3%**
Domestic air source heat pumps	1,113	1,113	**21%**
Non-domestic air source heat pumps	672	672	**12%**
EV chargers	452	452	**8%**
Total	**5,413**	**5,413**	**100%**

Figure 12.1 illustrates the capex timing profiles for the 2040 and 2050 scenarios, with Figure 12.2 showing capex vs Do Nothing with confidence intervals. In the 2050 scenario, capital expenditure is broken down by intervention, showing the deployment timeline for each

technology. This allows for a direct comparison with the 2040 scenario, which is presented as a single aggregated capex curve.

- **The 2040 scenario assumes much faster deployment rates:** all investment is concluded by 2040, compared to 2050. This assumes all investment over the next 14 years, rather than the next 24 years.
- **The acceleration and peak of investment is much greater in the 2040 scenario:** to achieve the earlier targets, the 2040 scenario assumes rapid scale up of investment with a peak at £761m per year, compared to a slower scale up and peak at £412m a year in the 2050 scenario.
- **Solar and EV chargers lead investment in early years** under both scenarios, with retrofit and ASHP gathering momentum through the 2030s.
- **Achievement of the 2040 scenario relies on accelerating investment in ASHPs and retrofit:** this will be aided by sustained grant support, reduction in electricity prices, and supply chain maturity.

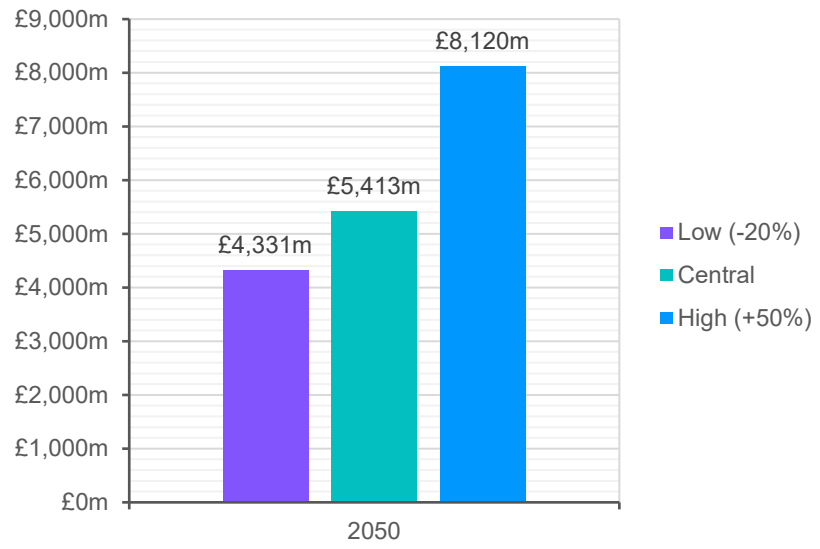
Figure 12.1: Capex, £' m, real, 2025, Undiscounted



Early strategic assessments have uncertainty over future costs, therefore interval ranges have been applied to illustrate a possible range of investment, reflecting the AACE Class 4 expected accuracy ranges:

- **An upper confidence interval of +50%**, reflecting the potential for cost escalation due to unforeseen scope changes, market volatility, or design evolution.
- **A lower confidence interval of -20%**, accounting for potential cost efficiencies or scope reductions.

Figure 12.2: 2050 Capex, vs Do Nothing with Confidence Intervals, £' m, real, Undiscounted, 2025



12.4.3 Discounted Capex

Discounted capex illustrates how timing impacts the value of capex and should be considered when appraising capital costs against other costs and benefits. The further the spend occurs in the future, the lower its valuation for the purposes of economic appraisal. This is presented in Table 12.4.

The effect of discounting reduces the present value of capital expenditure to £4.1 bn (2040) and £3.6 bn (2050). This is the relevant basis for comparing to other discounted of costs and benefits.

While the 2050 capital expenditure is lower, the potential benefits from this spend will also be valued lower due to the impact of discounting.

The slower pace of investment in the 2050 scenario reduces the valuation of capital costs by 12%, with slower deployment in all categories resulting in a lower valuation of cost.

Table 12.4: Discounted Capex, vs Do Nothing £' m (2025, Discounted)

	2040 (£' m)	2050 (£' m)	% total (2050 scenario)
Light fabric retrofit	118	105	3%
Deep fabric retrofit	1,702	1,481	41%
Domestic solar PV	464	464	13%
Non-domestic solar PV	149	149	4%
Domestic air source heat pumps	798	668	195
Non-domestic air source heat pumps	484	398	11%
EV chargers	385	345	10%
Total	**4,100**	**3,610**	**100%**

12.4.4 Carbon Impacts

The value of carbon savings is calculated by multiplying the value of carbon saved per intervention by carbon valuation rates per tonne of CO2e per the HM Treasury Green Book[64]. Both scenarios deliver over £1.0 billion of carbon savings compared to the counterfactual. These are presented in Table 12.5 and Figure 12.3, with the following key findings:

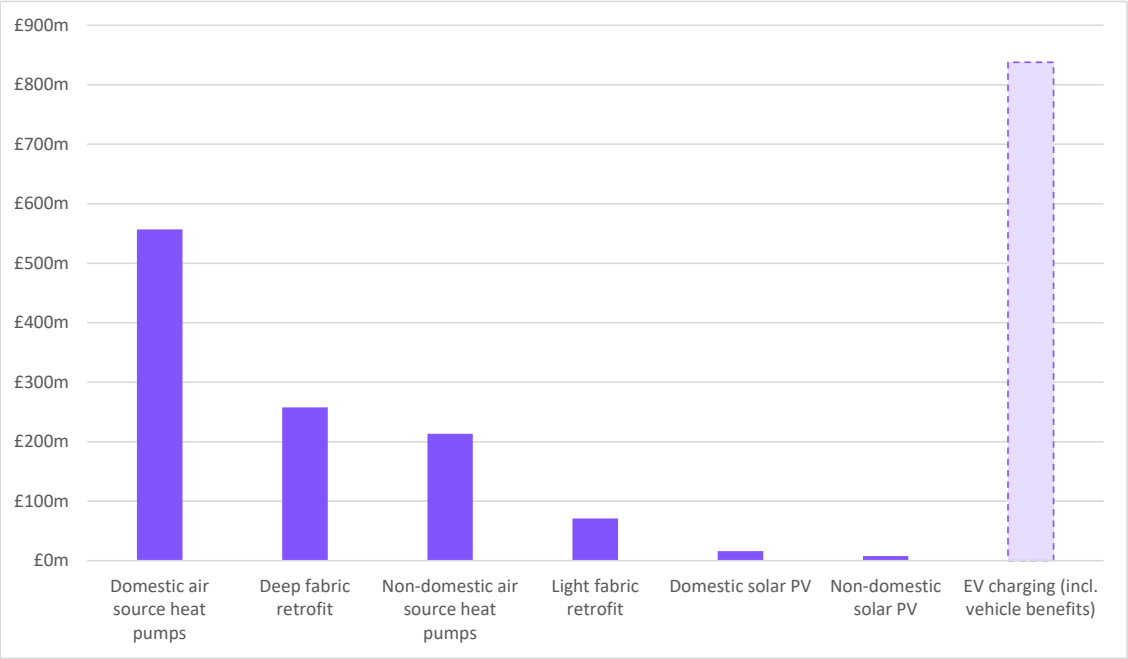
- **Early action drives greater carbon savings:** the 2040 scenario delivers greater carbon savings than the 2050 scenario (approximately £1.5 billion versus £1.1 billion), largely due to earlier deployment of key technologies like air source heat pumps and deep fabric retrofit. This means that accelerating implementation can yield stronger environmental benefits.
- **Domestic and non-domestic air source heat pumps are the most impactful intervention:** heat pumps are responsible for 69-74% of carbon savings in both scenarios, contributing between £771 million and £1,074 million in benefits.
- **EV charging could enable substantial carbon savings:** even though installation of chargers does not directly create carbon savings, the vehicle emission reductions that could be enabled are very significant. When vehicle benefits are included, EV charging could become the largest contributor to carbon savings (£780 million in 2040 and £837 million in 2050).
- **Solar PV has very low impact on carbon reduction:** the electricity grid is assumed to decarbonise through the coming decade. The benefits of PV will come through impact on bills and energy security, not through carbon reduction.

Table 12.5: Carbon Impacts, vs Do Nothing £m (2025, Discounted)

	2040 (£' m)	2050 (£' m)	% total (2050 scenario)
Light fabric retrofit	78	71	6%
Deep fabric retrofit	287	258	23%
Domestic solar PV	16	16	1%
Non-domestic solar PV	8	8	1%
Domestic air source heat pumps	776	557	50%
Non-domestic air source heat pumps	298	214	19%
EV charging (excl. vehicle benefits)	-	-	-
Total	1,463	1,123	100%
EV charging (incl. vehicle benefits)	979	837	

[64] Department for Energy Security and Net Zero, 2023, Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal available at: Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal - GOV.UK

Figure 12.3: Valuation of Carbon Benefits, 2050 Scenario vs Do Nothing, £' m (2025, real, Discounted)



12.4.5 Air Quality Improvements

Air quality improvements are assessed considering the change from fossil fuel heating and transport to electric sources. The change in fuel use is valued as an air quality improvement applying HM Treasury indices for air quality[65]. Air quality improvements carry less significant benefits for both scenarios compared to other types of impacts. These are shown in Table 12.6.

- **Air source heat pumps deliver small air quality gains:** air source heat pumps improve air quality a modest amount, with improvements increasing the earlier ASHPs are installed.
- **Enabling EV uptake could stimulate further air quality improvements.** Although EV charging infrastructure does not directly cause EV displacement of ICE vehicles, the vehicles supported could create benefits of a further £62 million to £81 million in improvement in air quality.
- **Many of the technologies were not assessed for air quality improvements**, as their impact on local emissions is negligible, as their installation does not directly impact human exposure to airborne pollutants, in the LAEP area. For instance, rooftop solar PV replaces grid electricity, which is often generated outside the region. As a result, any potential air quality benefits would not directly apply to the area.

Table 12.6: Air Quality Improvements, vs Do Nothing £m (2025, Discounted)

	2040 (£' m)	2050 (£' m)	% total (2050 scenario)
Light fabric retrofit	N/A	N/A	N/A
Deep fabric retrofit	N/A	N/A	N/A
Domestic solar PV	N/A	N/A	N/A

[65] Department for Energy Security and Net Zero, 2023, Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal available at: Green Book supplementary guidance: valuation of energy use and greenhouse gas emissions for appraisal - GOV.UK

	2040 (£' m)	2050 (£' m)	% total (2050 scenario)
Non-domestic solar PV	N/A	N/A	N/A
Domestic air source heat pumps	16	11	72%
Non-domestic air source heat pumps	6	4	28%
EV charging (excl. vehicle benefits)	N/A	N/A	N/A
Total	23	16	100%
EV charging (incl. vehicle benefits)	**62**	**81**	

12.4.6 Impact on Bills

Substantial energy bill savings could result from the transition. Discounted values are presented in Table 12.7, excluding VAT and tax.

The 2050 scenario delivers a slightly greater reduction in bills (£590 million) compared to the 2040 scenario (£560 million) due to the timing of asset installations. While there are lower savings from generation in the 2050 scenario, there are also lower additional costs from ASHPs.

- **Generation technologies deliver significant bill savings:** Rooftop solar PV installations are projected to deliver bill savings of £387 million for domestic and £138 million for non-domestic. These savings represent the avoided purchase of electricity from the grid.
- **Heating technologies risk increasing bills:** if consumers switch to ASHPs with flat rate tariffs at current average and forecast prices, they risk increasing energy bills on aggregate because the cost of electricity over gas outweighs efficiency gains. These are shown as a bill increase in the table below.
- **Air source heat pump bills can be reduced by use of bespoke tariffs** linked to the hours of use (time-of-use tariffs). This impact is not reflected below but is a key enabler to make the case for the adoption of ASHPs, alongside pairing with renewable generation.
- **Cost of EV charging is sensitive to tax impacts and method of purchase of fuel:** adoption of electric vehicles enabled by public infrastructure yields higher bills valued at £102 million to £120 million. However, this cost is likely to change into a saving if the impact of the significant taxes on petrol and diesel fuel is also considered. These are excluded in this analysis, to reflect Green Book guidance on economic benefits valuation.

Table 12.7: Impact on Bills, vs Do Nothing, £m (2025, Discounted)

Note – figures in black are a bill saving. Figures in (red) are a bill increase.

	2040 (£' m)	2050 (£' m)	% total (2050 scenario)
Light fabric retrofit	40	36	6%
Deep fabric retrofit	144	126	21%
Domestic solar PV	387	387	66%
Non-domestic solar PV	138	138	23%
Domestic air source heat pumps	(128)	(84)	(14%)
Non-domestic air source heat pumps	(22)	(14)	(2%)
EV charging (excl. vehicle benefits)	-	-	-
Total	**560**	**590**	**100%**

	2040 (£' m)	2050 (£' m)	% total (2050 scenario)
EV charging (incl. vehicle benefits)	(120)	(102)	

12.4.6.1 Impact on Bills Sensitivity Analysis

Sensitivity analysis assesses the impact of energy price volatility, which is an important consideration given the unpredictable nature of energy markets. The analysis involves adjusting gas and grid electricity prices using the low, medium, and high trajectories outlined in HM Treasury's Green Book. Two scenarios are assessed, and presented in Table 12.8:

- **Favourable scenario (A):** High gas price, and a low grid electricity price
- **Unfavourable scenario (B):** Low gas price, and a high grid electricity price

Results

- **The favourable scenario leads to further bill savings of £358m** (+61%) for the 2050 scenario. Under this scenario, total savings reach £948 million.
- Under the favourable scenario, ASHPs and EV chargers now save bills, due to lower electricity prices.
- **Under the favourable scenario, solar PV savings are lower,** as savings vs retail prices are lower. However, these reductions are offset by the bill savings from ASHPs.
- **The unfavourable scenario leads to lower bill savings, by £193m** (-33%) for the 2050 scenario. Total savings are still positive, but lower at £397 million.
- **In the unfavourable scenario, the dynamics reversed.** A high electricity price made rooftop solar PV more beneficial. However, air source heat pumps suffered a significant decline in performance due to both higher running costs and the reduced benefit of offsetting now cheaper gas.

Table 12.8: Impact on Bills Sensitivity Analysis, 2050 vs Do Nothing, £m (2025, Discounted)

Intervention	Impact on bills (£' m)			Variance to central assumptions (£' m)	
	Central	A	B	A	B
Light fabric retrofit	36	56	25	+20	(11)
Deep fabric retrofit	126	196	87	+71	(39)
Domestic solar PV	387	364	413	(23)	+25
Non-domestic solar PV	138	130	151	(8)	+13
Domestic air source heat pumps	(84)	110	(201)	+193	(117)
Non-domestic air source heat pumps	(14)	91	(78)	+105	(64)
EV charging (excl. vehicle benefits)	-	-	-	-	-
Total	**590**	**948**	**397**	**+358**	**(193)**
EV charging (incl. vehicle benefits)	(102)	(62)	(165)	+40	(63)

12.4.7 Employment Contribution – Gross Value Added (GVA)

The creation of employment from investment delivers substantial benefits across both scenarios. These figures are indicative for the benefit across the economy as a whole. Results are presented in **Table 12.9** and key findings include:

- Economic contribution has an average annual value of £82 million to £87 million, with aggregated figure to 2050 of £2.2 billion.
- **The 2040 scenario generates slightly more benefit due to the earlier installation of assets.** As these assets require ongoing maintenance and eventual replacement up to 2050, the overall volume of installation and upkeep activity is higher, resulting in increased job creation.
- **The assets that require the most investment generate the greatest employment contribution**: deep fabric retrofit and heat pumps account for 78% of employment contribution benefits, which mirrors the similar proportion of investment required for these assets.

Table 12.9: Cumulative Value of Employment Contribution, vs Do Nothing, £'m (2025, Undiscounted)

	2040 (£' m)	2050 (£' m)	% total (2050 scenario)
Light fabric retrofit	51	51	2%
Deep fabric retrofit	782	782	37%
Domestic solar PV	184	184	9%
Non-domestic solar PV	59	59	3%
Domestic air source heat pumps	601	552	26%
Non-domestic air source heat pumps	368	335	16%
EV charging	206	181	8%
Total	2,250	2,144	100%
Average per year (2025 – 2050)	**87**	**82**	

12.5 Capex - who might pay?

This section provides a view of how different capital interventions could be financed or funded to indicate where the cost of delivery may be borne by mapping interventions to funding mechanisms. The information provided is illustrative, based upon typical project examples and market dynamics.

Table 12.10 outlines the capital interventions identified by funding type and intervention category. It summarises probable sources of finance whether private capital, self-funding by residents or building owners, or reliance on government grants.

Table 12.10: Potential Funding and Financing Sources

Who pays	Undiscounted capex[66]	Net Zero measure /technology	Potential funding/financing mechanisms
Private developers	£452m	EV Chargers (shared public)	Cost borne by private investment based on commercial viability
Self-funded, residents	£572m	Rooftop solar PV, domestic Private EV chargers	Self-funded Smart Export Guarantee (SEG) EV chargepoint grant Warm Homes Plan
Grant-reliant, residents	£3,534m	Light fabric retrofit Deep fabric retrofit Air source heat pumps, domestic	Boiler Upgrade Scheme (BUS) Warm Homes Plan (ECO4)
Self-funded, public and private building owners	£183m	Rooftop solar PV, non-domestic	Self-funded Smart Export Guarantee (SEG) Local Power Plan
Grant-reliant, public and private estates	£672m	Air source heat pumps, non-domestic	Local authority and regional grants
Total	**£5,413m**		

The categorisation in Table 12.10 is based upon experience of current market conditions and typical project performance. The categories are expanded on below for the relevant interventions:

Private Developers

These technologies are assumed to be commercially viable for private developers and offer a sufficient profit incentive to attract investment. Investment is expected to come from energy developers, infrastructure funds, and private sector partnerships, with planning and grid coordination supported by local authorities.

Self-Funded, Residents

These interventions are considered financially viable at the household level, with market evidence that residents are investing their own capital. This is supported currently by zero VAT on solar panels and batteries, access to Smart Export Guarantee tariffs and actions for reduced capital installation costs. The financial resources available to residents is variable, (e.g. variation in household income), therefore additional support in the form of grants is likely required for some households.

Grant-Reliant, Residents

These interventions are considered reliant on existing grants for residents to install the intervention, as the payback is either uncertain or not significant enough to justify the capital. Existing grants could cover full or partial costs of insulation upgrades and low-carbon heating systems. Depending on the intervention, grant eligibility can be based on income, benefits, and property energy performance.

Self-funded, public and private building owners

[66] Undiscounted capex refers to the net capex required under the 2040 and 2050 scenario vs the counterfactual. Undiscounted capex has been used to reflect the real-world cost of the intervention.

These interventions are considered financially viable, with evidence that the public sector and businesses are investing their own capital. Rooftop solar PV installations on non-domestic properties including commercial premises, industrial facilities, and public sector assets could be self-funded by the building owners or operators.

Grant-reliant, Public and Private Estates

These interventions are considered reliant on existing grants for residents to install the intervention, as the payback is either uncertain or not significant enough to justify the capital. Funding is expected to come from national schemes. These measures are capital-intensive and often not commercially viable without subsidy, particularly in older or energy-intensive buildings.

12.6 Funding and Financing

This section explores the mechanisms available to cover upfront and ongoing costs, from non-repayable grants that reduce capital burdens to repayable finance options that leverage future revenues, as well as models that transfer risk and responsibility to third parties. It also considers the role councils can play in enabling businesses and residents to invest their own capital, ensuring that local energy projects are financially viable, equitable, and aligned with net zero objectives.

12.6.1 Non-Repayable Funding Sources for Project Costs

Non-repayable funding mechanisms are typically used when projects face financial barriers that make traditional debt or equity financing impractical. They help reduce overall capital costs, making projects more affordable and attractive to investors or communities. These funds are also critical for projects where the expected financial return cannot cover full life-cycle costs, ensuring essential low-carbon or social value initiatives can proceed. Additionally, they provide upfront capital to avoid drawing heavily on reserves or savings, enabling local authorities, businesses, and residents to launch projects without compromising financial stability.

Non-repayable sources of funding are presented below, split by those available to local authorities, and businesses and residents.

12.6.1.1 Local Authority

Community Infrastructure Levy (CIL)[67]

The CIL is a planning charge by local authorities in England and Wales on new developments to fund infrastructure such as transport, schools, parks, and public amenities. CIL funds can only be used for infrastructure supporting development and must comply with strict statutory regulations.

Section 106 (S106)[68]

S106 agreements are legally binding planning obligations between developers and local authorities, used to mitigate the impact of new developments by funding infrastructure, affordable housing, or community facilities. Unlike CIL, S106 is negotiated case-by-case, subject to meeting statutory tests, and can include both financial contributions and in-kind provisions tied to specific planning permissions. They remain a key tool for delivering site-specific benefits and ensuring developments are sustainable and aligned with local needs.

[67] Community Infrastructure Levy, GOV.UK, available at: Community Infrastructure Levy - GOV.UK

[68] Section 106, GOV.UK, available at: Planning obligations - GOV.UK

Great British Energy Community Fund (GBECF)[69]

The GBECF is a £5 million UK government-backed grant scheme by regional Net Zero Hubs to support feasibility and development costs for community-owned renewable energy projects. It offers up to £40,000 for Stage 1 feasibility studies and up to £100,000 for Stage 2 development work. Proposals require at least 50% community ownership and generating local benefit. The scheme was extended in 2025 for one year, and while funds are likely now allocated, it is possible that the scheme will be extended with further grant available in future years.

Public Works Loan Board (PWLB)

The PWLB is a UK government facility that provides low-cost loans to local authorities for capital projects, funded through the National Loans Fund, repayable from the overall council budget but not from the project. Councils use PWLB borrowing to finance infrastructure such as housing, transport, and regeneration, with rates typically linked to gilt yields plus a margin. It offers flexible repayment terms but requires compliance with prudential borrowing rules and restrictions on debt-for-profit activities.

Offsetting/Insetting[70]

Retrofit Credits allow organisations to offset their emissions by funding energy-efficiency upgrades in social housing, generating verified carbon credits. For councils, this offers two opportunities: they can purchase credits to compensate for residual emissions and meet net zero targets, or, if they own housing stock, they can implement retrofit projects, generate credits, and sell them to corporates. The revenue can then be reinvested into further retrofits, creating an insetting effect and accelerating decarbonisation of their own assets.

12.6.1.2 Businesses and Residents

Warm Home Plan[71]

The Warm Home Plan is a UK government initiative announced in 2025 to accelerate home energy efficiency and heat decarbonisation, backed by £13.2 billion of funding. It focuses on upgrading insulation, installing low-carbon heating systems, and supporting vulnerable households to reduce energy bills and emissions. The plan complements existing schemes like the BUS and ECO, aiming to deliver large-scale retrofits.

Local Power Plan[72]

The UK Government's Local Power Plan, announced in 2026, outlines £1 billion of investment for community owned energy projects through grants, loans and advice. This support is being delivered by DESNZ, Great British Energy and the National Wealth Fund through to 2030, with the purpose to support community energy groups to develop energy generation and storage projects that deliver benefits to the local area.

Great British Energy Community Fund (GBECF)

Refer to above.

[69] Great British Energy Community Fund, Community Energy England, available at: Great British Energy Community Fund - Community Energy England

[70] Retrofit Credits, Housing Associations' Charitable Trust, available at: Retrofit Credits - HACT

[71] Warm Homes Plan, GOV.UK, available at: Apply for the Warm Homes: Local Grant to improve a home - GOV.UK

[72] Local Power Plan, GOV.UK, available at: Local Power Plan

Boiler Upgrade Scheme (BUS)[73]

The BUS is a government grant program in England and Wales that offers households and small businesses up to £7,500 toward replacing fossil fuel heating systems with low-carbon alternatives like air-source heat pumps. It aims to accelerate heat decarbonisation by reducing upfront costs, with installers applying on behalf of customers and funding available until March 2028. The end date of this scheme poses a risk to the sustained uptake of heat pumps, and a replacement scheme or change in the capex and running costs of heat pumps is required for continued rates of adoption.

Electric Vehicle Chargepoint Grant[74]

The EV Chargepoint Grant, available to March 2027, is a UK government scheme that provides funding for installing electric vehicle chargepoints at homes and workplaces. For homeowners and renters with off-street parking as well as households with on-street parking, the grant provides up to £500 towards the cost of installing a chargepoint. Businesses, workplaces and landlords can access grants for multiple chargepoints up to a limit of £500 per socket. Under the Workplace Charging Scheme businesses can apply for grants for up to 40 sockets across all their sites with landlords able to apply for grants for up to 200 sockets across all their sites. A separate Workplace Charging Scheme is also outlined for state-funded education institutions, with grants of up to £2,000 available per chargepoint socket.

12.6.2 Repayable Funding Sources for Upfront Project Costs

Repayable funding mechanisms are used when projects have a clear revenue stream but need capital upfront to bridge the gap between construction costs and future income. They provide financing where the project's financial return is sufficient to cover third-party finance costs, making them suitable for commercially viable schemes. This approach is common when the organisation retains ownership and operational responsibility for assets, ensuring control while leveraging external capital to deliver net zero infrastructure without delaying implementation.

12.6.2.1 Local Authority

National Wealth Fund (NWF)[75]

The NWF is a UK government investment vehicle launched in 2024 to accelerate the transition to a green economy and boost economic growth. It channels public and private capital into strategic sectors such as clean energy, green steel, carbon capture, and advanced manufacturing, aiming to crowd in private investment and create high-quality jobs. Managed by the UK Infrastructure Bank, the fund supports projects that align with net zero goals and regional development priorities.

Local Climate Bonds[76]

Local Climate Bonds are a UK municipal investment mechanism that allows councils to raise funds for local net zero and climate projects by issuing bonds to residents and investors. They offer a low-risk, fixed-return investment, and proceeds are earmarked for projects such as renewable energy, EV infrastructure, and building retrofits. This approach promotes community engagement in climate action while providing councils with affordable finance for sustainability initiatives.

[73] Boiler Upgrade Scheme, GOV.UK, available at: Apply for the Boiler Upgrade Scheme: Overview - GOV.UK
[74] Electric Vehicle Chargepoint Grant, GOV.UK, available at: Electric vehicle chargepoint grants - GOV.UK
[75] National Wealth Fund, available at: National Wealth Fund | National Wealth Fund
[76] Local Climate Bonds, Green Finance Institute, available at: Green Finance Institute

Green Bonds[77]

Green bonds are fixed-income instruments issued to raise capital specifically for projects with environmental benefits, such as renewable energy, energy efficiency, or sustainable transport. They work like traditional bonds but are earmarked for green projects. This financing tool helps governments, companies, and institutions attract investors committed to sustainability while supporting the transition to a low-carbon economy.

UK Municipal Bonds Agency (UKMBA)[78]

The UKMBA is a financing platform created to help local authorities access cheaper borrowing by issuing bonds collectively rather than individually. It pools councils' borrowing needs to achieve economies of scale and better rates compared to traditional sources like the PWLB. This approach aims to diversify funding options for infrastructure and regeneration projects while reducing reliance on central government lending.

12.6.2.2 Business and Residents

Community Share Offers

Community share offers are a way for local people to invest in and own a stake in community-led projects, such as renewable energy, local services, or social enterprises. They raise capital by selling shares directly to individuals, often with modest financial returns and strong social or environmental benefits. This model promotes democratic ownership and keeps profits within the community while funding projects that deliver local impact.

12.6.3 Financing Through Third Party Delivery

Financing through third-party delivery is used when a private or external organisation takes responsibility for developing, funding, and operating an asset on behalf of the public or community sector. This approach transfers the need for upfront project finance and shifts operational and financial performance risks away from the commissioning body to the third party.

12.6.3.1 Local Authority

Service or Concession Agreement

A service or concession agreement typically allows a private provider to finance, install, and operate low-carbon infrastructure. Examples include heat networks, EV charging hubs, or renewable generation under a long-term contract with a public authority. The provider recovers costs through user tariffs or availability payments, while the authority sets performance standards to ensure carbon reduction goals are met.

Heat as a Service (Haas)[79]

HaaS is an emerging business pilot model where customers pay for the outcome including warmth and comfort, rather than for units of energy like gas or electricity. It typically involves smart controls and service agreements that guarantee a set temperature or heating schedule, enabling providers to optimize energy use and integrate low-carbon technologies. This approach shifts incentives toward efficiency and decarbonisation, making heating more

[77] Green Bonds, IMCA, available at: green-bonds-principles-june-2018-270520.pdf

[78] UK Municipal Bonds Agency, available at: Home - UK Municipal Bonds Agency - UKMBA

[79] Energy as a Service Pilot Phase Evidence Report, EON, available at: Energy as a Service: final report

affordable and sustainable for households. Models for heat as a service are in development for both domestic and non-domestic sectors.

12.6.3.2 Businesses and Residents

Heat as a Service (Haas)[80]

As above.

Pay As You Save (PAYS)[81]

PAYS is a financing model that enables households or businesses to install energy efficiency or low-carbon technologies such as insulation, heat pumps, or solar panels without paying upfront. The cost is repaid over time through a charge on the energy bill, with repayments designed to be lower than the savings achieved, so customers see immediate net benefits.

12.6.4 Council Actions to Enable Business and Resident Investment

To help businesses and residents invest their own capital in local energy projects, councils can play a vital enabling role by reducing barriers and creating confidence in returns. This often involves providing clear information on opportunities, offering technical guidance, and facilitating access to trusted suppliers or installers. Councils can also support through measures such as aggregating demand, coordinating bulk purchasing, and promoting financial incentives or accreditation schemes, all of which make investment more attractive and lower perceived risk for individuals and businesses.

Group Purchase

A group purchase scheme is a collective buying model where residents/organisations pool demand for clean solutions like solar or heat pumps to secure lower costs and accelerate adoption. It reduces upfront barriers and sends strong market signals to scale decarbonisation.

The leading scheme, Switch Together, previously known as Solar Together, has recently extended from solar to also include heat pumps. Switch Together is a group purchasing scheme, coordinated by local authorities, which enables residents to install technologies at reduced rates. Suppliers compete in a reverse auction to offer the lowest price, and participating households benefit from costs typically lower than those available individually. At present, Switch Together is the only established provider of this model, but similar group purchasing approaches could be explored for other technologies such as heat pumps or battery storage.

Revolving Loan Funds[82]

Revolving loan funds allow councils to provide low-cost loans for energy efficiency and renewable projects, using an upfront capital pool that is replenished as loans are repaid. These funds are typically administered by third parties such as community finance institutions or banks. While arrears are around 1%, risk can be mitigated through affordability checks and legal safeguards, making this a viable option for councils to support the able-to-pay and need-to-pay market.

Accredited Supplier Lists

The council could seek to collect and publish a list of known suppliers with suitable accreditation.

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[80] Energy as a Service Pilot Phase Evidence Report, EON, available at: Energy as a Service: final report

[81] Pay As You Save, UK Green Building Council, available at: Microsoft Word - GBC PAYS exec sum_FINAL.doc

[82] Lendology, available at: Accessible Finance for Home Energy Improvements

Facilitate Events and Forums for Suppliers and Interested Parties

The council could seek to facilitate events and forums where residents and businesses could meet with potential suppliers. The council could maintain a neutral stance by allowing all suppliers to attend who meet certain accreditation levels.

Innovation Mechanisms

Council can run pilots/support innovation mechanisms such as blended finance.

12.7 Next Steps

This chapter provides a high-level assessment of the economic implications of decarbonising the area, focusing on capital investment, benefits, and funding pathways across two transition scenarios. The analysis offers a foundation for understanding the scale and impact of net-zero interventions.

To build on this work for deeper strategic decision-making, we recommend the following next steps:

Expand to a Full Cost-Benefit Analysis (CBA): Building on the current capital expenditure and benefit assessment, the next stage should incorporate operational expenditure (OPEX) and wider societal benefits, enabling calculation of aggregate Net Present Social Value (NPSV). Undertaking a full CBA will provide a more holistic and transparent view of the long-term value and trade-offs associated with net-zero investments, strengthening the evidence base for investment decisions and policy development.

Deep Dive on Funding and Financing Pathways: While this chapter sets out funding and finance pathways at a high level, a more detailed review is required. This should include in-depth modelling of funding mechanisms, sources, and delivery models for each intervention. Achieving a clear and actionable approach will require proactive stakeholder engagement working with local authorities, residents, developers, and industry partners to validate assumptions, clarify roles, and co-design effective funding solutions.

These next steps will ensure the economic case for decarbonising the area is robust, comprehensive, and tailored to local needs, providing a strong foundation for future investment and delivery.

13 Prioritisation

This section details the recommended framework for prioritising decarbonisation interventions within the Nottingham LAEP. It identifies projects for short-term and long-term action, outlines key focus zones, and addresses dependencies and uncertainties.

13.1 Prioritisation Methodology

Interventions have been prioritised through a structured analysis that integrates both quantitative and qualitative considerations. This process was further strengthened by insights derived from stakeholder engagement sessions, ensuring that the prioritisation reflects not only technical feasibility but also local context and stakeholder aspirations. The combined approach provides clarity on the categorisation of actions into “quick wins,” which deliver immediate and visible benefits, “enablers,” which create the necessary conditions for future progress, and longer-term strategic investments that underpin systemic transformation.

Table 13.1 summarises the core criteria for the prioritisation analysis and how they will be ranked relative to each other by the local authorities and other stakeholders. Levels of priority will be fixed during the prioritisation workshop, however our experience of would suggest that the focus areas should include the impact to levels of fuel poverty, the use of existing funding streams that can be leveraged in the short term, and taking into account the local grid readiness. The system carbon impact of implementations was not considered to be a priority as the measures collectively are set out to achieve Net Zero, so the feasibility of implementation in the short term was considered to be more relevant in determining short-term actions.

Table 13.1: Summary of Prioritisation Criteria

Core Criteria	Definition	Why it matters	Ranking
Equity and fuel poverty	Extent the measure impacts on levels of fuel poverty.	Supports a just transition by ensuring vulnerable groups benefit from decarbonisation efforts	Higher
Funding Availability	Access to public or private finance for implementation	Determines the likelihood of implementation and scalability, especially in resource-constrained environments.	Higher
Local grid readiness	Likelihood of DNOs being able to facilitate implementation at the local level in the short term	Contributes to stable operation of the electricity network and allows time for DNOs to plan and execute necessary upgrades in constrained areas	Higher
Cost effectiveness (WLC)	Net present value of an intervention, as a proxy for affordability for end users	LAEP requires robust cost inputs and standardised assumptions to identify “most cost-effective combination of options”	Medium
Deliverability & readiness	Consenting, supply chain readiness, ease of installation	Ensures practical feasibility and timely deployment of measures to a high standard of quality	Medium
Local economic & health co-benefits	Job creation and improvements to air quality	Considers wider benefits associated with energy decarbonisation and how these can be realised locally	Lower
Risk & uncertainty exposure	Technology maturity, future-proofing, interoperability	Reduces exposure to technology uncertainty and focusses on long-term viability of investments	Lower
Carbon impact	Carbon abatement potential, including lifetime tCO_2e savings per project	Acknowledges the time-value of emissions by pursuing steep decarbonisation in the early years	Lower

13.2 Dependencies and Uncertainties for Interventions

Delivery of the interventions identified in the LAEP is influenced by a set of dependencies and uncertainties that shape its feasibility, timing, and overall impact. Dependencies refer to the enabling conditions or prerequisite actions that must be in place for successful delivery. These may include the availability of supporting infrastructure, alignment with regulatory frameworks, readiness of supply chains, and access to skilled labour. For example, the rollout of heat pumps may depend on grid capacity upgrades, installer training programmes, and consumer incentives.

Uncertainties, on the other hand, arise from factors that are difficult to predict or control, such as fluctuations in technology costs, changes in policy direction, market behaviour, and the pace of innovation. These uncertainties can influence both the cost-effectiveness and deliverability of interventions, requiring adaptive planning and risk mitigation strategies. Recognising these dynamics is essential for sequencing actions effectively, as interventions with high dependency or uncertainty may need to be phased later or supported by enabling measures.

Table 13.2 summarises the key dependencies and uncertainties relevant to the successful delivery of this LAEP and provides a clear reference point for understanding the conditions that underpin successful implementation and the risks that must be managed to maintain progress toward long-term objectives.

Table 13.2: Summary Dependencies and Uncertainties

Dependency / Uncertainty	Why it matters	Suggested mitigation
Funding	Funding availability is essential for project delivery and scalability	Identify and align with existing funding streams. Coordinate with EMCCA to explore alternative funding mechanisms and partnership opportunities. Explore public-private sector partnerships to enable access to wider expertise and funding, to accelerate delivery. Leverage the ‘able-to-pay’ and support ‘need-to-pay’ markets through education around the benefits associated with interventions.
Electricity network capacity & connection queues	PV, ASHPs, EV projects depend on headroom; connection delays can defer benefits	Ongoing detailed engagement with NGED with regard to the outcomes of this LAEP and with regard to any projects that are taken forward off the back of the LAEP. Ensure targeted grid reinforcement to enable delivery of priority projects.
Energy price volatility	Operating costs (ASHP vs Gas vs Heat network)	Adopt a fabric first approach to minimise demand when switching to lower carbon solutions. Adopt local renewable generation and energy storage systems to help shift demand and reduce exposure to pricing risk. Ensure energy consumers are educated on the opportunities and risks associated with prosumer behaviours, such as use of time-of-use tariffs for ASHP.
Supply chain & skills	Heat pump, insulation, delivery capacity may constrain pace	Policy considerations such as Training programmes, funding and incentives. Strategic partnerships between public and private sector.
Public trust & uptake	Public acceptance is essential to drive uptake	Community engagement and communication programmes to share good news stories. Work with community energy groups to support with messaging and delivery. Undertake demonstration/pilot projects to enable delivery of and showcase best practice.

Dependency / Uncertainty	Why it matters	Suggested mitigation
Policy evolution	Changes to boiler phase out, market design or zoning rules could shift the plan.	Ensure policy tracking is in place i.e. through a framework to monitor national and regional policy developments and regularly review the LAEP or subsequent project to align with these. Engage with or create local energy forums to enable collaborative adaption of plans and projects to policy changes.
Hydrogen availability/cost	The industrial decarbonisation pathway for Nottingham is highly sensitive to hydrogen price, electricity grid carbon intensity, and technology costs. If hydrogen remains expensive, switching high-temperature processes may be delayed or limited.	Detailed engagement with key stakeholders in this space such as East Midland Hydrogen to advise on potential hydrogen needs in the area. Maintain focus on hard-to-treat high temperature loads with more readily available technologies utilised for wider decarbonisation.

13.3 Focus Zones

Given the large scale of interventions required to achieve a net zero energy system at the local level, it is important to determine where to start the roll-out. 'Focus zones' have be identified that will meet the criteria for short-term implementations. These will be further refined following the prioritisation workshop. Within these focus zones, specific schemes can then be developed by the local authorities to move towards delivery.

13.3.1 Areas With High Fuel Poverty

Fuel poverty remains a significant challenge in Nottingham, with 15.2% of households estimated to be in fuel poverty. This proportion is higher than the East Midlands average of 11.7% and the national average for England of 11.4%, highlighting the disproportionate impact on households in the city compared to regional and national trends.[83]

The Low-Income Low Energy Efficiency (LILEE) definition of fuel poverty was introduced in 2019. Before this, a home was classified as fuel poor if it spent more than 10% of its annual income on space heating and energy services.[84] This is far more likely in a home rated EPC E or below due to lack of insulation and poor thermal retention capability.

Fuel poverty currently contributes to around 155 excess winter deaths across EMCCA annually. Retrofitting homes can have a huge impact on reducing this alongside reducing health inequalities and reducing absences from school and work arising from damp and cold air related illnesses.[85]

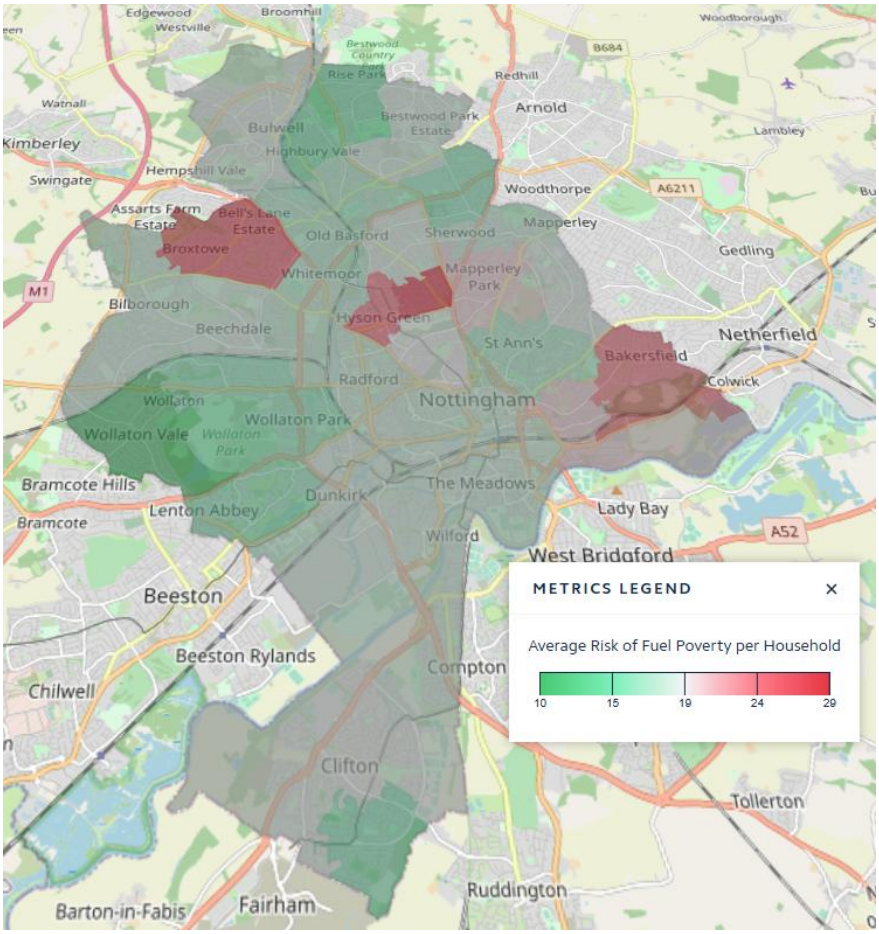
The spatial distribution of average risk of fuel poverty within Nottingham City is uneven, illustrated in Figure 13.1, with certain neighbourhoods more vulnerable to fuel poverty. This disparity underscores the urgent need for targeted interventions that address energy affordability and thermal comfort. Analysis at the MSOA level shows the three areas with the highest proportion of households[86] in fuel poverty in each local authority area, which are set out

[83] Fuel Poverty in England: sub-regional - data.gov.uk
[84] Fuel poverty methodology handbook 2025: Low Income Low Energy Efficiency (LILEE)
[85] 3997_EMCCA RETROFIT STRATEGY_1.pdf

in The visualisation from the IES Digital Twin visualises average risk of fuel poverty across Nottingham City. To granularly analyse fuel poverty at MSOA level, the UK Government fuel poverty dataset has been used, which identifies households classified as fuel poor. The resulting visualisations may vary due to differences in underlying methodology, indicators, and spatial aggregation, as the IES approach reflects relative vulnerability and exposure to fuel poverty drivers, whereas the UK Government dataset reports the prevalence of fuel poverty based on a defined income and energy cost threshold.

Table 13.3.

Figure 13.1: Fuel Poverty across Nottingham City per MSOA



Source: IES Digital Twin

The visualisation from the IES Digital Twin visualises average risk of fuel poverty across Nottingham City. To granularly analyse fuel poverty at MSOA level, the UK Government fuel poverty dataset has been used, which identifies households classified as fuel poor. The resulting visualisations may vary due to differences in underlying methodology, indicators, and spatial aggregation, as the IES approach reflects relative vulnerability and exposure to fuel poverty drivers, whereas the UK Government dataset reports the prevalence of fuel poverty based on a defined income and energy cost threshold.

Table 13.3: Proportion of Fuel Poor Households in Nottingham MSOAs

Local Authority	MSOA	Total Number of Fuel Poor Households	Proportion of Fuel Poor Households
Nottingham City	Lenton & Dunkirk	159	28.2%

Local Authority	MSOA	Total Number of Fuel Poor Households	Proportion of Fuel Poor Households
	Hyson Green	813	25.0%
	Forest Fields	592	22.3%

Focusing retrofit programmes on these zones offers significant benefits. Fabric-first measures, including improved insulation, airtightness, and glazing upgrades, can substantially reduce heat loss, lower energy bills, and improve indoor comfort. Beyond carbon reduction, these interventions deliver critical social co-benefits: alleviating fuel poverty, improving health outcomes, and reducing financial stress for vulnerable households.

Within the areas with high fuel poverty, implementation can be further focussed on properties with an EPC rating below D. The spatial distribution of these properties across the area is shown in Figure 13.1. The number of these properties within each of the MSOAs is shown in The visualisation from the IES Digital Twin visualises average risk of fuel poverty across Nottingham City. To granularly analyse fuel poverty at MSOA level, the UK Government fuel poverty dataset has been used, which identifies households classified as fuel poor. The resulting visualisations may vary due to differences in underlying methodology, indicators, and spatial aggregation, as the IES approach reflects relative vulnerability and exposure to fuel poverty drivers, whereas the UK Government dataset reports the prevalence of fuel poverty based on a defined income and energy cost threshold.

Table 13.3. Within these identified properties, the local authorities can have the most influence over housing association properties. The LAEP modelling has identified the number of properties that are occupied as social housing, and those properties suitable for light and deep fabric retrofit.

Through combining these characteristics, we can determine the number of social housing properties in each MSOA that are suitable for a “light + deep” retrofit package, and those that are suitable for a light retrofit only. These are summarised in Table 13.4.

Table 13.4: Properties and Types of Retrofit Packages in Nottingham City

MSOA	Homes below EPC D (1)	Of (1), suitable for light retrofit only	Of (1), suitable for deep retrofit only	Of (1), suitable for light and deep retrofit
Lenton & Dunkirk				
Social Housing	35	5	13	16
Owner Occupied	192	23	53	98
Privately Rented	335	22	46	252
Hyson Green				
Social Housing	48	3	12	31
Owner Occupied	286	3	92	191
Privately Rented	227	1	50	175
Forest Fields				
Social Housing	29	-	11	17
Owner Occupied	447	7	119	318
Privately Rented	228	4	53	167
Total	1,827	68	449	1,265

In addition, 88% of the social housing properties in these focus zones have been identified as suitable for ASHP, which could be implemented at the same time, in a ‘touch the property once’ approach. It should be noted, though, that in order to achieve the fuel poverty alleviation

benefits of ASHP in these properties, education of the residents on how to realise the benefits through appropriate electricity tariffs and operation of the system is likely to be required to avoid unintended outcomes.

13.3.2 Electricity Headroom Pockets

Electricity network capacity is a key determinant of where electrification measures, such as heat pump deployment and EV charging, and electricity generation, can be accelerated. Analysis of grid utilisation across Nottingham City, in Section 11.1, identifies pockets of available headroom for both demand and generation, where additional electrical systems can be accommodated without immediate reinforcement. These areas represent prime opportunities for early roll out of ASHP, PV and EV charging, as they are likely to be able to be delivered with minimal infrastructure upgrades, reducing cost and complexity.

Demand Headroom

Analysis in Section 11 indicates that demand headroom at the primary substation level is mostly in The Park & Castle and St Ann's West regions in the near-term. Based on this, focus zones for the early roll-out of ASHP would be in The Park & Castle, Beechdale and St Ann's West regions, with EV charging focus zones in the more urban areas with headroom, such as The Park & Castle and St Ann's West regions.

Areas with high grid utilisation require a different approach. In these zones, demand-side response (DSR) strategies should be prioritised to manage peak loads in the short term while longer-term network reinforcement is planned and delivered. These measures may include solar PV paired with battery storage or the use of vehicle-to-grid technologies, which can help optimise network operation and reduce immediate constraints. However, flexibility services do not remove the need for all reinforcement and should be viewed as transitional interventions that support system operation during the delivery of required infrastructure upgrades and the preparation of the network for future electrification.

Further detailed engagement with NGED will be required to determine viable timescales for delivery as projects are developed in more detail, ensuring that planned interventions align with network reinforcement schedules and operational constraints and support a coordinated and efficient rollout of electrification measures.

Table 13.5: MSOAs with Highest headroom

MSOAs with highest headroom	Homes above EPC D (1)	Of (1), social housing (2)	Of (2), homes suitable for ASHP	Of (1), homes suitable for ASHP
The Park & Castle	787	72	69	712
Beechdale	1,162	668	663	1,124
St Ann's West	1,387	738	241	606
Total	3,336	1,478	973	2,442

13.3.3 Heat Network Zones

Potential heat network zones have been identified, clustering around key anchor loads and off-takers that provide a strong foundation for network viability. Developing these zones as a priority intervention offers multiple benefits: it alleviates grid constraints in surrounding areas by reducing reliance on electricity for heating, supports rapid decarbonisation at scale, and delivers lower-cost, and potentially lower-carbon, heat compared to the alternative scenario of widespread ASHP deployment in these zones.

This approach leverages existing infrastructure and demand clusters to create a strategic, cost-effective pathway for heat decarbonisation. The identified focus (City Centre and Western Zone) are set out in Section 7. These potential heat networks could provide an alternative to the deployment of 6,941 heat pumps across domestic and no-domestic properties across Nottingham.

13.4 Quick Win Projects

Quick wins represent a category of interventions that can be implemented immediately with minimal complexity and high confidence in successful delivery. These actions are often described as “no regrets” because they rely on existing evidence, proven technologies, and established funding routes, making them low-risk and highly practical. They deliver immediate carbon savings, are highly cost-effective, and offer visible progress that builds momentum for more complex programmes. Quick wins also generate wider benefits such as reduced operational costs, improved system efficiency, and enhanced social and economic outcomes. Their prioritisation is underpinned by high scores for system carbon impact, cost-effectiveness, and deliverability, while also addressing equity and co-benefits where possible.

13.4.1 Rooftop Solar PV on Public Estate Buildings

Installing rooftop solar PV systems on suitable public properties, such as libraries, schools, and community centres, paired with battery storage where viable, presents an immediate opportunity to decarbonise public sector operations. This intervention focuses on sites with consistent daytime energy loads, making effective use of existing roof space for on-site renewable generation. By reducing grid dependency and lowering operational costs for public services, it delivers strong technical and economic benefits. The measure scores highly on carbon impact, cost-effectiveness, and deliverability, while also performing well on network impact by optimising grid flexibility. In addition, it offers local economic co-benefits through job creation in installation and maintenance and demonstrates visible leadership that can encourage wider adoption.

Table 13.6: Summary of Public Estate Sites with Associated Baseline Electricity Demand

Local Authority	Primary Use Type	Number	Baseline Electricity Demand (MWh)
Nottingham	Community Centre	74	2,386
	Primary School	479	17,397
	Public Administration Building	8	1,136
	Secondary School	28	1,136

13.4.2 Fuel Poverty Led Social Housing Retrofit

Targeting fuel-poor households through social housing retrofit programmes, such as the Warm Homes Social Housing Fund, supports both climate and social equity objectives. These initiatives focus on areas of greatest need by improving building fabric and thermal efficiency. This intervention not only reduces emissions but also improves energy affordability, lowers household bills, and enhances health outcomes for vulnerable residents. Areas such as Lenton & Dunkirk, Hyson Green and Forest Fields have the highest concentration of households in fuel poverty. Notably, over 70% of properties in these areas are rated EPC D or below.

Table 13.7: Identified Implementations of Fuel Poverty Led Social Housing Retrofit

MSOA	Number of properties identified	Light Retrofit CAPEX	Deep Retrofit CAPEX	Estimated Annual Carbon Savings Light Retrofit (tCO2e)	Estimated Annual Carbon Savings Deep Retrofit (tCO2e)
Lenton & Dunkirk	72	£333,920	£10,836,630	25	162

MSOA	Number of properties identified	Light Retrofit CAPEX	Deep Retrofit CAPEX	Estimated Annual Carbon Savings Light Retrofit (tCO2e)	Estimated Annual Carbon Savings Deep Retrofit (tCO2e)
Hyson Green	668	£605,582	£19,273,359	41	296
Forest Fields	738	£109,231	£9,070,637	6	164

13.4.3 Light Retrofit Measures

Light retrofit measures, including cavity wall insulation and loft insulation top-ups, represent low-cost, high-deliverability actions that can be implemented relatively quickly across the able-to-pay market. These measures improve energy efficiency, reduce running costs, and create immediate co-benefits such as improved comfort and lower energy bills. However, the speed of rollout depends on addressing common barriers such as homeowner awareness, upfront costs, and trust in installers. While these measures are technically straightforward, homeowners and landlords may choose not to invest without clear incentives or support.

To enable rapid uptake, the council can play a proactive role in creating an environment that encourages action. This could include launching targeted awareness campaigns to highlight the benefits of retrofit and the availability of funding or incentive schemes, as well as providing a centralised one-stop shop for advice and guidance on retrofit options, costs, and potential savings. Establishing and promoting a list of council-approved installers would help build consumer confidence and reduce perceived risks associated with quality and reliability. In addition, signposting to financing options such as grants, low-interest loans, or national schemes can help overcome concerns about upfront costs.

Table 13.8: Estimated Light Retrofit Investment and Carbon Savings by Housing Tenure Type

Tenure Type	Count of Properties	Estimate CAPEX	Annual Carbon Savings (tCO2e)
Housing Association	2,523	9,530,654	629
Local Authority	3,435	10,196,032	588
Owner Occupied	27,532	134,775,085	9,510
Privately Rented	10,702	37,517,079	2,566

13.4.4 Small Roof-Mounted PV and Battery Storage Installs on Suitable Homes

Small roof-mounted PV installations on suitable homes offer a scalable solution for household-level renewable generation. We modelled the uptake and estimated costs of these systems alongside domestic battery storage, assessing their potential contribution to local energy generation and flexibility.

This measure empowers residents to participate in the energy transition, reducing reliance on fossil fuels and enhancing energy resilience. It performs strongly on system carbon impact and cost-effectiveness and deliverability. Co-benefits include increased energy independence and potential local economic gains through installation activity.

As with other homeowner-led measures, uptake depends on motivation and overcoming barriers such as upfront costs, lack of awareness, and trust in installers. The example enabling actions outlined in 13.4.3, including council-led awareness campaigns, a one-stop shop for retrofit advice, and maintaining a list of approved installers, are also relevant here. These can

be complemented by PV-specific initiatives such as signposting funding schemes and exploring group-buying or community solar programs to reduce costs and increase participation.

Table 13.9: Estimated Solar PV Investment and Carbon Savings by Property Type

Property Type	Estimated Capex (£)	Annual Yield (MWh)	Estimated Annual Carbon Savings (tCO2e)
Multi Dwelling	£55,530,919	22,924	4,745
Single Dwelling	£384,704,352	157,454	32,593
Non-Domestic	£215,455,572	88,411	18,301

13.5 Enabling Actions

Enabling actions are interventions that do not directly deliver physical assets but are critical to unlocking future opportunities and accelerating delivery at scale. They establish the institutional, technical and market conditions required for the successful implementation of physical interventions

Enabler projects are interventions that do not necessarily deliver the largest immediate carbon savings but are critical for unlocking future opportunities and accelerating the transition at scale. These actions create the foundational conditions required for the successful deployment of more complex or high-impact measures. Unlike quick wins, which focus on immediate and visible benefits, enablers are strategic investments in capability, infrastructure, and market readiness. They often involve activities such as upgrading grid capacity, developing supply chains, implementing supportive policy frameworks, and investing in workforce training. For example, large-scale electrification of heating systems cannot proceed without prior investment in grid reinforcement and installer skills development, both of which are typical enabling actions.

Enablers also include interventions that address systemic barriers, such as data gaps, regulatory constraints, and financing challenges. By resolving these issues early, enabler projects reduce uncertainty and dependency risks for subsequent interventions, ensuring that future programmes can be delivered efficiently and cost-effectively. These actions often require collaboration across multiple stakeholders, including local authorities, industry partners, and community organisations, to align priorities and secure long-term commitment. In many cases, enabler projects will require coordination with DNOs, regional authorities such as EMCCA, and private sector actors to ensure that technical, regulatory, and financial conditions are met.

In the residential sector, enabling actions are particularly important because households are not homogeneous in their ability to invest in decarbonisation measures. For the purposes of delivery, residents can be broadly grouped into fuel-poor households, “need to pay” households[87], and able-to-pay households. Fuel-poor households typically require full or near-full grant support, while able-to-pay households can finance upgrades independently through private capital. However, a substantial proportion of households fall into the “need to pay” category: not fuel poor, but constrained by high upfront costs, uncertainty, or lack of access to affordable finance. Enabler projects that address financing models, provide trusted advice,

[87] Stakeholder feedback highlights that the need-to-pay segment represents a significant proportion of households and is critical to support if the net zero transition is to be achieved at scale.

aggregate demand, and support market development are therefore critical to unlocking uptake among this group and enabling residential decarbonisation to scale.

13.5.1 Electricity Grid Capacity Outlook

The targeted grid reinforcement is a fundamental enabler for large-scale electrification and deployment of distributed renewable generation. Rising demand from heat pumps, electric vehicles and solar PV is already placing pressure on local networks, with capacity constraints presenting a material barrier to delivery. Strategic reinforcement in areas with lower existing constraints can improve efficiency, reduce costs and better align investment with future demand growth.

Local authorities have an important convening role in supporting effective planning. At a strategic level, the LAEP should be submitted to local DNOs to inform regulatory submissions, longer-term forecasting and annual updates to the DFES, ensuring visibility of future demand, community energy activity and renewable ambitions.

In the short term, particularly within focus zones, local authorities should facilitate early engagement with DNOs through ‘Connections Surgeries’. These sessions enable early verification of connection feasibility at neighbourhood level, helping to manage expectations and identify potential constraints before formal applications are submitted and costs incurred. They can also help identify areas with available capacity to inform subsequent phases of delivery.

Connections Surgeries are publicly accessible and provide an opportunity to discuss technical requirements, timescales, consents and constraints with network planners. Holding these sessions at an early stage supports informed decision-making and reduces the risk of abortive work.

Developers and delivery partners should also be encouraged to use publicly available tools, including NGED’s Network Opportunity Map and the NGED open data portal. Given the number of grid-related challenges raised during the LAEP process, ensuring awareness of these resources across local authority teams, commercial developers and community energy groups are particularly valuable.

Targeted grid reinforcements are a fundamental enabler for the large-scale deployment of electrification technologies and distributed renewable generation. As electricity demand rises due to the adoption of heat pumps, electric vehicles, and rooftop solar PV, grid capacity constraints present a significant barrier to progress. Strategic reinforcement in areas with minimal existing constraints ensures that upgrades are delivered efficiently, cost-effectively, and in alignment with future demand growth.

In line with regulatory requirements, NGED must demonstrate a clear and evidenced need for grid reinforcement before investment can be progressed. Local authorities therefore have an important role in providing confidence in future demand through robust project pipelines, spatial planning evidence, and early engagement on anticipated electrification programmes, helping to de-risk investment decisions and support timely delivery of reinforcement works.

13.5.2 Education and Demonstrator Projects

The successful delivery of the LAEP will depend on building public understanding and confidence in low-carbon technologies and retrofit measures. Education and demonstrator projects are essential to achieve this. The council can lead targeted educational initiatives that explain the benefits of energy efficiency, renewable generation, and electrification, while addressing common concerns about cost, disruption, and reliability. This could involve public workshops, and online resources.

Alongside education, demonstrator projects will provide visible examples of best practice and allow residents to see successful implementations first-hand. These projects might include retrofit exemplars in council-owned housing, pilot schemes for technologies such as heat pumps and solar PV, and open-home events where early adopters share their experiences. Demonstrator projects not only help overcome scepticism but also provide valuable data and insights to inform wider rollout.

13.5.3 Local Bulk Procurement Frameworks

Local bulk procurement frameworks for retrofit measures, solar PV and heat pumps are a strategic enabler that can address cost, delivery risk and supply-chain capacity. Aggregating demand across projects and stakeholders unlocks economies of scale, reduces unit costs and provides suppliers with greater confidence to invest.

Well-designed frameworks can improve quality assurance, accelerate market readiness and support local economic development by providing smaller contractors with access to larger programmes. Delivery will require coordinated action between local authorities, housing providers and private sector partners to ensure procurement processes are transparent, efficient and aligned with long-term decarbonisation objectives.

These frameworks could also support the development of an ‘approved supplier’ list hosted through the LAEP hub, improving consumer confidence and establishing minimum quality standards. Lessons from initiatives such as the Nottingham Energy Partnership could inform governance and oversight arrangements, while procurement criteria could also be used to deliver wider social value outcomes.

In parallel, opportunities for collective power purchase agreements could be explored, including negotiated offtake from large-scale solar or future community energy projects. Pairing technology procurement with favourable tariffs may offer additional benefits, although this would require significant community participation and supplier engagement.

Collectively, these approaches would particularly be valuable to support the need-to-pay market by reducing upfront costs, increasing confidence in delivery, and lowering market and participation risks for households that require coordinated support.

13.5.4 Workforce Training Programmes

Workforce training programmes are critical to ensuring that the transition to net zero is supported by a skilled and capable labour force. The scale of retrofit and low-carbon technology deployment required over the coming decade far exceeds current workforce capacity, creating a risk of delivery delays and cost escalation. Investing in training programmes now will build the necessary skills base for installing heat pumps, delivering high-quality retrofits, and integrating renewable energy systems.

These programmes should be developed in partnership with industry bodies, vocational training providers, and regional authorities to ensure alignment with market needs and future demand. Workforce development not only supports decarbonisation objectives but also delivers wider economic benefits through job creation and skills enhancement.

13.5.5 Financing Mechanisms for Low-Income Households

A key consideration regarding funding mechanisms is starting by maximising uptake of existing central government schemes. Through keeping up to date with central government policy, such as the recent expansion of the Boiler Upgrade Scheme to include air-to-air ASHPs and taking responsibility for sharing the appropriate information with relevant residents and businesses, uptake of supported interventions could be increased in the near future.

In addition to this, developing innovative financing mechanisms for low-income households is essential to ensure an equitable and inclusive transition. Many households face significant financial barriers to adopting energy efficiency measures or low-carbon technologies, even when long-term savings are substantial. Enabler actions in this area for the local authorities in partnership with other stakeholders include the creation of accessible loan schemes, targeted grant programmes, and blended finance models that reduce upfront costs and spread repayments over time. These mechanisms should complement existing national schemes while addressing local gaps in provision.

13.5.6 Funding Opportunities

The suspension of the PSDS has created an urgent need to identify alternative funding streams for public sector organisations. Many local authorities and public institutions operate under severe financial constraints, limiting their ability to invest in energy efficiency and renewable energy projects. An alternative funding model is urgently needed to maintain momentum in public sector decarbonisation. These should prioritise projects that deliver high-impact carbon reductions and operational savings, such as building retrofits, heat decarbonisation and renewable energy installations. Some suggested alternative funding routes have been outlined in Section 12.6.

13.5.7 Industrial Decarbonisation & Hydrogen Readiness

Industrial decarbonisation is essential to achieving net zero while maintaining competitiveness. Limited data availability and variable decarbonisation pathways mean further engagement is required, particularly with large emitters not engaged through the LAEP process.

An initial step could include establishing an industrial electrification showcase to connect businesses with suppliers and address perceptions around cost and feasibility. Awareness of mechanisms such as the British Industry Supercharger[88] will be important in supporting uptake. This approach complements a fabric-first and electrification-first strategy while retaining optionality for hydrogen where appropriate.

Where electrification is not feasible, hydrogen readiness represents a critical enabling action. Coordinated preparation across demand, infrastructure, skills and governance reduces delivery risk and supports timely adoption when supply becomes viable.

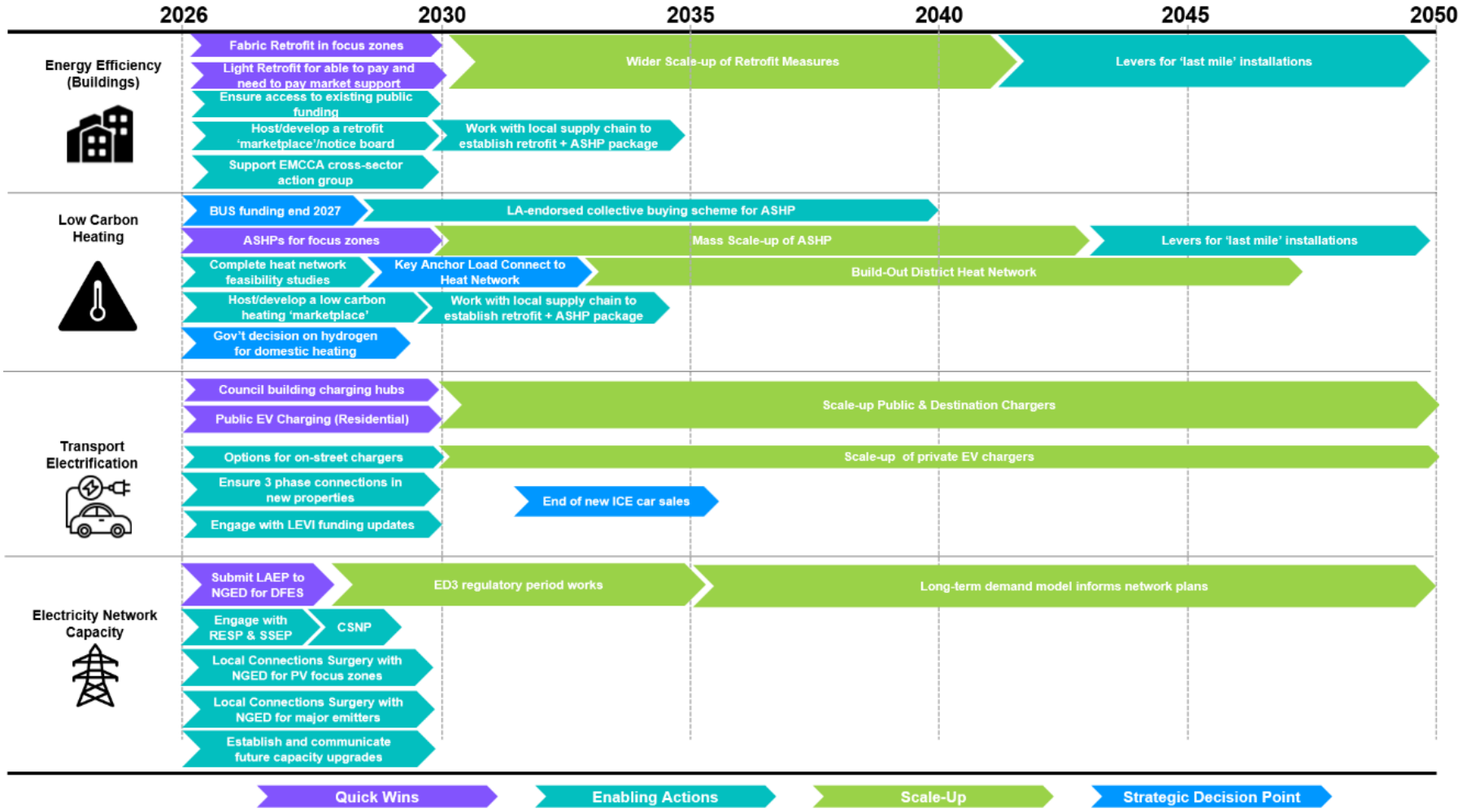
Improving understanding of industrial and commercial energy demand and decarbonisation intentions will also support more effective infrastructure planning. Integrating this insight into DFES processes will help DNOs align reinforcement with combined residential and industrial demand and may unlock opportunities for cross-sector collaboration, such as waste heat use in heat networks.

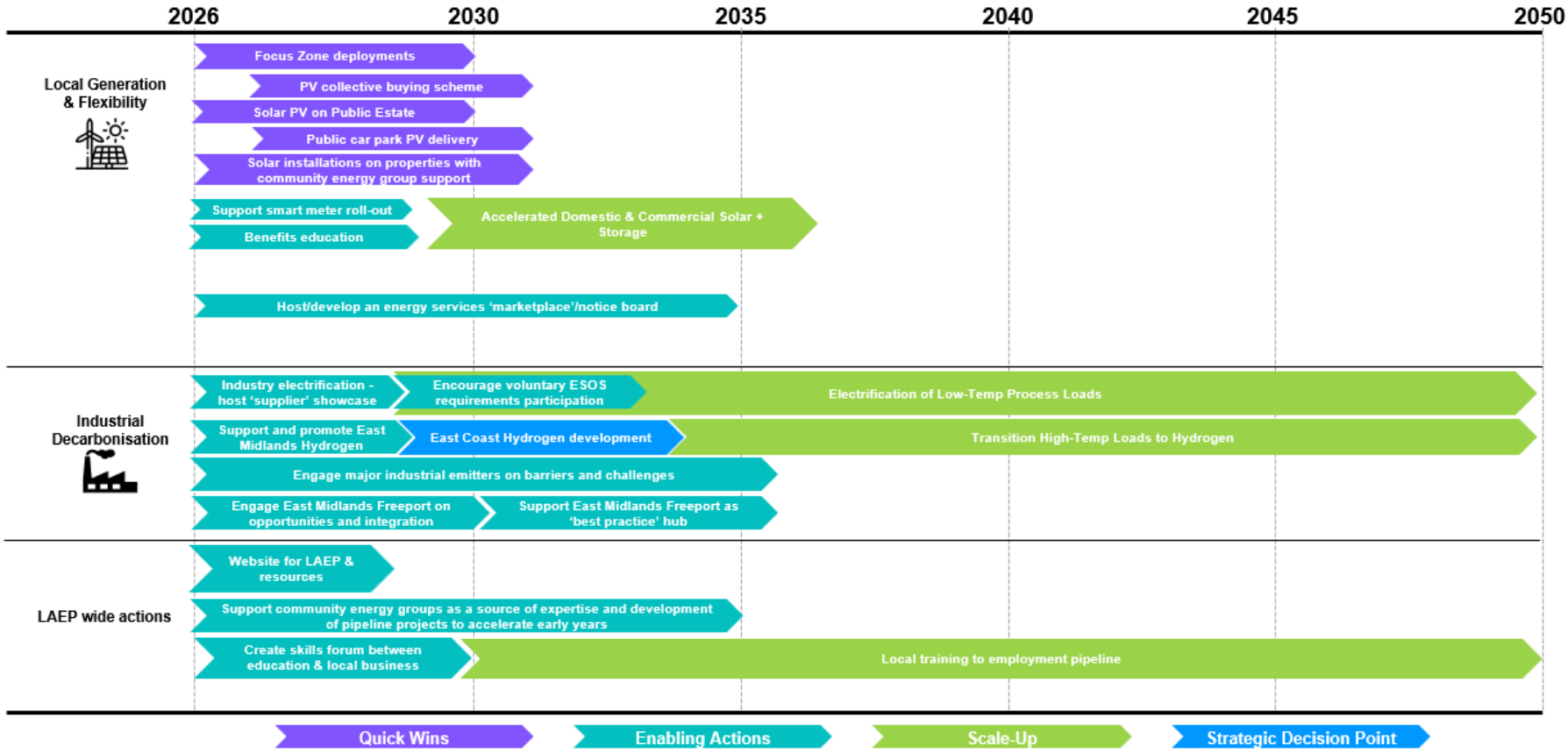
13.6 Phased Pathway

Figure 13.2 sets out the delivery sequence for Nottingham's net zero interventions. Actions are phased to prioritise "quick wins" and "low regret" measures first, those that are cost-effective, widely supported, and deliver immediate benefits. Enabling actions and demonstrators lay the groundwork for larger-scale roll-out, while strategic decision points and uncertainties are highlighted to ensure the plan remains flexible and responsive as technologies and funding evolve. This approach maximises early impact, manages risk, and builds momentum for long-term transformation.

[88] The British Industry Supercharger is a UK government support package that reduces electricity and network costs for energy-intensive industries to bring their power prices in line with international competitors and support competitiveness and decarbonisation.

Figure 13.2: Nottingham City Phased Pathway of Quick Wins, Enabling Actions, Scale Up and Strategic Decision Points




2026
2030
2035
2040
2045
2050
Local Generation & Flexibility
Focus Zone deployments
PV collective buying scheme
Solar PV on Public Estate
Public car park PV delivery
Solar installations on properties with community energy group support
Support smart meter roll-out
Benefits education
Accelerated Domestic & Commercial Solar + Storage
Host/develop an energy services 'marketplace'/notice board
Industrial Decarbonisation
Industry electrification - host 'supplier' showcase
Encourage voluntary ESOS requirements participation
Electrification of Low-Temp Process Loads
Support and promote East Midlands Hydrogen
East Coast Hydrogen development
Transition High-Temp Loads to Hydrogen
Engage major industrial emitters on barriers and challenges
Engage East Midlands Freeport on opportunities and integration
Support East Midlands Freeport as 'best practice' hub
LAEP wide actions
Website for LAEP & resources
Support community energy groups as a source of expertise and development of pipeline projects to accelerate early years
Create skills forum between education & local business
Local training to employment pipeline
Quick Wins
Enabling Actions
Scale-Up
Strategic Decision Point

14 Conclusions and Next Steps

The Nottingham LAEP provides a robust, data-driven, and spatially informed framework for delivering an equitable and economically efficient transition to net zero. It aligns Nottingham's local ambitions with regional and national policy objectives while tailoring interventions to the area's unique socioeconomic, infrastructural, and industrial characteristics.

The analysis presented throughout this plan confirms that Nottingham can significantly decarbonise its energy system by accelerating progress on energy efficiency, heat decarbonisation, and transport electrification while expanding local generation and enhancing system flexibility. The modelling outcomes demonstrate that these interventions, when coordinated effectively, deliver measurable benefits in emissions reductions, cost efficiency, and community well-being.

14.1 Key Outcomes

The modelling and analysis confirm that Nottingham can achieve substantial emission reductions across properties, transport, and industry by following a sequenced and place-based approach. The emissions reductions are supported by strong co-benefits in fuel poverty alleviation and energy resilience.

Energy efficiency forms the cornerstone of the transition. Retrofit measures particularly in pre-1929 solid-wall homes and poorly insulated estates can significantly reduce space heating demand and operational costs while improving indoor comfort. A fabric-first approach is not only the most immediate means of reducing carbon emissions but also the foundation for cost-effective heat decarbonisation and grid stability. Targeting deep retrofit in focus zones with high fuel poverty risk ensures that the social benefits of net zero are distributed fairly.

Heating system transformation is equally central. The deployment of air-source heat pumps, heat networks, and supporting controls will replace the area's reliance on natural gas. Ensuring access to available funding and appropriate education for residents will be key to realising the benefits, alongside working with local business and skills institutions to establish the supply chain to keep the economic benefits of the installation pipeline in the local area.

Transport electrification presents the single largest emissions reduction potential. The LAEP scenario requires approximately 166,900 electric vehicles by 2050, supported by an accessible charging network. Starting from a low level of charging infrastructure, the area needs to progress this at a fast pace in the early years to avoid long-term impacts from a delayed start. Smart charging integration and uptake of time-of-use tariffs are essential for minimising strain on the grid and unlocking flexibility as well.

Local renewable generation, particularly rooftop solar, stands out as a major economic driver. It delivers net benefits exceeding £400 million and underpins local resilience by reducing exposure to volatile energy prices. The rollout will need to be planned in conjunction with the local electricity distribution network (NGED) in order to deliver in line with changes to network capacity. Integration with storage and smart systems enables households and organisations to participate actively in a flexible, low-carbon energy market.

Economic appraisal indicates that the 2040 Net Zero scenario requires approximately £4.0 billion in additional discounted capital investment. Although this represents a substantial commitment, the system-wide benefits, including around £654 million in bill savings, £33m in improved health outcomes, and £1.7 billion of carbon savings, position the transition as an economically rational long-term investment.

14.2 Strategic Implications

Delivering the LAEP will require coordinated action, stable policy support, and institutional readiness. The plan identifies the need for a dedicated Nottingham LAEP Delivery Partnership comprising Nottingham City Council, EMCCA, DNO, local housing providers, industry representatives, and community organisations. This governance structure would ensure that delivery is sequenced, resourced, and monitored effectively across multiple actors.

Funding and finance remain critical enablers. Leveraging national mechanisms such as the Warm Homes Plan, and Great British Energy programmes will be essential. However, innovative local financing models, including community energy investment, public–private partnerships, and aggregated purchase schemes, will also be needed to bridge funding gaps.

Skills and supply chain development represent both a challenge and an opportunity. The transition will require a significant expansion of the local workforce trained in retrofit, and heat pump installation. Collaboration between regional universities, local colleges, and industry partners can help build a resilient regional skills pipeline, ensuring that the economic benefits of the transition remain within the local economy.

Integration with spatial planning and infrastructure investment is also key. Embedding LAEP outputs into the councils' Local Plans and infrastructure pipeline will help ensure that energy considerations shape new housing developments, regeneration projects, and industrial growth corridors. Similarly, early engagement with the DNO will be necessary to align reinforcement schedules with the forecast growth of low-carbon technologies.

Nottingham's transition to net zero is both an environmental necessity and an opportunity to create a fairer, healthier, and more prosperous area. The LAEP demonstrates that with clear priorities, place-based planning, and coordinated governance, it is possible to achieve deep decarbonisation while delivering tangible local benefits.

The next decade will be decisive. By acting early on energy efficiency, low-carbon heat, and electrified transport, Nottingham can capture the economic and social advantages of the transition ahead of national timelines. Regular monitoring, transparent reporting, and adaptive management will ensure that progress remains on track and that interventions continue to deliver value for money.

14.3 Next Steps

To ensure the timely and effective delivery of the LAEP, the following immediate and critical steps are recommended:

- **Establish a Nottingham LAEP Delivery Partnership**: Create a cross-sector partnership chaired by Nottingham Council and supported by EMCCA, DNO, local businesses, housing associations, and community representatives. This body should oversee programme coordination, track progress, and identify funding opportunities
- **Launch Public Uptake and Engagement Programme with online 'hub':** Implement the recommended community engagement and communication strategy with urgency. This programme is vital to build public confidence, share good news stories, and drive the necessary adoption of low-carbon technologies like heat pumps. Priority should be given to demonstration and pilot projects that showcase best practice and real-world results.
- **Develop a Delivery Roadmap and Investment Plan**: Prioritise the short-, medium-, and long-term interventions identified in Chapter 13, including both quick wins and enabling actions.

- **Secure Early-Stage Funding and Demonstrator Projects**: Identify and secure initial funding mechanisms (local, regional, and national) to kick-start demonstrator projects in focus zones that can showcase tangible early benefits and build public support.
- **Hydrogen**: Initiate detailed engagement with key regional hydrogen stakeholders, such as East Midlands Hydrogen and Cadent Gas, to better advise on Nottingham's specific industrial demand and the infrastructure development timeline. This will allow for informed decision-making regarding long-term solutions for high-temperature, hard-to-treat loads.
- **Monitor, Review, and Update:** Establish a monitoring framework with key performance indicators (KPIs) aligned to emissions reduction, energy demand, and social outcomes. The LAEP should be reviewed on a five-year cycle to reflect policy developments, technological advances, and local progress.
- Continued consultation on **local projections for district heating** rollout, including quantification of the associated energy impacts, as well as further validation of non-domestic energy demand reviewing digital-twin land-use classifications.
- Improved identification of **construction timelines for non-domestic developments**, along with greater visibility of new domestic developments post 2029 energisation. This will ensure more accurate assessment of peak demand to support effective engagement and future planning with distribution and system operators.
- Continued **engagement with National Grid** to ensure LAEP modelling outputs are effectively incorporated into DFES. Continued engagement with NESO to ensure planning for new developments and low-carbon technology rollout is reflected in regional network planning.

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A. Glossary of Terms

Term	Definition
ADMD (After Diversity Maximum Demand)	The expected peak electrical demand after accounting for diversity of use; used by distribution network operators to assess grid impacts of electrification.
Anchor Load	A large, consistent heat or electricity demand (e.g. hospitals or universities) that underpins the technical and commercial viability of heat networks.
ASHP (Air Source Heat Pump)	An electrically powered heating system that extracts heat from outdoor air to provide space heating and hot water.
BAU (Business as Usual)	A baseline projection that assumes only currently legislated policies and no additional local intervention; used as the counterfactual scenario.
BSP (Bulk Supply Point)	A high-voltage electrical substation that transfers electricity from the transmission network to primary substations.
Building Geometries	Digital representations of building footprints, height, and form used within the energy model to simulate energy demand and emissions.
Capex (Capital Expenditure)	Up-front investment costs required to deliver technologies and infrastructure associated with decarbonisation.
CCC (Climate Change Committee)	The UK's independent advisory body on climate change, responsible for setting Carbon Budgets and recommended decarbonisation pathways.
CN28 (Carbon Neutral Nottingham 2028)	Nottingham City Council's programme aiming to achieve carbon neutrality for Scope 1 and Scope 2 emissions by 2028.
COP (Coefficient of Performance)	A measure of heat pump efficiency, defined as the ratio of heat output to electrical input.
Desk-Based Stakeholder Mapping	An initial analytical process to identify and categorise relevant stakeholders using existing information prior to direct engagement.
DESNZ	Department for Energy Security and Net Zero; UK government department responsible for energy policy and net zero delivery.
Digital Twin	A spatially resolved energy model, developed by IES, used to simulate building-level energy demand, generation, and emissions.
Dynamic 3D Digital Map	An interactive three-dimensional visualisation generated from the Digital Twin, showing spatial variations in energy demand, generation, and emissions.
DNO (Distribution Network Operator)	The organisation licensed to operate and maintain the local electricity distribution network (NGED in Nottingham).
DFES (Distribution Future Energy Scenarios)	Scenario projections produced by DNOs to forecast future energy demand, low-carbon technology uptake, and network impacts.
EMCCA (East Midlands Combined County Authority)	The regional authority commissioning the LAEP and coordinating decarbonisation activity across the East Midlands.
Energy Baseline	A quantified representation of current energy consumption and associated emissions, used as the reference point for scenario modelling.
EPC (Energy Performance Certificate)	A standard UK rating of building energy efficiency, from A (most efficient) to G (least efficient).
EV (Electric Vehicle)	A vehicle powered by electricity rather than fossil fuels, producing zero tailpipe emissions.
Fabric Retrofit	Upgrades to building fabric (walls, roofs, floors, windows) to reduce heat loss and energy demand.
Focus Zones	Geographic areas prioritised for intervention based on overlapping criteria such as fuel poverty, building efficiency, and grid capacity.
Fuel Poverty (LILEE definition)	A condition where households have low income and low energy efficiency, resulting in high energy costs to maintain adequate warmth.

Term	Definition
GIS (Geographic Information System)	Spatial analysis tools used to map buildings, energy infrastructure, emissions, and intervention priorities.
GSP (Grid Supply Point)	The interface between the national electricity transmission network and regional distribution networks.
GVA (Gross Value Added)	A measure of economic contribution resulting from employment and investment activity.
Heat Network / District Heating	A system that supplies centrally generated heat to multiple buildings via insulated underground pipes.
Heat Network Zoning (HNZ)	A national policy framework identifying areas where heat networks represent the most cost-effective decarbonisation solution.
LAEP (Local Area Energy Plan)	A place-based, evidence-led plan identifying the optimal pathway to net zero through coordinated local action.
LCT (Low Carbon Technology)	Technologies that significantly reduce greenhouse gas emissions, including heat pumps, EVs, solar PV, and battery storage.
Light Retrofit	Lower-cost building fabric improvements, such as loft insulation and cavity wall insulation.
MEES (Minimum Energy Efficiency Standards)	UK regulations establishing minimum EPC requirements for rented properties.
MSOA (Middle Super Output Area)	A UK statistical geography used for spatial analysis, typically containing 3,000–6,000 buildings.
NESO (National Energy System Operator)	NESO is the energy system operator for Great Britain.
Net Zero	A state in which greenhouse gas emissions are reduced to zero or fully offset.
National Grid Electricity Distribution (NGED)	National Grid Electricity Distribution; the DNO responsible for Nottingham's electricity distribution network.
Predictive Modelling	The use of historical data, assumptions, and scenarios to forecast future energy demand, technology uptake, costs, and emissions.
PSDS (Public Sector Decarbonisation Scheme)	A government grant programme supporting low-carbon heating and energy-efficiency upgrades in public buildings.
PV (Photovoltaics)	Solar panels that convert sunlight into electricity, commonly installed on rooftops.
Retrofit (Deep)	Comprehensive, higher-cost fabric upgrades such as solid wall insulation, window replacement, and floor insulation to significantly reduce heat demand and enable low-carbon heating.
Retrofit (Light)	Targeted, low-cost energy-efficiency upgrades such as loft and cavity wall insulation to reduce heat loss in buildings with moderate fabric performance.
Scenario Modelling	Simulation of alternative future pathways (Do Nothing, Net Zero 2050, Net Zero 2040) to compare costs and impacts.
S-Curve (Logistic Uptake)	A modelling approach representing slow early adoption, rapid growth, and eventual saturation of technology uptake.
Scope 1 and Scope 2 Emissions	Direct emissions from fuel use (Scope 1) and indirect emissions from purchased energy (Scope 2).
tCO_2e / $ktCO_2e$	Tonnes (or thousand tonnes) of carbon dioxide equivalent, used to report greenhouse gas emissions.
UPRN (Unique Property Reference Number)	A unique identifier used to link building-level data within energy modelling and analysis.
U-Value (W/m^2K)	A measure of thermal transmittance of a building component; lower values indicate better insulation performance.
Validation	The process of checking model outputs against observed data to ensure results are credible and within acceptable tolerances.
V2G (Vehicle-to-Grid)	A technology enabling electric vehicle batteries to export electricity back to the grid to provide flexibility services.

Term	Definition
Warm Homes Plan	**A UK government programme targeting home energy-efficiency improvements and reductions in fuel poverty.**

B. Data Types and Validation

Energy Savings Trust building attributes

Table B.1: List of Attributes Available from Energy Savings Trust for Domestic and Non-Domestic Buildings

Attribute	Domestic	Non-domestic
UPRN	✓	✓
Council Ward	✓	✓
LSOA	✓	×
Postcode	✓	✓
Address	✓	✓
Property Type	✓	×
Property Tenure	✓	×
Property Age band	✓	×
Number of Storeys	✓	×
Property Class	×	✓
Primary Use	×	✓
Mixed Use	×	✓
Building storey height	×	✓
Asset rating band	×	✓
Listed Building	✓	×
Wall Construction Type	✓	×
Wall Insulated	✓	×
In Conservation Area	✓	×
Flood Risk	✓	×
Floor Construction	✓	×
Floor Insulated	✓	×
Loft Insulation Prediction	✓	×
Glazing Type Prediction	✓	×
Heating System	✓	×
Fuel Type	✓	✓
EPC Rating	✓	×
SAP Score	✓	×
Roof Orientation	✓	×
Off gas grid	✓	×
Probability of fuel poverty	✓	×
ECO funding eligibility	✓	×
LAD funding eligibility	✓	×

C. IES Modelling Methodology

Modelling Methodology for Local Area Energy Plans (LAEPs)

Document created by:

Integrated Environmental Solutions Limited

International Sustainability Consulting Developers of the **IES Virtual Environment**

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1 Introduction

The LAEP energy baseline provides an accurate representation of the current local energy system to enable good springboard to base the future energy interventions and decarbonisation pathways from. To model the energy and carbon baseline, as well as interventions and scenarios, IES' digital twin technology was used.

Data from Ordnance Survey (OS), Energy Savings Trust (EST), Electricity Distribution Network Operator (DNO) and Gas Distribution Network (GDN) were input to build the model. Using this data, dynamic thermal physics-based energy simulations were undertaken for each building in the area to determine the baseline energy and carbon results. The attributes and simulated energy results are stored for each building within the digital twin model and can be visualised in the digital online viewer.

The simulated consumption for gas and electricity was verified against UK Government metered data. The energy baseline has been completed for every building in the area, with a large set of linked attributes. The simulated energy consumption and associated carbon emissions are available for each building at annual, monthly levels, and can be broken down into separate components of heating, domestic hot water (DHW), lighting, and equipment. These can also be aggregated to Middle Super Output Area (MSOA) and Local Authority levels.

This 'digital twin' model was used to determine the suitability of energy efficiency interventions including fabric improvements, heat decarbonisation, and renewables. Once measures were mapped to appropriate buildings, simulations were re-run to understand their impact.

2 Model Input Data

The LAEP baseline modelling was performed using IES's Digital Twin software (iCD) which uses available GIS and building related data to simulate the energy and carbon baseline, and to provide results on how energy is used across all buildings. The key data sets were:

1. **Ordnance Survey GIS NGD Buildings data set** to create a 2D polygon layer with building geometries.
2. **Energy Savings Trust (EST) Home Analytics Domestic and Non-Domestic Data Sets** to populate the model with information regarding building characteristics and conditions e.g. building fabric, heating system type, fuel type, etc. The home analytics dataset includes all data recorded in lodged EPC reports, with the EST using a predictive model to estimate the attributes for buildings without an EPC.

The table below lists all attributes imported into the digital twin for domestic and non-domestic buildings, the source, and use in the LAEP.

Note: For a minority of buildings there was limited or non-existent data, therefore a review similar type buildings sourced attributes for assignment.

Attribute	Data Source	Use in LAEP	Domestic Data	Non-domestic Data
UPRN	OS & EST	Geo-locate buildings and map correct attributes	✓	✓
2D Building Polygon	OS	Create building visualisation	✓	✓
Property Age Band	EST	Simulate building energy use	✓	×
Floor Area	EST	Simulate building energy use	✓	✓
Number of Storeys	EST	Simulate building energy use	✓	×
Wall Construction Type	EST	Simulate building energy use	✓	×
Wall Insulated	EST	Simulate building energy use	✓	×
Floor Construction	EST	Simulate building energy use	✓	×
Floor Insulated	EST	Simulate building energy use	✓	×
Loft Insulation Prediction	EST	Simulate building energy use	✓	×
Glazing Type Prediction	EST	Simulate building energy use	✓	×
Building Height	EST	Simulate building energy use	×	✓
Heating System	EST	Simulate building energy use	✓	×
Fuel Type	EST	Simulate building energy use	✓	✓
Property Type	EST	Simulate building energy use	✓	×
Roof Orientation	EST	Simulate suitable PV locations	✓	×
Council Ward	EST	Can be filtered/ visualised	✓	✓
LSOA	EST	Can be filtered/ visualised	✓	×
Postcode	EST	Can be filtered/ visualised	✓	✓
Address	EST	Can be filtered/ visualised	✓	✓
Property Tenure	EST	Can be filtered/ visualised	✓	×

Attribute	Data Source	Use in LAEP	Domestic Data	Non-domestic Data
Property Class	EST	Can be filtered/ visualised	×	✓
Mixed Use	EST	Can be filtered/ visualised	×	✓
Asset Rating Band	EST	Can be filtered/ visualised	×	✓
Listed Building	EST	Can be filtered/ visualised	✓	×
In Conservation Area	EST	Can be filtered/ visualised	✓	×
Flood Risk	EST	Can be filtered/ visualised	✓	×
EPC Rating	EST	Can be filtered/ visualised	✓	×
SAP Score	EST	Can be filtered/ visualised	✓	×
Probability of Fuel Poverty	EST	Can be filtered/ visualised	✓	×
ECO Funding Eligibility	EST	Can be filtered/ visualised	✓	×
X&Y Coordinates	OS & EST	Can be filtered/ visualised	✓	✓
Electricity Network Capacity Data at MSOA Level	National Grid DNO, Western Power, Northern Powergrid	Can be filtered/ visualised	✓	✓
Non-domestic Gas Consumption at SIC Code Level	Gas GDN	To determine and visualise the Top Non-Domestic Gas Users	×	✓
Local Authority Building Data Sample (where available)	Local Authority	Additional attributes added to Digital Twin	×	✓

3. Baseline Energy Simulation Process

The data required for energy simulations from EST was imported into IES' software and mapped to templates prior to simulation. The templates are prebuilt descriptions of building data.

Once the templates are populated, IES' dynamic thermal simulation engine was used to simulate the energy performance of each building. It uses physics first-principles to model and analyses the energy efficiency of a building, allowing it to be optimised. The calculations performed comply with the following:

- UK Approved document L2: 2021 / UK National Calculation Methodology (NCM) Modelling Guide 2021.
- ASHRAE 90.1: 2019. Energy Standard for Sites and Buildings Except Low-Rise Residential Buildings.
- CIBSE Guide A (1995, 1999, 2001, 20006). Environmental Design.
- CIBSE Guide C - Heat transfer coefficient.
- ISO 14683: 2017 – Thermal bridges in building construction.
- UK BR 443: 2019 – Conventions for U-value calculations & BR 497 (2nd ed.) 2016 Conventions for calculating linear thermal transmittance and temperature factors.
- Building Envelope Thermal Bridging Guide v1.5 2020 (Morrison Hershfield Limited).

For more details and the methods used in simulating building energy performance, please see this link**:** **IES Help**

Energy use is converted into carbon emissions using the UK Government's carbon conversion factors found here:

https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2025

For the LAEP, the baseline year was 2023, and simulations were run at monthly timesteps then aggregated to monthly results.

To ensure all buildings were modelled under normal weather conditions, a CIBSE Test Reference Year (TRY) file for Nottingham was used, with 2016 the most recent year available. A CIBSE Test Reference Year (TRY) file is a Chartered Institution of Building Services Engineers (CIBSE) data set used in building simulations to represent a "typical" weather year. It consists of 12 constructed monthly data sets (based on historical data from 1984–2013) to model energy consumption, compliance with UK Part L Building Regulations, and annual energy assessments. More formation on weather files can be found here: https://www.cibse.org/weatherdata

TRY files are essential for energy modeling to ensure buildings are designed to be energy-efficient under normal weather conditions.

Chartered Institution of Building Services Engineers (CIBSE)

Chartered Institution of Building Services Engineers (CIBSE)

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Key Characteristics and Usage:

Purpose: Primarily for calculating yearly energy consumption, heating, and cooling loads.

Composition: Composed of 12 average months selected from historical data based on dry-bulb temperature, humidity, and cloud cover.

Context: Unlike a Design Summer Year (DSY) file, which is used for extreme heat/overheating analysis, the TRY represents long-term average conditions.

Updates: The 2016 dataset updated the earlier 1984-2004 data to a 1984-2013 baseline for 14 UK locations.

Data Types: Contains hourly data for variables like air temperature, wind speed, wind direction, and solar radiation.

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TRY files are essential for energy modeling to ensure buildings are designed to be energy-efficient under normal weather conditions.

The table below details how the imported data was mapped to the model templates for the baseline, with all other data imported as is into the models:

Data Input	Purpose to the Model	Energy Savings Trust (EST) Data	Data Used for Simulation
Property Age Band	Age band used to derive year property was built. If insulation and glazing data is not available, the construction year is mapped to building regulations of that year. The software then associates the levels of insulation and glazing (U-values) according to the building regulations of that year.	Pre-1900	1900
		1900- 1929	1920
		1930-1949	1950
		1950-1966	1950
		1967-1982	1950
		1983-1995	1986
		Post 1996	2012
Floor area	Used to calculate energy use intensity per m^2.	Building conditioned floor area m2	Same as EST
Number of Storeys	Used to calculate the height of each storey. Influences energy modelling via internal and external interactions.	No. of storeys	EST data used to calculate no. storeys divided by building height.
Property type	Defines occupancy profiles, hours of use, internal gains (equipment and electricity templates), and heating setpoints. **Note:** The property typology in the software is derived from building location and geometry. A building may be shown here as 'single family detached' when in reality terraced/semi-detached. The software recognises the attachment from the geometry and surrounding buildings to correctly account for shared walls, reduced exposed surfaces, and inter-building heat transfer, while standalone buildings will treat all walls as external with no shared heat transfer.	Block of flats	Single family detached
		Small block of flats	
		Large block of flats	
		Flat in mixed use building	
		Detached house	
		Semi-detached house	
		End terraced house	
		Mid-terraced house	

Building height	Used to calculate the height of each storey. Influences energy modelling via internal and external interactions.	Building height (m)	EST data used to calculate no. storeys divided by building height.
Wall Construction Type	Used to inform the retrofit scenarios i.e. which buildings are suitable for different types of insulation. **Note:** the software uses default average U-values for walls where exact construction is not known. These are automatically adjusted based on the construction date and other insulation inputs.	Cavity construction	Same as EST
		Solid brick/stone system built	
		Timber frame	
External Wall Insulation	Used to calculate heat loss through building walls.	Insulated	Wall outer insulation 40mm
		Uninsulated	No insulation applied
Floor Construction	Used to calculate heat loss through building floors.	Suspended	Suspended
		Solid	Solid
		Unheated space	Unheated space
Floor Insulation	Used to calculate heat loss through building floors.	Insulated	Exposed floor insulation 150mm
		Uninsulated	No insulation
Loft Insulation prediction	Used to calculate heat loss through building roofs. The EST data is only used for buildings which are built before 1986. For buildings after 1986, the software assigns U-values meeting higher insulation standards without the need for additional loft insulation measures.	0-50m	No insulation
		51mm-150mm	100mm
		150mm+	200mm
Glazing Type Prediction	Used to calculate solar gains/losses from glazing. Note: If building was built in 2012 or after this will be set to U-value 2.2 W/m^2K for double glazing.	Single/Partial	U Value = 5.2 W/m^2K
		Double (pre-2002)	U Value = 2.2 W/m^2K
		Double (post-2002)	U Value = 2.2 W/m^2K
		Triple	U Value = 0.8 W/m^2K
Heating System	Used in conjunction with fuel type to derive the type of system used for heating along with the associated energy use and carbon emissions.	Boiler	Gas
		Communal	Communal
		Heat Pump	ASHP

	A boiler efficiency of 85% was used as no information was available regarding the actual efficiency or installation date of the boilers. This value provides a reasonable default for modelling purposes as per the following source: https://www.boilerguide.co.uk/boilers/erp-efficiency-explained	No heating or hot water	No heating or hot water
		Other	Other
		Room heaters	Room heaters
		Storage heaters	Storage heaters
Fuel Type (Heating and Hot Water)	Used in conjunction with heating systems to derive the type of system used for heating along with the associated energy use and carbon emissions	Mains Gas	Natural Gas
		Electricity	Electricity
		Biomass	Biomass
		No fuel	No fuel
		Solid	Solid
		Oil	Oil
		LPG	LPG
Roof Orientation	Used to assign suitable buildings for solar PV installation.	North	Same as EST
		North West	
		North East	
		South West	
		South East	
		East	
		West	

For the non-domestic sector, all data was imported as is into the models, however data was not available for the details regarding construction and fabric conditions, and defaulted data had to be used. With building construction dates across the region ranging from early 19th century to the modern day, 1986 was used as an appropriate year to assign as a default. This ensured the model applied building regulations and corresponding fabric U-values appropriate to that period and provided a satisfactory baseline model by ensuring all buildings meet at least minimum regulatory standards. Glazing was assigned separately with the default U-value of 2.2 W/m^{2}K, reflecting the assumption buildings of this age have generally been upgraded to double glazing.

4. Baseline Energy Results Verification

The templates and results used in the software were originally validated against the UK building typologies created via the EU Funded Tabula project (https://episcope.eu/building-typology/country/gb/ which created building typologies and energy performance assessments across EU countries.

For the East Midlands LAEPs, the digital twin model results were verified against UK Government data by comparing the gas and electrical consumption of buildings (https://www.gov.uk/government/collections/sub-national-electricity-consumption-data).

The modelling for the Local Authority was split into different areas known as 'Middle Super Output Areas' (MSOAs). This is the UK Government's geographical classification for the reporting of 'small area' statistics, with each MSOA containing approximately 2,000 to 5,000 buildings. The validation for the domestic sector was conducted at this level, however as the Government data was unavailable for the non-domestic sector, the validation buildings were at local authority level.

For the domestic sector, the model was considered as validated if the results were within +/- 20% of Government metered data, with any outside the range warranting a closer inspection on the reasons.

Verification of the non-domestic sector results was limited due to:

- Availability of the input data.
- UK Government caveats of missing and wrongly classified metered data.
- UK Government data including industrial process loads, which are not included in the simulations.

Additional data was obtained for the non-domestic metered gas data from the Gas DNO, which was used as a more accurate figure for the overall gas consumption and allowed the non-domestic sector baseline to be broken down by gas used for heating spaces and hot water (from IES simulation figures), and gas used for industrial processes (metered total gas consumption minus IES simulated gas consumption).

The data was also combined with local knowledge to derive high consuming gas sites so that engagement could occur regarding decarbonisation potential.

5. Energy Interventions

The energy interventions were applied to each relevant building.

Note for non-domestic buildings fabric improvements where not simulated due to the limited data available.

The digital twin model was initially re-simulated with all light fabric retrofit measures applied on the appropriate buildings without this measure previously fitted, and then secondly re-simulated with the deep retrofit measures.

For heat decarbonisation, the model was re-simulated assuming all fossil fuel boilers were replaced with heat pumps. The heat decarbonisation scenario was simulated for both light and deep retrofit measures.

Energy Intervention	**Applied to:**	**Assumptions**	**Source**
Light retrofit	Domestic buildings without the highest recommended level of insulation. Domestic buildings without cavity wall insulation.	Light retrofit includes cavity wall insulation and loft insulation top up to 300mm.	Home Analytics data from EST defines which measures are currently on which buildings and therefore used to decide which measures could be applied in future. The software uses U-values attributed to different forms and levels of insulation according to the UK Government SAP (Standard Assessment Procedure), with adjustments made based on internal expertise and knowledge.
Deep retrofit	Domestic buildings with only single glazing. Domestic buildings with single walls and without internal/external wall insulation.	Deep retrofit includes: – Upgrade to double glazing – Internal wall insulation – External wall insulation – Suspended floor insulation (see the Baseline Energy Simulation Process table for U-values)	Home Analytics data from EST defines which measures are currently on which buildings and therefore used to decide which measures could be applied in future. The software uses U-values attributed to different forms and levels of insulation according to the UK Government SAP (Standard Assessment Procedure), with adjustments made based on internal expertise and knowledge.

Air source heat pump	Domestic & non-domestic buildings that have a fossil fuelled boiler	Applied to all fossil fuelled boilers. Co-efficient of performance (CoP) used for ASHPs was 2.7.	Based on Home Analytics data from EST which defines which buildings are currently served by ASHPs. Used to decide which measures could be applied in future. Sources suggest a range between 2.4 and 2.7 is reasonable for modelling purposes. An upper average COP of 2.7 was chosen to account for technical improvements in the technology. https://www.buildingenclosureonline.com/blogs/14-the-be-blog-building-enclosure/post/85012-gauging-the-seasonal-efficiency-of-air-source-heat-pumps
Other electric heating (infrared, storage, fan)	Domestic and non-domestic buildings with fossil fuel boilers.	Applied to all fossil fuelled boilers. Co-efficient of performance (CoP) used was 1 (1 unit of electrical energy into 1 unit of heat)	https://www.electricradiatorsdirect.co.uk/news/are-all-electric-heaters-the-same-efficiency/#:~:text=to%20do%20this?-,How%20are%20electric%20heaters%20efficient?,fact%20have%20the%20same%20efficiency. https://lifestyle.sustainability-directory.com/term/coefficient-of-performance/#:~:text=The%20Coefficient%20of%20Performance%20(CoP)%20quantifies%20the%20ratio%20of%20useful,divided%20by%20the%20work%20input.
Solar PV (roof top) with and without battery storage	Domestic & non-domestic buildings All buildings with SE – SW roof orientation	With/without BESS: Percent of energy generated and used directly in building without BESS = 45%. Percent energy generated and used directly in building with BESS = 100%. Assumption that PV panels can cover 25% of the roof area.	https://solartogether.co.uk/blog/best-ways-to-increase-solar-self-consumption/#:~:text=What%20are%20the%20best%20ways,most%20of%20your%20solar%20system https://www.sunsave.energy/solar-panels-advice/system-size/output

		Assumption of PV panel efficiency at 17.5%.	
District heating network potential	Areas with potential low carbon heat sources, a variety of building types/uses, and no blocking infrastructure.	Aggregated heat demand from all buildings in the boundary was calculated. Aggregated carbon emissions from heat demand of all buildings in the boundary was calculated. Assumption that all buildings would connect to the network to give the potential for carbon savings.	District Heating carbon coefficient is DESNZ value 0.207 (2023) If source is waste heat, a carbon coefficient of 0.05 was used. See source: https://eprints.whiterose.ac.uk/id/eprint/207360/3/1-s2.0-S1359431124000498-main.pdf
Solar PV (ground mounted) with battery storage	Areas which will supply local communities, not the National Grid. Where land ownership is known. Where planning is not restricted in Local Plan guidance.	There were no areas identified and none were modelled.	Not applicable
Wind	Areas which will supply local communities, not the National Grid. Where land ownership is known. Where planning is not restricted in Local Plan guidance	There were no areas identified and none were modelled.	Not applicable

6. Digital Twin Model and Viewer

Each building within the whole local authority can be observed online using the digital twin viewer.

Default views were setup for each area as follows:

View	Description
Building type	All buildings by type according to EST data.
District heating network	Shows a visualisation of the potential district heating areas identified and high-level associated metrics.
EPC Rating lower than C	All buildings with EPC Rating lower than C according to EST data.
EPC Rating F-G	All buildings with EPC Rating F-G according to EST data.
Fuel Type	All buildings by their main fuel type for heating hot water and spaces.
Heating Energy	All buildings visualised by annual heating energy consumption (kWh/m^2/year).
Top Non-Domestic Gas Users	Highest non-domestic gas users derived from DNO and Government data.
Total Energy Consumption	All buildings visualised by annual energy consumption (kWh/m^2).

Users can click on any building to see the data attributes imported from the EST along with the simulated energy cand carbon results at annual and monthly levels per building.

D. EV Modelling Datasets

D.1 Datasets

Modelling has been undertaken using the following publicly available statistics and datasets:

D.1.1 ONS Middle layer Super Output Area population estimates (supporting information)[89]

D.1.2 Research on East Midland cars[90] and people[91] per household

D.1.3 CCC 7th Carbon Budget[92]

D.1.4 Midlands Connect 'Supercharging the Midlands' report[93]

D.1.5 ZapMap[94] and government private charger research[95]

D.2 Socioeconomic Parameters

To perform modelling, socioeconomic parameters have been retrieved from available statistics and datasets:

D.2.1 Population of Nottingham = 111,133 (ONS, 2021)

D.2.2 Average number of cars per household in the East Midlands (2023) = 1.23

D.2.3 Average number of people in an East Midlands household, (2023) = 2.4

D.3 Assumptions and Exclusions

D.3.1 Not all ICE vehicles are decommissioned within the 2040 and 2050 scenarios.

D.3.2 The CCC EV uptake projection is assumed proportionate across the UK.

D.3.3 The model only includes the uptake of Battery Electric Vehicles (BEVs) and therefore does not account for Plug-in Hybrids (PHEVs), Hybrid Electric Vehicles (HEVs), Fuel Cell Electric Vehicles (FCEVs), Range-Extended EVs (REEVs), biofuel/biodiesel or other transitional technologies, which are assumed negligible by 2050

D.3.4 The model only considers private transport and therefore does not account for public transport, freight transport, or heavy-duty vehicles.

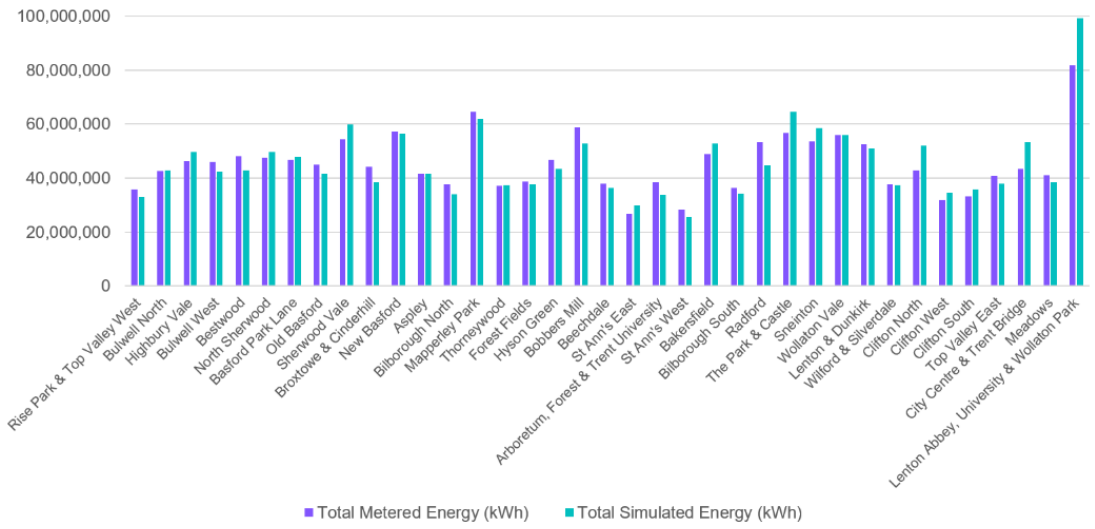
D.3.5 Motorcycles, mopeds, and other forms of micro-mobility are excluded.

D.3.6 Behavioural changes such as modal shift, car-sharing, or reductions in private car ownership are assumed to match the relative increase in population resulting in an equal volume of private cars in 2050 compared to today

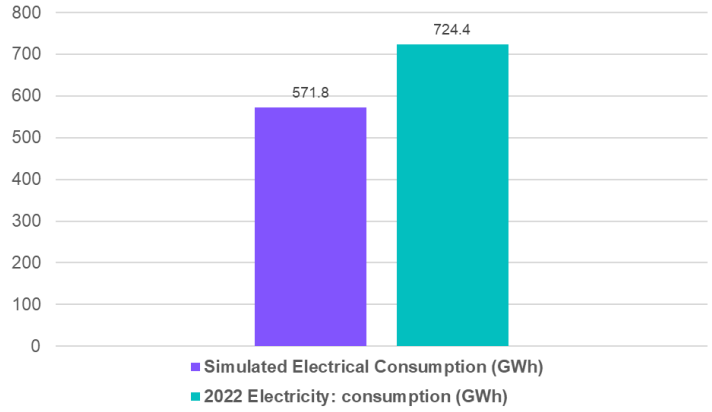
[89] Middle layer Super Output Area population estimates (supporting information) - Office for National Statistics
[90] https://www.nimblefins.co.uk/cheap-car-insurance/number-cars-great-britain
[91] https://www.statista.com/topics/12526/families-in-the-uk/#topicOverview
[92] https://www.theccc.org.uk/wp-content/uploads/2025/02/The-Seventh-Carbon-Budget.pdf
[93] https://www.midlandsconnect.uk/media/i1spcsr1/mc-supercharging-the-midlands-document.pdf
[94] https://www.theccc.org.uk/wp-content/uploads/2025/02/The-Seventh-Carbon-Budget.pdf
[95] https://www.gov.uk/government/publications/electric-vehicle-drivers-attitudes-and-behaviours

E. Baseline Validation by MSOA

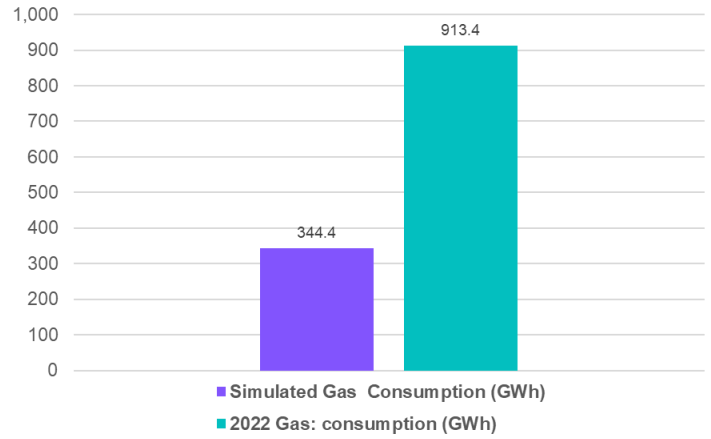
IES Digital Twin simulation results validation for domestic sector



IES Digital Twin Simulation Results Validation for Non-Domestic Electricity Consumption



IES Digital Twin Simulation Results Validation for Non-Domestic Gas Consumption



F. Non-Domestic Aggregated Consumption of Top Gas Users

Process Temperature Categorisation	Annual Gas Consumption (GWh)	Building Electricity Consumption (GWh)	Total Carbon Emission (ktCO2e)
Low	548	125	136
High	26	3	6

G. Buildings Interventions by MSOA

MSOA	Intervention	CAPEX (£,000)	Energy Savings (MWh/yr)	Gas Displacement (MWh/yr)	Electricity Generation (MWh/yr)	Carbon Savings (tCO2e/yr)
Nottingham 001 - Rise Park & Top Valley West	Light Retrofit	70	21			4
	Deep Retrofit	210	19			3
	Domestic ASHP	43,099		20,799		
	Non-Domestic ASHP	8,001				
	Domestic Solar PV	10,741	4,521			936
	Non-Domestic Solar PV	2,459	1,009			209
Nottingham 002 - Bulwell North	Light Retrofit	862	374			75
	Deep Retrofit	9,606	966			192
	Domestic ASHP	48,477		25,439		
	Non-Domestic ASHP	18,117				
	Domestic Solar PV	11,329	4,613			955
	Non-Domestic Solar PV	9,046	3,712			768
Nottingham 004 - Highbury Vale	Light Retrofit	134	43			8
	Deep Retrofit	5,550	554			110

MSOA	Intervention	CAPEX (£,000)	Energy Savings (MWh/yr)	Gas Displacement (MWh/yr)	Electricity Generation (MWh/yr)	Carbon Savings (tCO2e/yr)
	Domestic ASHP	50,126		25,149		
	Non-Domestic ASHP	12,073				
	Domestic Solar PV	15,328	6,195			1,282
	Non-Domestic Solar PV	2,991	1,227			254
Nottingham 005 - Bulwell West	Light Retrofit	556	182			36
	Deep Retrofit	2,138	199			40
	Domestic ASHP	54,366		28,137		
	Non-Domestic ASHP	23,497				
	Domestic Solar PV	12,672	5,180			1,072
	Non-Domestic Solar PV	7,872	3,230			669
Nottingham 006 - Bestwood	Light Retrofit	698	233			47
	Deep Retrofit	2,704	844			168
	Domestic ASHP	51,951		26,824		
	Non-Domestic ASHP	4,440				
	Domestic Solar PV	13,202	5,407			1,119
	Non-Domestic Solar PV	699	287			59

MSOA	Intervention	CAPEX (£,000)	Energy Savings (MWh/yr)	Gas Displacement (MWh/yr)	Electricity Generation (MWh/yr)	Carbon Savings (tCO2e/yr)
Nottingham 007 - North Sherwood	Light Retrofit	614	133			25
	Deep Retrofit	23,351	2,871			574
	Domestic ASHP	47,510		22,841		
	Non-Domestic ASHP	20,520				
	Domestic Solar PV	12,071	5,015			1,038
	Non-Domestic Solar PV	6,738	2,765			572
Nottingham 008 - Basford Park Lane	Light Retrofit	569	196			39
	Deep Retrofit	17,897	2,040			405
	Domestic ASHP	48,070		24,621		
	Non-Domestic ASHP	10,958				
	Domestic Solar PV	14,120	5,672			1,174
	Non-Domestic Solar PV	3,484	1,430			296
Nottingham 009 - Old Basford	Light Retrofit	366	162			32
	Deep Retrofit	6,729	971			194
	Domestic ASHP	47,101		23,434		
	Non-Domestic ASHP	22,934				

MSOA	Intervention	CAPEX (£,000)	Energy Savings (MWh/yr)	Gas Displacement (MWh/yr)	Electricity Generation (MWh/yr)	Carbon Savings (tCO2e/yr)
	Domestic Solar PV	14,756	5,967			1,235
	Non-Domestic Solar PV	5,232	2,147			444
Nottingham 010 - Sherwood Vale						
	Light Retrofit	79	22			4
	Deep Retrofit	5,365	480			96
	Domestic ASHP	53,554		25,817		
	Non-Domestic ASHP	9,560				
	Domestic Solar PV	14,477	6,004			1,243
	Non-Domestic Solar PV	3,455	1,418			293
Nottingham 011 - Broxtowe & Cinderhill						
	Light Retrofit	924	217			43
	Deep Retrofit	5,447	1,639			328
	Domestic ASHP	45,211		23,270		
	Non-Domestic ASHP	3,178				
	Domestic Solar PV	10,909	4,448			921
	Non-Domestic Solar PV	1,190	488			101
Nottingham 012 - New Basford						
	Light Retrofit	336	174			35
	Deep Retrofit	11,789	916			183

MSOA	Intervention	CAPEX (£,000)	Energy Savings (MWh/yr)	Gas Displacement (MWh/yr)	Electricity Generation (MWh/yr)	Carbon Savings (tCO2e/yr)
	Domestic ASHP	53,777		25,988		
	Non-Domestic ASHP	22,910				
	Domestic Solar PV	16,747	6,819			1,411
	Non-Domestic Solar PV	7,292	2,992			619
Nottingham 013 - Aspley	Light Retrofit	410	68			14
	Deep Retrofit	18,047	2,076			415
	Domestic ASHP	40,184		20,946		
	Non-Domestic ASHP	3,891				
	Domestic Solar PV	11,615	4,740			981
	Non-Domestic Solar PV	657	269			56
Nottingham 014 - Bilborough North	Light Retrofit	315	88			17
	Deep Retrofit	2,496	549			110
	Domestic ASHP	44,336		22,528		
	Non-Domestic ASHP	30,450				
	Domestic Solar PV	8,979	3,654			756
	Non-Domestic Solar PV	2,887	1,185			245

MSOA	Intervention	CAPEX (£,000)	Energy Savings (MWh/yr)	Gas Displacement (MWh/yr)	Electricity Generation (MWh/yr)	Carbon Savings (tCO2e/yr)
Nottingham 015 - Mapperley Park	Light Retrofit	143	33			7
	Deep Retrofit	8,307	559			109
	Domestic ASHP	52,534		23,559		
	Non-Domestic ASHP	18,632				
	Domestic Solar PV	13,733	5,645			1,169
	Non-Domestic Solar PV	2,301	944			195
Nottingham 016 - Thorneywood	Light Retrofit	286	84			15
	Deep Retrofit	5,800	619			120
	Domestic ASHP	37,766		19,721		
	Non-Domestic ASHP	10,745				
	Domestic Solar PV	12,281	5,011			1,037
	Non-Domestic Solar PV	1,972	809			167
Nottingham 017 - Forest Fields	Light Retrofit	109	30			6
	Deep Retrofit	9,071	638			128
	Domestic ASHP	32,242		15,744		
	Non-Domestic ASHP	26,650				

MSOA	Intervention	CAPEX (£,000)	Energy Savings (MWh/yr)	Gas Displacement (MWh/yr)	Electricity Generation (MWh/yr)	Carbon Savings (tCO2e/yr)
	Domestic Solar PV	5,880	2,423			502
	Non-Domestic Solar PV	3,272	1,342			278
Nottingham 018 - Hyson Green						
	Light Retrofit	606	209			41
	Deep Retrofit	19,273	1,480			296
	Domestic ASHP	39,884		19,831		
	Non-Domestic ASHP	15,685				
	Domestic Solar PV	7,758	3,185			659
	Non-Domestic Solar PV	4,020	1,649			341
Nottingham 019 - Bobbers Mill						
	Light Retrofit	556	151			29
	Deep Retrofit	7,799	831			164
	Domestic ASHP	57,528		28,012		
	Non-Domestic ASHP	15,289				
	Domestic Solar PV	12,012	4,994			1,034
	Non-Domestic Solar PV	4,230	1,736			359
Nottingham 020 - Beechdale						
	Light Retrofit	283	102			20
	Deep Retrofit	2,985	625			125

MSOA	Intervention	CAPEX (£,000)	Energy Savings (MWh/yr)	Gas Displacement (MWh/yr)	Electricity Generation (MWh/yr)	Carbon Savings (tCO2e/yr)
	Domestic ASHP	43,982		22,060		
	Non-Domestic ASHP	32,546				
	Domestic Solar PV	12,394	5,092			1,054
	Non-Domestic Solar PV	8,048	3,302			684
Nottingham 021 - St Ann's East	Light Retrofit	195	74			12
	Deep Retrofit	11,197	998			198
	Domestic ASHP	23,283		14,454		
	Non-Domestic ASHP	8,037				
	Domestic Solar PV	11,582	4,678			968
	Non-Domestic Solar PV	3,196	1,311			271
Nottingham 022 - Arboretum, Forest & Trent University	Light Retrofit	232	81			16
	Deep Retrofit	19,275	966			194
	Domestic ASHP	29,724		12,841		
	Non-Domestic ASHP	32,629				
	Domestic Solar PV	8,233	3,387			701
	Non-Domestic Solar PV	7,568	3,106			643

MSOA	Intervention	CAPEX (£,000)	Energy Savings (MWh/yr)	Gas Displacement (MWh/yr)	Electricity Generation (MWh/yr)	Carbon Savings (tCO2e/yr)
Nottingham 023 - St Ann's West	Light Retrofit	367	89			10
	Deep Retrofit	5,299	420			77
	Domestic ASHP	18,542		10,709		
	Non-Domestic ASHP	26,989				
	Domestic Solar PV	11,207	4,579			948
	Non-Domestic Solar PV	11,491	4,715			976
Nottingham 024 - Bakersfield	Light Retrofit	226	61			12
	Deep Retrofit	8,516	982			196
	Domestic ASHP	51,966		25,689		
	Non-Domestic ASHP	11,262				
	Domestic Solar PV	11,977	4,913			1,017
	Non-Domestic Solar PV	1,957	803			166
Nottingham 025 - Bilborough South	Light Retrofit	264	104			20
	Deep Retrofit	2,465	307			62
	Domestic ASHP	44,495		22,420		
	Non-Domestic ASHP	15,349				

MSOA	Intervention	CAPEX (£,000)	Energy Savings (MWh/yr)	Gas Displacement (MWh/yr)	Electricity Generation (MWh/yr)	Carbon Savings (tCO2e/yr)
	Domestic Solar PV	10,273	4,213			872
	Non-Domestic Solar PV	5,619	2,306			477
Nottingham 026 - Radford						
	Light Retrofit	288	119			24
	Deep Retrofit	5,579	477			95
	Domestic ASHP	43,982		22,691		
	Non-Domestic ASHP	14,602				
	Domestic Solar PV	12,699	5,293			1,096
	Non-Domestic Solar PV	7,231	2,967			614
Nottingham 028 - The Park & Castle						
	Light Retrofit	150	125			25
	Deep Retrofit	1,230	107			22
	Domestic ASHP	63,831		27,837		
	Non-Domestic ASHP	26,840				
	Domestic Solar PV	10,188	4,162			861
	Non-Domestic Solar PV	5,309	2,178			451
Nottingham 029 - Sneinton						
	Light Retrofit	471	136			27
	Deep Retrofit	19,217	1,652			330

MSOA	Intervention	CAPEX (£,000)	Energy Savings (MWh/yr)	Gas Displacement (MWh/yr)	Electricity Generation (MWh/yr)	Carbon Savings (tCO2e/yr)
	Domestic ASHP	54,956		27,953		
	Non-Domestic ASHP	24,237				
	Domestic Solar PV	13,707	5,493			1,137
	Non-Domestic Solar PV	10,851	4,453			922
Nottingham 030 - Wollaton Vale	Light Retrofit	82	11			2
	Deep Retrofit	268	37			7
	Domestic ASHP	70,157		33,289		
	Non-Domestic ASHP	2,720				
	Domestic Solar PV	21,781	8,761			1,813
	Non-Domestic Solar PV	1,876	770			159
Nottingham 031 - Lenton & Dunkirk	Light Retrofit	334	130			26
	Deep Retrofit	10,837	808			162
	Domestic ASHP	50,100		24,491		
	Non-Domestic ASHP	65,947				
	Domestic Solar PV	8,825	3,637			753
	Non-Domestic Solar PV	23,402	9,603			1,988

MSOA	Intervention	CAPEX (£,000)	Energy Savings (MWh/yr)	Gas Displacement (MWh/yr)	Electricity Generation (MWh/yr)	Carbon Savings (tCO2e/yr)
Nottingham 034 - Wilford & Silverdale	Light Retrofit	52	9			2
	Deep Retrofit	529	28			6
	Domestic ASHP	47,646		23,486		
	Non-Domestic ASHP	6,991				
	Domestic Solar PV	8,408	3,469			718
	Non-Domestic Solar PV	1,151	472			98
Nottingham 035 - Clifton North	Light Retrofit	680	127			23
	Deep Retrofit	621	23			5
	Domestic ASHP	65,907		39,340		
	Non-Domestic ASHP	14,115				
	Domestic Solar PV	11,768	4,807			995
	Non-Domestic Solar PV	4,239	1,739			360
Nottingham 036 - Clifton West	Light Retrofit	235	68			14
	Deep Retrofit	1,008	88			18
	Domestic ASHP	46,735		24,125		
	Non-Domestic ASHP	3,090				

MSOA	Intervention	CAPEX (£,000)	Energy Savings (MWh/yr)	Gas Displacement (MWh/yr)	Electricity Generation (MWh/yr)	Carbon Savings (tCO2e/yr)
	Domestic Solar PV	9,052	3,735			773
	Non-Domestic Solar PV	1,014	416			86
Nottingham 037 - Clifton South						
	Light Retrofit	164	53			10
	Deep Retrofit	321	33			7
	Domestic ASHP	49,192		26,195		
	Non-Domestic ASHP	2,698				
	Domestic Solar PV	9,024	3,714			769
	Non-Domestic Solar PV	1,071	439			91
Nottingham 038 - Top Valley East						
	Light Retrofit	283	64			13
	Deep Retrofit	1,092	124			24
	Domestic ASHP	50,620		26,089		
	Non-Domestic ASHP	2,305				
	Domestic Solar PV	11,530	4,751			983
	Non-Domestic Solar PV	1,205	494			102
Nottingham 039 - City Centre & Trent Bridge						
	Light Retrofit	120	61			14
	Deep Retrofit	3,715	340			66

MSOA	Intervention	CAPEX (£,000)	Energy Savings (MWh/yr)	Gas Displacement (MWh/yr)	Electricity Generation (MWh/yr)	Carbon Savings (tCO2e/yr)
	Domestic ASHP	31,650		20,599		
	Non-Domestic ASHP	136,214				
	Domestic Solar PV	7,958	3,312			686
	Non-Domestic Solar PV	23,916	9,814			2,031
Nottingham 040 - Meadows	Light Retrofit	406	118			24
	Deep Retrofit	12,725	1,136			228
	Domestic ASHP	41,578		20,972		
	Non-Domestic ASHP	58,146				
	Domestic Solar PV	6,783	2,842			588
	Non-Domestic Solar PV	14,954	6,136			1,270
Nottingham 041 - Lenton Abbey, University & Wollaton Park	Light Retrofit	808	160			17
	Deep Retrofit	20,254	1,972			392
	Domestic ASHP	112,865		56,491		
	Non-Domestic ASHP	55,039				
	Domestic Solar PV	24,235	10,048			2,080
	Non-Domestic Solar PV	11,563	4,745			982

H. Connected Generation Sites in Nottingham City

Customer Name	Customer Site	Technology	Capacity (MW)
Merrivale farms ltd	Merrivale farms ltd	Solar	0.08
Robert thomas farms	Little tythe irrigation pump 51e0938	Solar	0.10
Papplewick farms limited	Newstead grange farm	Solar	0.05
Inchcape estates limited	408 derby road, nottingham, ng7 2gq	Solar	0.07
--REDACTED--	--REDACTED--	Solar	0.06
--REDACTED--	--REDACTED--	Solar	0.05
Slack&co floor coverings ltd	1 park road east	Solar	0.05
Cropwell bishop primary school	Cropwell bishop primary school	Solar	0.07
--REDACTED--	--REDACTED--	Solar	0.05
Its a miracle pension scheme	Unit 7 orchard park business park, sandiacre, town street	Solar	0.10
Cotgrave welfare scheme social club ltd	Cotgrave, cotgrave welfar scheme social club	Solar	0.08
Hall farm poultry limited	Hall farm, langar lane, langar, notts ng13 9hb	Solar	0.08
Micro-mesh engineering ltd	Nottingham, dabell avenue	Solar	0.08
Hucknall sheet metal ltd	Hucknall sheet metal engineering limited	Solar	0.06
Print 4 limited	Print 4 limited	Solar	0.09
Evo energy	Area 2, millennium way	data not available	0.16
Ac gill ltd	Ntg house willow road lenton nottingham ng7 2ta	Solar	0.10
Tyler bros limited	Kirkby-in-ashfield, tyler bros (sutton-in-asfield) ltd	Solar	0.10
Friars pride limited	Mallard road, victoria business park, netherfield, nottingham, ng4 2pe	Solar	0.16
Rapala vmc uk limited	The development centre	Solar	0.12
Hydrotechnik uk test engineering limited	Lenton lane	Solar	0.10
Lafarge cement uk	Works lane	Biofuel - Landfill gas	0.50
I holland ltd	Meadow lane	Solar	0.15
The two counties trust	Wilsthorpe school derby road	Solar	0.10
Midland regional printers limited	Midland regional printers limited	Solar	0.21
Sports and leisure management ltd	Hucknall, hucknall leisure centre	Solar	0.11

Customer Name	Customer Site	Technology	Capacity (MW)
Ten entertainment ltd	Tenpin ltd, clifton boulevard, redfield way, nottingham, ng7 2uw	Solar	0.07
Building product design ltd	Pinxton building product design plymouth avenue pinxton	Solar	0.05
Ideagen limited	1 mere way ruddington fields business park ruddington ng11 6js	Solar	0.15
Crd catering (city) limited	Holiday inn nottingham, castle bridge road	Solar	0.06
Goodman metal works	Goodman metal works, private road no7, colwick industrial estate nottingham, ng4	Solar	0.15
David lloyd leisure limited	David lloyd west bridgford	Solar	0.30
John deere ltd	Langar, harby road	Solar	0.10
Contract furniture group limited	Little tennis street south, trent park	Solar	0.08
Ac gill ltd	Ntg house, willow road	Solar	0.17
Webro cable & connectors ltd	Webro cable & connectors ltd	Solar	0.14
Sherwood press (nottingham) limited(the)	Sherwood press (nottingham) limited (the) company number: 1881167	Solar	0.21
Bunches florapost ltd	Bunches florapost limited, unit 19, hazelford way, newstead village ng15 0dq	Solar	0.15
Mitchells & butlers plc	Toby carvery, daleside road east	Solar	0.05
Bfs group limited	Langley mill enterprise way bidfood	Solar	0.60
Sherwood press (nottingham) limited(the)	Sherwood press (nottingham) limited (the) company number: 1881167	Solar	0.12
Nw uk (2010) pure offices limited	Pure offices lake view drive sherwood park	Solar	0.20
Severn trent water limited	Stapleford, stapleford sewage treatment works	Solar	0.62
Aecom infrastructure & environment uk limited	Aecom ltd	Solar	0.13
Glen barry limited	Glen barry ltd, langar north trading estate, langar, nottingham, ng13 9hy	Solar	0.06
Copley scientific limited	Copley scientific supply 2, 8 colwick quays business park ng4 2jy	Solar	0.05
Inchcape estates limited	Mercedes dealership	Solar	0.08
Tm trustees limited	Office 4c	Solar	0.05
Newark and sherwood district council	Brunel business park	Solar	0.05
Nottingham city council	Minver crescent	Solar	0.05
Nottingham college services limited	Broxtowe college	Solar	0.08
Excellerate bioscience limited	Excellerate bioscience limited	Solar	0.05
The nottingham emmanuel school	West bridgford, the emmanuel c of e school	Solar	0.25
Big yellow group plc	Lenton lane	Solar	0.12
Nottingham wildcats community basketball & sports trust ltd	Nottingham wildcats arena	Solar	0.14
Frontier agriculture ltd	Barn farm	Solar	0.09
Samworth farms	Samworth farms	Solar	0.10

Customer Name	Customer Site	Technology	Capacity (MW)
--REDACTED--	--REDACTED--	Wind	0.09
Aisling renewables ltd	Swingate farm, swingate,	Wind	0.09
Nottingham city council	Nottingham tennis centre	Solar	0.15
Nottingham city council	Harvey haddon leisure centre	Solar	0.07
Central england co-operative limited	Kirkby in ashfield 18 skegby road	Solar	0.07
Jccj ltd	Woodborough park farm	Wind	0.50
Nottingham trams limited	Wilkinson street tram depot no2	Solar	0.42
F s peake & son limited	Ricketwood farm	Solar	0.09
Sandicliffe limited	Nottingham, lenton, abbeyfield road	Solar	0.12
Nottingham college	Basford hall college	Solar	0.10
N&f renewables limited	Hill farm generation	Wind	0.50
Nottinghamshire police	The arrow centre	Solar	0.05
Toray advanced composites uk ltd	Toray advanced composites	Solar	0.47
Barracks farm ltd	Barracks farm wind turbine & pv	Wind	0.50
Sherwood farms ltd	North farm	Solar	0.23
John a wells ltd	Barn farm	Solar	0.13
John a wells ltd	Barn farm	Solar	0.13
Wwwmy-furniturecom ltd	My furniture 1 mark street sandiacre nottingham ng10 5ad	Solar	0.20
The smashing glass company (nottingham) limited	Smashing glass company ltd	Solar	0.10
Sandicliffe limited	Abbeyfield road, lenton, nottingham ng7 2sx	Solar	0.06
Belwood foods limited	Belwood foods hunt close lowmoor business park	Solar	0.15
Games workshop ltd	Games workshop leenside warehouse	Solar	0.00
Highslade properties ltd	Stragglethorpe poultry farm	Solar	0.20
Farmfoods limited	Farmfoods ltd	Solar	0.05
The campbell clinic limited	2 edwalton business park	Solar	0.05
Nottingham city council	Ncc eastcroft depot hv supply	Solar	0.14
Nottingham city council	Broadmarsh bus station car park	Solar	0.10
Nottingham city council	Broadmarsh bus station	Solar	0.05
Sainsbury's supermarkets limited	Colwick colwick loop road, nottingham ng4 2jn	Solar	0.55
Rushcliffe borough council	Bingham bingham arena, chapel lane	Fossil - Gas	0.10
John a stephens ltd	Castle meadow road, nottingham ng2 1ag	Solar	0.34
Nottinghamshire county council	Oak house	Solar	0.09
East midlands education trust	The south wolds academy & sixth form	Solar	0.05
--REDACTED--	--REDACTED--	Solar	0.10
Nottingham high school	Nottingham high school	data not available	0.10
Gedling borough council	data not available	Solar	0.08
--REDACTED--	--REDACTED--	Solar	0.05
--REDACTED--	--REDACTED--	Solar	0.07

Customer Name	Customer Site	Technology	Capacity (MW)
--REDACTED--	--REDACTED--	data not available	2.40
Severn trent water limited	Stoke lane, stoke bardolph	Fossil - Gas	6.39
Nottingham university hospitals nhs trust	Queens medical centre, nottingham univer	Fossil - Gas	6.13
Nottingham university	University boulevard	Solar	0.33
Infinis ltd	Export site, burntstump landfill	data not available	0.33
Alkane energy uk limited	Former gedling colliery	Fossil - Gas	3.10
Severn trent wind power ltd	Newthorpe sewerage treatment works wind turbines	Wind	2.60
Lightsource spv 62 limited	Lodge farm	Solar	10.00
Gedling solar limited	Gedling solar farm	Solar	4.80
stragglethorpe energy limited	Stragglethorpe anaerobic digestion plant	Biofuel - Biogas	1.00
Sune elton farm solar limited	Shelton lodge	Solar	3.50
Equitix esi chp (nottingham) ltd	John brookes sawmill	Waste	7.80
Mercia power response (nottingham road) limited	Toton stor site nottingham rd attenborough	Fossil - Gas	7.00
Uk capacity reserve limited	Nottingham road stor	Fossil - Gas	20.00
Mercia power response (private road no 5) limited	11kv generation	Fossil - Gas	5.20
Mercia power response (private road no 5) limited	Private road no 5	Fossil - Gas	16.00
Mercia power response (private road no5) limited	Colwick mercia power bess private rd no 5	Stored Energy	1.60
Nottingham city council	London road heat station	Solar	11.37
Non fossil purchasing agency	Ebet export site 2	Biofuel - Landfill gas	1.00

I. Primary Substation Demand Aggregated per MSOA

MSOA	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Nottingham 001	1.1	1.7	2.5	3.5	4.7	6.1	7.7	9.4	11.2	13.1	15.1	17.0	18.7	20.3	21.6	22.8
Nottingham 002	1.4	2.2	3.2	4.4	6.0	7.8	9.8	11.9	14.2	16.7	19.3	21.7	24.0	26.0	27.7	29.1
Nottingham 004	1.5	2.3	3.3	4.6	6.2	8.1	10.1	12.3	14.6	17.1	19.6	22.1	24.3	26.3	28.0	29.5
Nottingham 005	1.6	2.5	3.6	5.1	6.9	9.0	11.3	13.8	16.5	19.5	22.5	25.4	28.1	30.4	32.4	34.1
Nottingham 006	1.8	2.7	3.9	5.4	7.2	9.4	11.7	14.0	16.5	19.2	21.8	24.4	26.8	28.9	30.7	32.3
Nottingham 007	1.4	2.2	3.2	4.5	6.0	7.9	9.9	12.0	14.4	16.9	19.5	22.0	24.3	26.3	28.0	29.5
Nottingham 008	1.6	2.4	3.5	4.9	6.5	8.5	10.6	12.8	15.1	17.7	20.2	22.7	25.0	26.9	28.7	30.2
Nottingham 009	1.5	2.3	3.3	4.7	6.3	8.2	10.3	12.6	15.0	17.7	20.4	23.1	25.5	27.6	29.4	31.0
Nottingham 010	1.4	2.2	3.2	4.5	6.1	8.0	10.0	12.1	14.4	16.9	19.4	21.8	24.0	26.0	27.7	29.2
Nottingham 011	1.7	2.6	3.8	5.2	7.0	9.1	11.2	13.4	15.8	18.2	20.7	23.1	25.2	27.2	28.9	30.4
Nottingham 012	1.9	2.8	4.2	5.8	7.8	10.2	12.7	15.5	18.4	21.5	24.7	27.8	30.6	33.0	35.2	37.1
Nottingham 013	1.6	2.4	3.5	4.9	6.5	8.4	10.4	12.5	14.7	16.9	19.2	21.4	23.5	25.3	26.8	28.3
Nottingham 014	1.3	2.0	2.9	4.2	5.6	7.5	9.4	11.6	14.0	16.6	19.2	21.9	24.3	26.3	28.1	29.6
Nottingham 015	1.6	2.5	3.7	5.2	7.0	9.1	11.4	13.9	16.5	19.3	22.2	25.1	27.6	29.9	31.8	33.5
Nottingham 016	1.4	2.2	3.1	4.4	5.8	7.6	9.5	11.5	13.5	15.8	18.0	20.2	22.2	23.9	25.5	26.8
Nottingham 017	1.4	2.1	3.1	4.4	5.9	7.7	9.6	11.7	13.9	16.4	18.8	21.2	23.4	25.3	27.0	28.4
Nottingham 018	1.6	2.5	3.6	5.0	6.7	8.8	10.9	13.2	15.6	18.1	20.7	23.2	25.5	27.5	29.3	30.8
Nottingham 019	1.9	2.9	4.2	5.9	7.9	10.4	12.9	15.6	18.5	21.6	24.7	27.8	30.6	33.0	35.1	37.0
Nottingham 020	1.2	1.9	2.9	4.0	5.5	7.3	9.2	11.3	13.7	16.3	19.0	21.6	24.0	26.1	27.8	29.3
Nottingham 021	1.5	2.3	3.3	4.5	6.0	7.8	9.6	11.5	13.5	15.5	17.6	19.6	21.4	23.0	24.4	25.7
Nottingham 022	2.2	3.3	4.8	6.7	9.0	11.7	14.5	17.4	20.5	23.8	27.1	30.3	33.3	35.8	38.1	40.1
Nottingham 023	2.2	3.4	4.9	6.8	9.1	11.8	14.6	17.4	20.4	23.5	26.6	29.6	32.4	34.8	37.0	39.0
Nottingham 024	1.6	2.4	3.5	4.9	6.5	8.6	10.7	12.9	15.4	17.9	20.6	23.1	25.5	27.5	29.3	30.8
Nottingham 025	1.2	1.8	2.6	3.7	5.0	6.6	8.3	10.1	12.1	14.3	16.5	18.7	20.7	22.4	23.9	25.1
Nottingham 026	2.7	4.1	5.9	8.2	10.9	14.1	17.4	20.7	24.2	27.8	31.4	34.9	38.1	41.0	43.5	45.8
Nottingham 028	1.9	2.9	4.2	6.0	8.0	10.6	13.2	16.1	19.3	22.7	26.2	29.6	32.7	35.5	37.8	39.8
Nottingham 029	1.8	2.8	4.1	5.8	7.7	10.1	12.7	15.4	18.4	21.5	24.8	27.9	30.8	33.3	35.5	37.4
Nottingham 030	1.5	2.3	3.3	4.7	6.3	8.3	10.4	12.6	15.1	17.7	20.4	23.0	25.4	27.5	29.3	30.8
Nottingham 031	2.0	3.1	4.6	6.5	8.7	11.6	14.6	18.0	21.8	25.9	30.1	34.3	38.1	41.4	44.2	46.5
Nottingham 034	1.1	1.8	2.6	3.6	4.8	6.3	7.9	9.7	11.6	13.6	15.6	17.7	19.5	21.1	22.5	23.7
Nottingham 035	1.8	2.7	3.9	5.6	7.5	9.8	12.2	14.9	17.7	20.8	23.9	27.0	29.7	32.2	34.3	36.1
Nottingham 036	1.1	1.7	2.5	3.4	4.6	6.0	7.6	9.2	10.9	12.8	14.7	16.6	18.3	19.8	21.1	22.2
Nottingham 037	1.2	1.8	2.7	3.8	5.0	6.6	8.2	10.0	11.9	13.9	15.9	18.0	19.8	21.4	22.8	24.0
Nottingham 038	1.4	2.2	3.1	4.4	5.9	7.7	9.5	11.5	13.6	15.8	18.1	20.3	22.3	24.1	25.6	27.0
Nottingham 039	1.8	2.9	4.3	6.3	8.6	11.6	15.1	19.0	23.6	28.7	34.0	39.3	44.1	48.2	51.6	54.4
Nottingham 040	1.5	2.3	3.4	4.9	6.7	8.9	11.3	14.0	17.0	20.3	23.8	27.2	30.2	32.9	35.1	37.0
Nottingham 041	3.3	5.1	7.5	10.6	14.2	18.7	23.5	28.7	34.4	40.6	46.9	53.2	58.8	63.7	67.9	71.5