BURO HAPPOLD

Local Area Energy Planning

Stafford, Cannock Chase and Lichfield

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Final draft of LAEP

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Executive Summary

This Local Area Energy Plan (LAEP) provides pathways for decarbonisation of the energy system in Stafford, Cannock Chase and Lichfield. This is done by taking elements of the National Grid Future Energy Scenarios (FES)[1] and applying them to the local area, taking into account the unique building stock, geography and existing energy system in the area. There are three core scenarios examined:

- Business as Usual (BaU) – this represents the slowest credible decarbonisation (as defined by National Grid), with minimal behavioural change and decarbonisation of transport but not heat.
- Hydrogen Heavy – this relies on national policy driving a switch from natural gas to hydrogen to decarbonise heating (this is considered high risk as limited action happens in the early stages of the LAEP), transport decarbonisation is similar to the BaU.
- Consumer Led – this scenario has widespread electrification of heating, the fastest transition of the transport fleet to zero carbon and the highest level consumer behaviour change.

A summary of the key characteristics for each of the core scenarios is provided in Table 0—1.

Table 0—1 Summary characteristics of core scenarios

	Business as Usual	Hydrogen Heavy	Consumer Led
Heating system	High retention of current heating systems. Some limited decarbonisation including adoption of heat networks.	Transition of existing heating systems, with a large focus on hydrogen – particularly in a domestic setting. Includes a higher level of heat network deployment than the BaU. Electrification of heat largely confined to off gas areas.	Transition of existing heating systems – with a large focus on electrification (predominantly heat pumps), with hydrogen only being seen in the non-domestic sectors for hard to electrify users. Highest level of heat network deployment.
Fabric efficiency	Some fabric improvements of properties.	High level of fabric improvements – this is particularly important in early years to create carbon savings before hydrogen starts to become available in the mid-2030s.	High level of fabric improvements – this is considered for all properties, with a focus on creating properties where heat pumps will function efficiently.
Transport	Decarbonisation of transport happens fully but more slowly than other scenarios. Predominantly electrification for cars and vans, for larger vehicles there is a mix of technologies but a hydrogen focus.	Decarbonisation of transport. Predominantly electrification for cars and vans, for larger vehicles there is a mix of technologies but a hydrogen focus.	Decarbonisation of transport – this happens fastest in this scenario. Predominantly electrification for cars and vans, for larger vehicles there is a mix of technologies but a hydrogen focus.
Flexibility	Very limited demand management/smart energy systems leading to very little demand diversity.	Some more demand management than the BaU scenario, however, this is still limited and as a result the impact on demand diversity is still low.	Demand management is key in this scenario, with the greater diversity it creates being key with the high level of electrification seen.
Electricity	Decarbonisation of electricity – this is driven by national decarbonisation through centralised low carbon generation but there is still increased local generation.	Decarbonisation of electricity – national level grid decarbonisation is key but substantial local generation, exceeding that in the BaU scenario, is also seen.	Decarbonisation of electricity – national level grid decarbonisation is still important but very high levels of local generation are also seen.

These scenarios are modelled out until 2050, in this time frame the BaU does **not** hit net zero whilst the Hydrogen Heavy and Consumer Led both do, with the latter making progress faster.

These scenarios, even the BaU, carry a high cost to change the current energy system infrastructure – this is explored in Figure 0—1.

[1] The FES used was from 2021

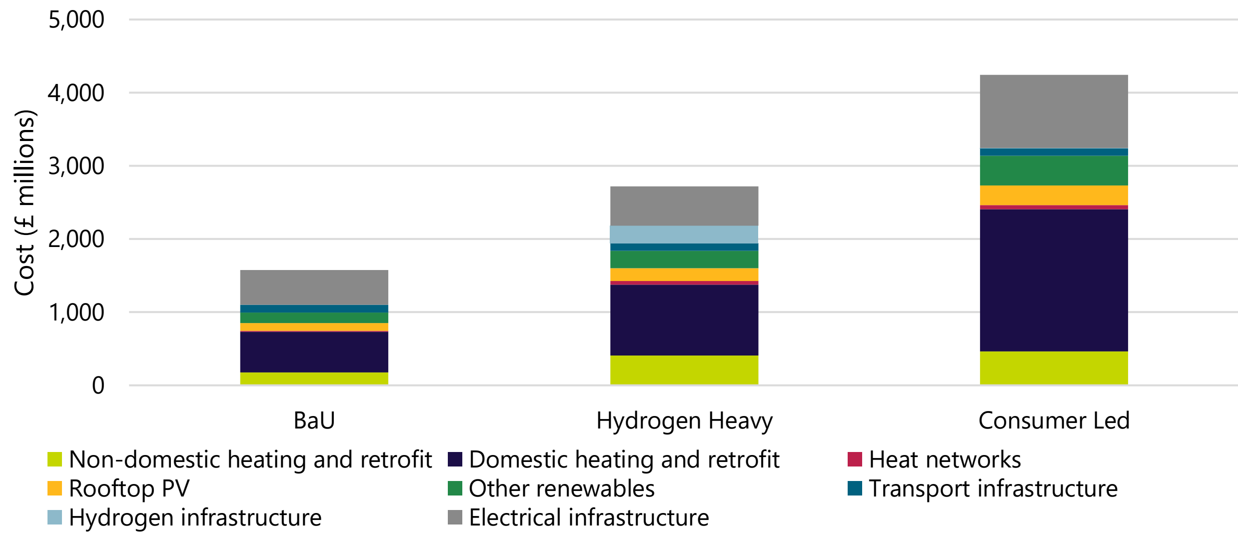


Figure 0—1 Capital costs for different aspects of the net zero energy system for the three core LAEP scenarios.

The Consumer Led scenario is the most costly in terms of capital expenditure; this is largely due to the relative price of heat pumps compared to gas boilers (even the hydrogen boilers) and the greater electricity network reinforcement required for electrification of heat. However, this electrification of heat coupled with improved energy efficiency results in lower fuel consumption which, despite the higher cost of electricity, result in a drop in total fuel costs over the course of the LAEP period (from 2022 to 2050). An illustration of this is provided in Figure 0—2.

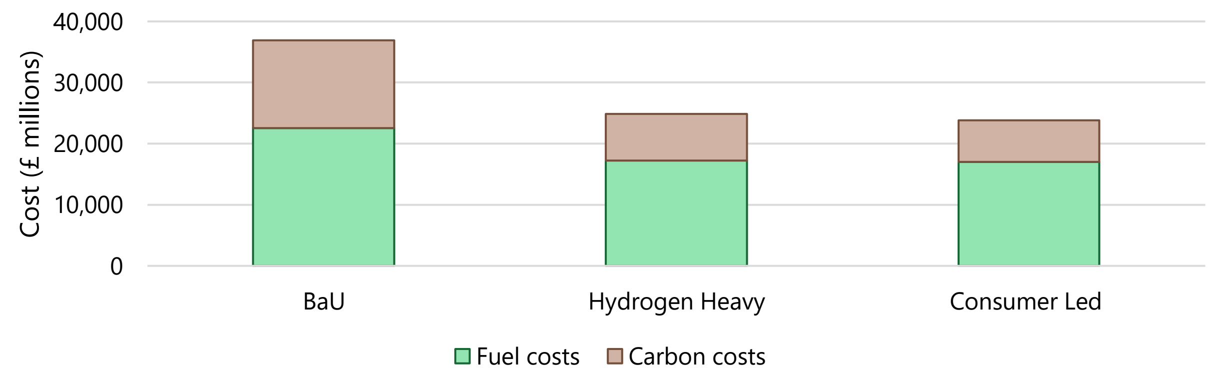
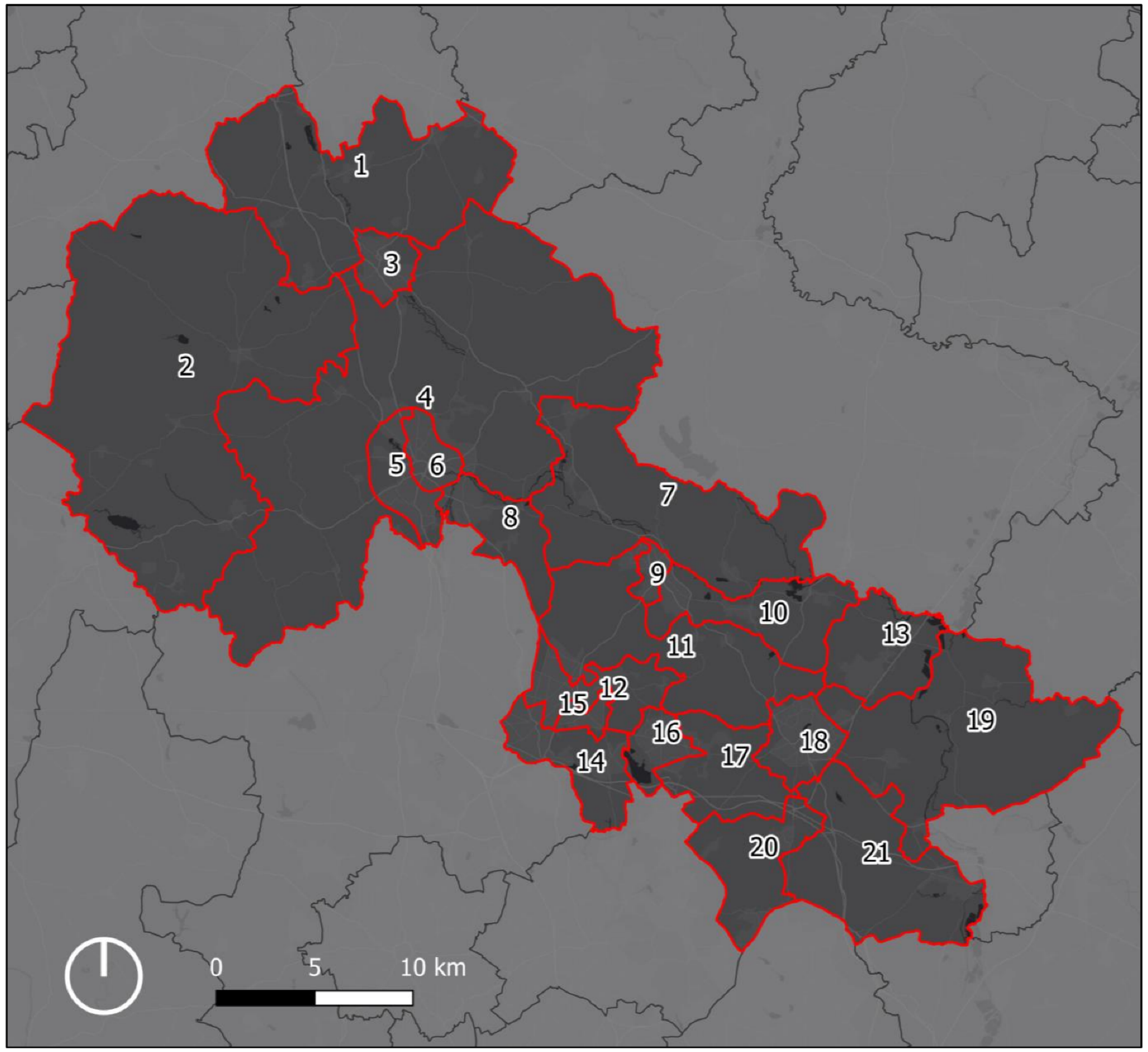


Figure 0—2 Total expenditure on fuel and carbon costs to 2050 (based on 2020 £s).

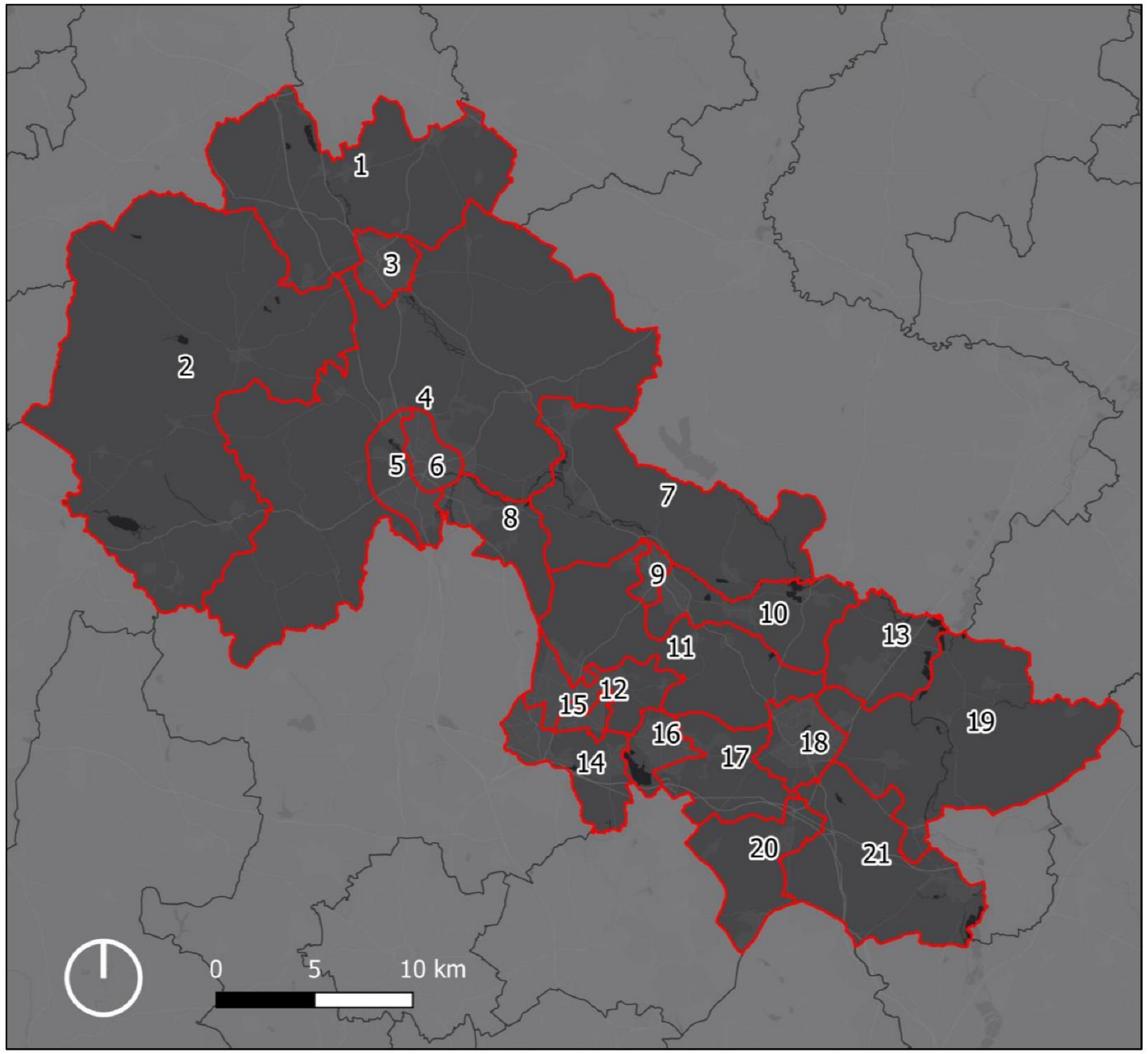
The total spend on fuel is far higher[2] than the capital costs associated with the infrastructure transition over the course of the LAEP. The Consumer Led scenario has slightly lower associated fuel costs than the Hydrogen Heavy scenario, with the BaU having the highest fuel spend. The LAEP also analyses the cost of carbon, based on BEIS standard factors. Again, the Consumer Led scenario performs best due to cutting emissions early followed by the Hydrogen Heavy scenario, with the BaU having a greater carbon cost than the other two scenarios combined. The rising cost of carbon across the LAEP timeframe means that in 2050 the annual carbon cost in the BaU was modelled at £216 million.

Based on the modelling outputs and the greater local influence - the Consumer Led scenario is the primary net zero scenario for the LAEP area. Following this scenario different areas in the LAEP will have different decarbonisation pathways, speed of change and roles to play for the area to meet net zero (explored in Figure 0—3). This is defined by their geography and existing energy infrastructure and to allow this to be summarised in one diagram, the LAEP is summarised into areas defined by amalgamating electoral wards.

[2] In the Consumer Led scenario where there is the least difference the fuel cost is still £17 billion compared to £4.2 billion capital investment.



Ward group code	Ward names	Area summary
1	Barlaston, Fulford, Swynnerton & Oulton	The area has buildings which are generally suited to heat pumps, including ground source systems in the rural locations. The eastern area has more on gas grid properties whilst the west has some off gas grid opportunities (the village of Swynnerton – for example). Grid constraint will make early electrification and renewable deployment generally a challenge in much of the western area, whilst there is good capacity in the east. This makes the east more of an early focus for decarbonisation technology, including renewable generation (both roof and ground mounted PV).
2	Eccleshall, Gnosall & Woodseaves	In the long-term a large contribution to renewable generation is modelled, however, in the short-term it is limited by grid constraint. The high number of off gas grid properties (some of which are local authority/social housing) also makes it a low regrets area for heat pumps (which could be ground or air source) but this is also limited by grid capacity in the near term.
3	St Michael's & Stonefield, Walton	The area has a high number of properties that are suited to heat pumps with no or limited fabric improvements, this includes properties in the local authority/social housing tenure type – making it an early decarbonisation opportunity. There are high levels of non-domestic demand in the area, including the largest single energy consumer identified in the LAEP. Two potential heat networks are identified in the area for further consideration, one of which could take advantage of several waste sources. With the general urban nature of the area there is a need for on street EV car charging facilities as well as deployment in car parks.
4	Seighford & Church Eaton, Milwich	The majority of demand in the area is concentrated immediately north and surrounding Stafford town centre, which contains the large Meece Brook development site, which is assumed to align to net zero standards in the LAEP. There are also extensive business parks and distribution hubs around the outskirts of Stafford. This makes it an area well suited to non-domestic rooftop PV deployment as well as workplace charging and is highlighted in the LAEP as a focus for HGV decarbonisation. The area immediately to the west of the town centre includes one of the best heat network opportunities identified. Given the rural nature of most of the geography there is a relatively high number of off gas grid properties – many of which are suited to heat pumps. The issue of grid constraint limits early deployment of these in the west of the area.
5	Holmcroft, Doxey & Castletown, Rowley, Highfield & Westerns Downs, Manor, Penkside	The area has a mix of levels of fuel poverty, with a high number of properties suitable for heat pumps and particularly large opportunities in the local authority/social housing sector. There are also homes which would need a high level of fabric improvement for heat pumps to function most effectively, which makes decarbonisation across the whole area challenging. A large number of properties are also electrically heated currently, for these not all are considered to switch to heat pumps (with resistive heating being considered more cost optimal in some situation). However, the poor fabric efficiency in a large number of such homes needs to be addressed. The fabric improvements in this area are generally challenging with the walls requiring insulation often not being of cavity construction, making the improvements more costly. The area also includes a high level of non-domestic demand, which will need to be met with a combination of building level solutions as well as opportunities for shared solutions through heat networks. From a transport perspective the area would benefit from public sector input with the need for on street charging and substantial EV charging capacity required in car parks in the area (this includes public sector owned car parks).
6	Common, Coton, Littleworth, Forebridge	This is an area with a mix of domestic properties ranging from some which are already suited for the transition to heat pumps and some which need substantial fabric improvement to enable this – the fabric improvement measures are quite challenging in the area due to building construction type. There is a high number of local authority/social housing properties along with the high level of fuel poverty in large portions of the area make it a priority for improvement. Being in the town centre there is also substantial need for provision of on street and car park charging. There is also a high density of non-domestic properties, resulting in the area being flagged for heat network opportunities.
7	Haywood & Hixon, Colton & the Rideways	The area contains two proposed 50 MW solar farms, taking advantage of the existing grid infrastructure at the nearby old Rugeley Power Plant site, this makes it the most important area for immediate largescale renewable deployment. From a demand perspective settlements are widely distributed but despite the general rural nature the majority of settlements are on gas which, along with the building character in the area, means it is not a priority for heat pump transition but is also not seen as particularly challenging. The more rural location does open up opportunities for ground source heat pumps alongside the more widely deployed air source systems. The Hixon area in the west of the zone has a high density of industrial parks and is the focus for non-domestic decarbonisation in the area.
8	Baswich, Weeping Cross & Wildwood, Milford	The area is dominated by the owner occupied tenure, however, from a technical perspective it is one of the best for early action in the domestic sector (for an on gas area). It has the highest density of homes requiring cavity wall insulation (a relatively low cost improvement measure) and it already has a high number of houses suited to heat pumps (both ground and air source). The relatively large properties and associated roof space means it is also one of the highest opportunity areas for rooftop PV. This is combined with a high proportion of off street parking, meaning the power generated could help charge the owner's vehicles. This helps realise more value for the electricity (both form an economic and carbon displacement perspective) and potentially reducing the need for grid reinforcement.
9	Western Springs, Hagley	The area has a relatively high level of fuel poverty, which is combined with good opportunities for heat pumps - with properties requiring relatively cheap fabric improvements to enable effective adoption. There are also some small heat network opportunities that could be examined, some of which take advantage of public sector assets in the area to help trigger development.



Ward group code	Ward names	Area summary
10	Brereton and Ravenhill, Armitage with Handsacre	This contains the large redevelopment area on the old site of Rugeley Power Plant. The high energy efficiency and net zero credentials of this development could make it an exemplar for other housing developments, which are required in each of the local authority areas. The existing grid substation in the area and planned large scale battery make it an important area for large scale energy infrastructure. The area includes some large non-domestic users, focused in the Tower Business Park. This includes a very large Amazon warehouse, which along with the other non-domestic assets in the area highlight it as an early opportunity for HGV decarbonisation.
11	Etching Hill and The Heath, Hednesford North, Longdon	The west of the zone is dominated by the Cannock Chase Area of Outstanding Natural Beauty, which limits the renewable deployment but makes it key for carbon sequestration for the LAEP. The east of the zone has a relatively high number of off gas grid properties already suitable for heat pumps making this the biggest immediate focus for heat decarbonisation in the area. The lack of local authority/housing association tenure types means it is not an early focus for on gas grid property decarbonisation.
12	Hednesford Green Heath, Cannock North, Cannock East, Hednesford South, Rawnsley	The wards contain areas with a relatively high level of deprivation and fuel poverty, particularly in the western side of the zone (the Cannock North ward). This area also has a large portion of local authority/social housing domestic properties – which are suitable for heat pumps. The societal need and the opportunity for intervention makes the Cannock North ward an early focus area for heat pumps, particularly in the local authority/housing association assets.
13	Alrewas & Fradley	This contains one of the largest industrial parks and HGV hubs in the LAEP. This is a non-domestic typology which is key to the LAEP area and this could be an exemplar site for decarbonisation. There is a large scale private wire opportunity for ground mounted solar or PV development on the extensive rooftops of the industrial estate. A large heat network has also been flagged in the area but these can be challenging with the type of users. From the domestic sector perspective it is not a priority area.
14	Cannock West, Cannock South, Norton Canes	This is one of the best areas for early action in the non-domestic sector, there are options for local generation and private wire development, heat networks and an HGV charging hub. From the domestic perspective it is not as high priority being relatively typical in terms of insulation measures required and suitability for heat pumps, however, there are some areas which will require more on street charging than the LAEP norm.
15	Hawks Green, Heath Hayes East and Wimblebury	The area generally has a high level of fabric efficiency, making homes generally well suited to heat pump adoption, however, there is a very low level of local authority/social housing. When combined with properties being on gas grid it is not as highly prioritised as other areas, notably ward group 12 which surrounds the northern edge.
16	Chase Terrace, Boney Hay & Central, Chasetown, Summerfield & All Saints	The area has a high number of on gas properties that are suitable for heat pumps, or would be with limited retrofit, many of these are local authority/social housing tenure type making them an early focus. Other early heat decarbonisation opportunities include several potential heat networks identified across the wards, which merit further investigation. The Burntwood Business Park is highlighted as an HGV hub to consider for decarbonisation.
17	Highfield, Hammerwich with Wall	The area has a relatively high proportion of uninsulated cavity walls, which make it an easy win from an energy efficiency perspective in the domestic sector. When relatively low cost fabric improvement measures like this are put in place it becomes one of the most suitable areas in the LAEP for heat pumps deployment. However, the area is on gas and the majority of properties are private tenure so the early focus is on the cavity wall insulation rather than heat pump adoption. Being between two larger settlements the wards have a high level of car ownership, with this is a high level of off-street charging identified in the model. These chargers are identified as coupling well with good potential for rooftop PV in the area.
18	Chadsmead, Curborough, Stowe, Boley Park, St John's, Leomansley	Lichfield has broadly similar characteristics across the whole city. For an urban area it has a lower requirement for on street chargers than equivalent areas (e.g. the towns of Cannock and Stafford) but there are opportunities for EV charge points in public car parks to pursue in the near term. The homes are well suited to heat electrification with a high number that already suited to heat pumps (including a density in the middle and north of the city that are public/housing association owned) or will be with limited fabric retrofit. The non-domestic heat demands create some excellent opportunities for heat networks, including three highlighted for further exploration.
19	Whittington & Streethay, Mease Valley	This area has the highest density of off gas grid properties which could make the transition to heat pumps without significant grid constraint hindering early deployment. This makes it an initial focus area for heat pumps due to the greater carbon saving of displacing oil over natural gas and also the improved economics that tend to be seen due to relative fuel prices. Being rural there is also opportunity for renewable deployment, including a 50 MW solar PV farm currently in the planning system.
20	Shenstone, Little Ashton & Stonnall	Although the wards are rural the large settlements are all on the gas grid, with the building stock not being particularly well suited to heat pumps. This makes it one of the lower priority areas for immediate action, particularly given relatively low levels of deprivation and fuel poverty. A high level of off-street charging potential, along with good rooftop PV potential to provide charging, meant transport was highlighted as the early decarbonisation opportunity for these wards.
21	Bourne Vale, Fazeley	The area is flagged as being suitable for decarbonisation of HGVs and similar vehicles, in part due to the large scale extraction/manufacture/distribution of building materials in the area. The area also includes a theme park, these factors combine to make it one of the target areas for non-local authority non-domestic decarbonisation.

Figure 0—3 Summary of decarbonisation pathways for strategic areas based on wards across the LAEP, based on the Consumer Led scenario. Background map from ESRI.

In the Consumer Led scenario there are some ward groups highlighted to focus on for early decarbonisation opportunities:

- Off gas grid properties switch to heat pumps in ward group **19**
- On gas grid switch to heat pumps ward groups **5, 6, 12** and **18**
- Domestic fabric retrofit measures in ward groups **5, 8, 9, 12** and **18**
- Heat networks ward groups **3, 4, 5, 6, 9, 14, 16** and **18**
- On street EV charging ward groups **3, 5, 14** and parts of **18**
- Car park EV charging ward groups **5, 14** and **18**
- HGV hub decarbonisation ward groups **4, 10, 13, 14** and **21**
- Rooftop PV has extensive potential across most areas, however, ward groups **8** and **18** have a strong opportunity to link this potential with high levels of opportunity for home-based off-street EV charging

A high-level quantification of the different low carbon technologies required in the Consumer Led scenario as well as the BaU and Hydrogen Heavy pathways is provided in Table 0—2.

Table 0—2 Summary of additional low carbon technologies installed for different scenarios.

	Business as Usual	Hydrogen Heavy	Consumer Led
Domestic Heating system	45,000 heat pumps (includes hybrid)	58,000 heat pumps (includes hybrid) and 10,900 hydrogen boilers.	140,000 heat pumps
Domestic fabric efficiency	18,000 fabric retrofit measures	132,000 fabric retrofit measures	121,000 fabric retrofit measures
Non-domestic Heating system	34 MW heat pumps and 55 MW hybrid heat pumps	78 MW heat pumps, 92 MW hybrid heat pumps and 19 MW hydrogen boilers	123 MW heat pumps, 13 MW hybrid heat pumps and 2 MW hydrogen boilers
Non-domestic fabric efficiency	Save 17 GWh/yr	Save 93 GWh/yr	Save 86 GWh/yr
Heat networks	Provide 24 GWh/yr	Provide 83 GWh/yr	Provide 92 GWh/yr
Transport	113,000 home EV chargers, 2,000 on street chargers, 114 MW work/destination charging, 57 MW car park charging, 170 HGV electric chargers, 40 MW of HGV electrolysis units and 20 electric bus chargers	113,000 home EV chargers, 2,000 on street chargers, 114 MW work/destination charging, 57 MW car park charging, 170 HGV electric chargers, 40 MW of HGV electrolysis units and 20 electric bus chargers	113,000 home EV chargers, 2,000 on street chargers, 114 MW work/destination charging, 57 MW car park charging, 170 HGV electric chargers, 40 MW of HGV electrolysis units and 20 electric bus chargers
Renewable generation	66 MW domestic rooftop PV, 12 MW non-domestic rooftop PV and 192 MW ground mounted PV	110 MW domestic rooftop PV, 20 MW non-domestic rooftop PV and 321 MW ground mounted PV	172 MW domestic rooftop PV, 31 MW non-domestic rooftop PV, 501 MW ground mounted PV and 25 MW of wind

The Hydrogen Heavy scenario carries with it the highest risk, being reliant on large scale production of hydrogen and conversion of the gas network at a national level – where there is currently no clear national policy. To try and offset this risk and maximise what can be done at a local level there is an early focus on energy efficiency improvements. There is, however, a limit for all scenarios about what can be achieved by a LAEP without wider national input – this is explored in Figure 0—4.

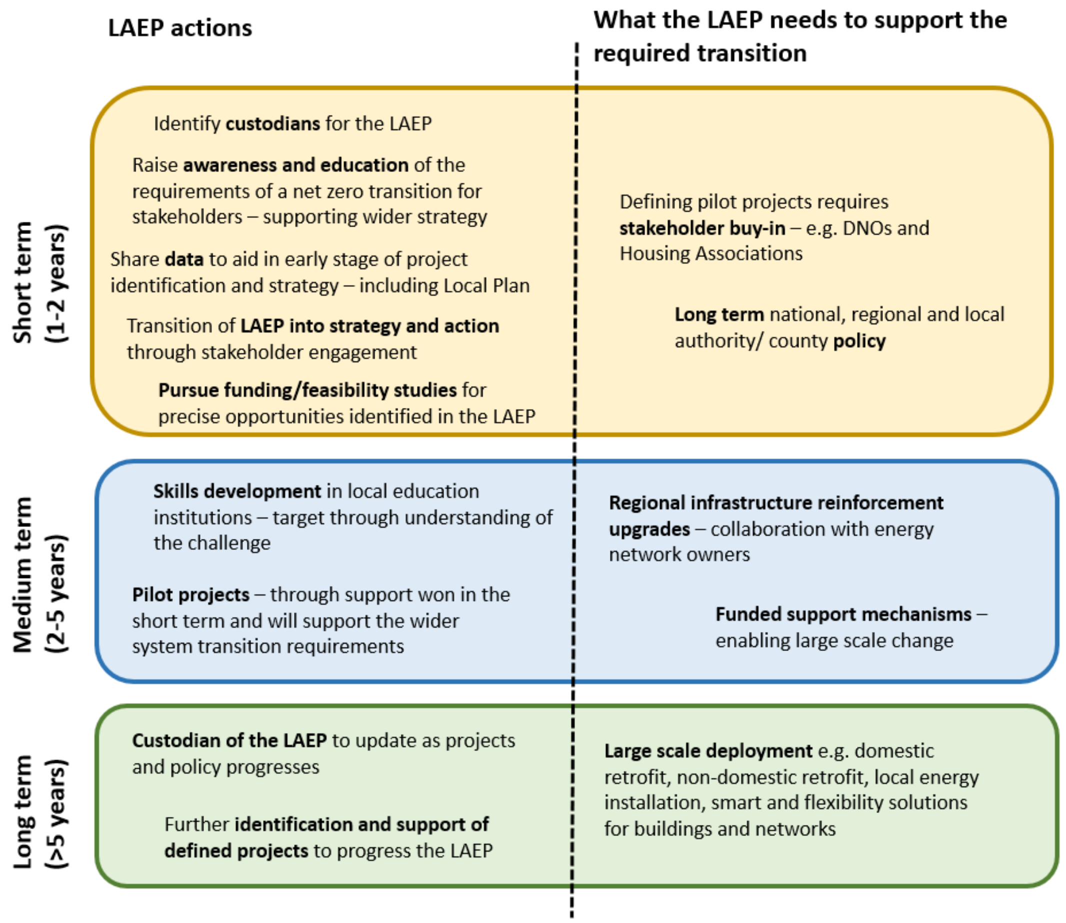


Figure 0—4 Making it happen, what the LAEP can help deliver and what requires wider action.

Key actions and areas in the short term identified for consideration are:

- For the Stafford, Cannock Chase and Lichfield local authorities to use the findings of the LAEP to inform, evidence and feed into Local Plans.
- Focus on local authority/housing association domestic properties in the early years, this is both for heat pumps and fabric improvements. To enable this, prepare for Social Housing Decarbonisation Fund round 2 – supported by the LAEP generated data.
- Address local authority/public sector non-domestic buildings, both from a fabric and heating system perspective (including potential heat network connection). Prepare for the Public Sector Decarbonisation Scheme round 2 to support these projects.
- The high number of industrial estates, HGV hubs and storage sites in the area make these type of non-domestic energy users a priority to engage with exemplar decarbonisation approaches potentially being applicable across large sectors of the non-domestic demand in the LAEP
- Certain aspects of transport such as on street chargers and car parks are under greater public sector influence and can be progressed early. The substantial HGV numbers in the area means identifying a suitable site and stakeholders to help decarbonisation of this sector is important and given the road infrastructure in the area, would be significant on a national scale. One pilot project could be an electrolysis unit fed by local renewables for hydrogen HGVs – Fradley Distribution Park and the Orbital Retail Park area of Cannock.
- Utilisation of public land assets, this can be for many different uses such as: renewable generation (ideally sold through private wire arrangements), routing for heat network pipes or borehole arrays for ground source heat pumps.
- Pursuing funding to realise pilot projects highlighted throughout the LAEP, notably various frameworks for supporting heat network deployment.

1 Introduction

This document provides a Local Area Energy Plan for the three local authorities of Stafford, Cannock Chase and Lichfield. This covers all aspects of the energy system and the actions and costs required to fully decarbonise it. Buro Happold were commissioned by Energy Systems Catapult to undertake this piece of work as part of an Innovate UK funded project creating Local Area Energy Plans for three distinct areas of the UK. Although this work was not directly commissioned by Stafford, Cannock Chase and Lichfield or Staffordshire County Council they are the natural owners of the plan to help progress it through to strategy and delivery, and as such they have been engaged through the plan's development.

1.1 Purpose of a Local Area Energy Plan (LAEP)

Local Area Energy Planning is a process which has the potential to inform, shape and enable key aspects of the energy system transition[3]. Key to this is understanding the specific characteristics of the local area and how this translates into different pathways for a net zero energy system. Net zero is taken to mean all emissions are equal to or less than the emissions removed from the atmosphere in the area examined.

The LAEP looks across all energy system vectors at multiple scales from building level to beyond a local authority boundary (see Figure 1—1 for an illustration of this complexity).

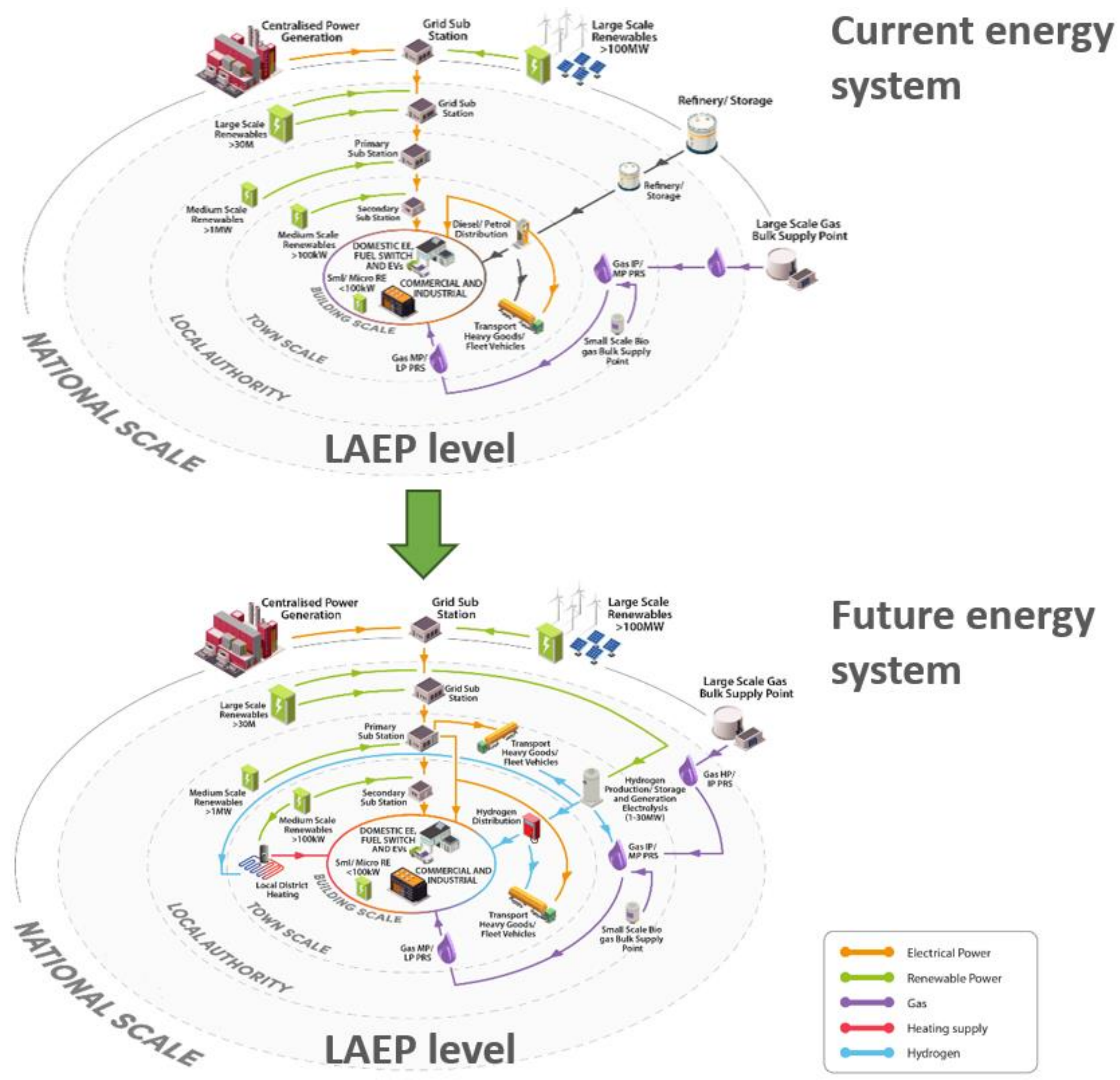


Figure 1—1 Illustration of the different scale of the energy system and the transition from the current energy system to potential future systems.

LAEPs sit between the local authority influence and the national scale, striking the balance between wider national strategy and the precise local requirements. As Figure 1—1 illustrates the energy system is likely to become more complex and interconnected as it transitions to net zero, meaning it is important to have a plan in place at a suitable scale to understand these complexities and implement this transition.

There are many different scenarios for reaching net zero, perhaps best characterised by the direction of travel for the decarbonisation of heat; with large scale electrification of heat or the switch from natural gas to hydrogen being key options considered nationally. The LAEP examines different pathways or scenarios for decarbonisation of all energy demand sectors, be it heat, transport or electricity to see which is most suitable for the local area. This takes into account geography, local policy and likelihood of deployment among other factors.

Across different scenarios for decarbonisation there are likely to be common technologies and themes, such as energy efficiency improvements. This LAEP identifies areas which present a good initial opportunity for such measures, creating

[3] https://es.catapult.org.uk/report/local-area-energy-planning-the-method/

low regrets actions which can be taken in the near term as they represent low regrets opportunities (i.e. common solutions) across all scenarios.

1.2 Area Character

The LAEP covers the three neighbouring local authorities of Stafford, Cannock Chase and Lichfield – shown in Figure 1—2.

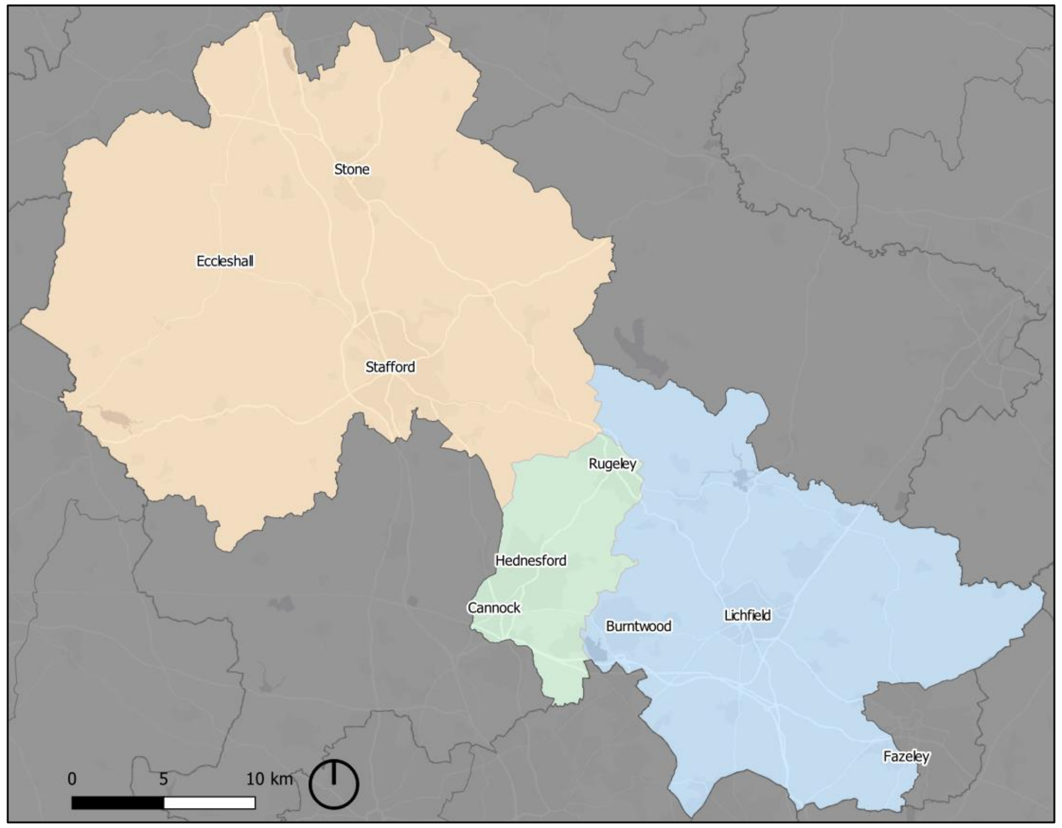
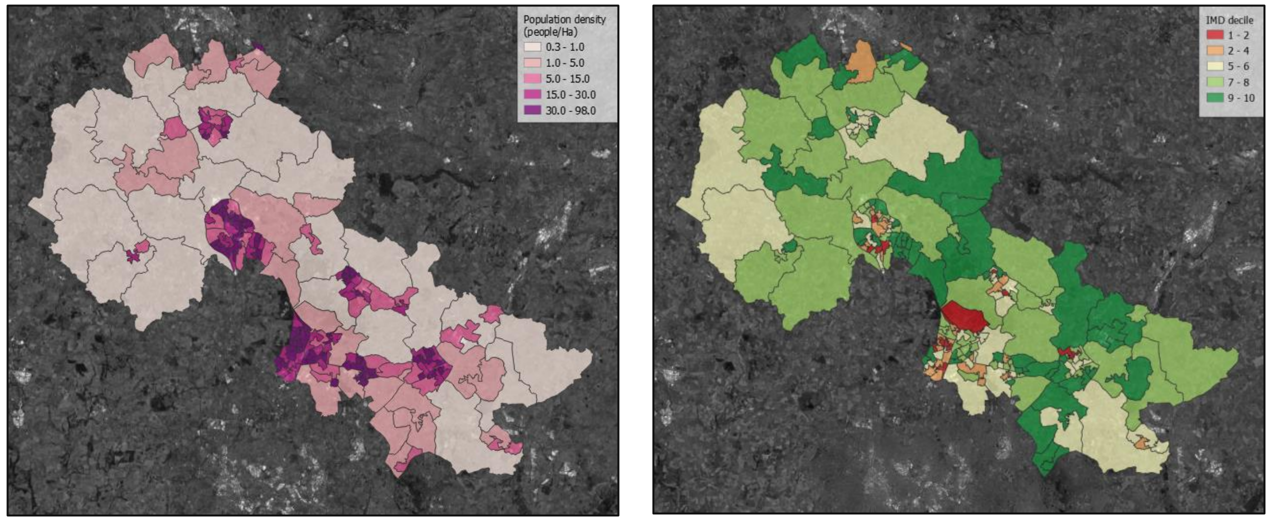


Figure 1—2 LAEP area covered. Background imagery from ESRI. The orange area is the Stafford local authority area, green Cannock Chase and blue Lichfield.

This is a large area of over 100,000 Ha and is also populous, being home to ~340,000 people. The area has a mix of rural and urban geographies, providing opportunities for large scale renewable generation in the rural areas and wide-spread role out of low carbon heat solutions, such as heat networks, in the urban areas. The spread of rural and urban geographies is illustrated in Figure 1—3 which illustrates the breakdown in population density across the LAEP area.



Population density – darker colours indicate higher population density

Levels of deprivation – red indicates high levels of deprivation green low levels

Figure 1—3 Summary of population density and levels of deprivation across the LAEP area at Lower Sized Output Area (LSOA) level. Basemap imagery from Google Satellite and overlain data the Office of National Statistics.

The majority of the LAEP area's population live in relatively densely populated urban developments, with 79% of the LSOAs[4] having a density above 5 people per hectare and 64% over 15 people per hectare (for reference the English average is ~4 people per hectare). Despite a tendency towards urban populations the area represents a mix of population densities, with over 20% still being in more rural areas. This diversity in population density generally translates to diversity within the energy system (e.g. a mix of on and off gas grid areas).

Levels of deprivation are also indicated in Figure 1—3, in general the area is less deprived than the UK average (the area decile has a mean of 6.5 and a median of 7 compared to the UK average of 5). There are, however, pockets of high levels of deprivation particularly in the towns of Stafford and Cannock. Factors like this are integrated into the LAEP process, trying to help address these inequalities.

A large part of this deprivation is fuel poverty, the area has a current fuel poverty rate of 14.3% of households, higher than the English average of 13%. Both numbers are likely to rise substantially with the increased fuel price, making it more important to address this imbalance. Analysis of fuel poverty and Indices of Multiple Deprivation for the LAEP area showed a strong correlation between high levels of deprivation and fuel poverty[5]. This suggests addressing fuel poverty will reach those who are generally in areas of highest overall deprivation. Tackling fuel poverty is key to the makeup of an LAEP, as they promote more efficient energy systems – lowering ongoing fuel costs.

The LAEP area is also characterised by containing nationally significant road and rail links, these are illustrated in Figure 1—4.

[4] LSOA stands for Lower Layer Super Output area and is a standard geographic unit for reporting data such as fuel poverty. They have a population of 1000-3000 people and are one are the standard geographic boundaries used in the LAEP. The other two major boundaries (excluding local authority areas themselves) are Middle Layer Super Output Areas (MSOAs) that have between 5000 and 7200 inhabitants and electoral wards.

[5] r^2 of 0.67

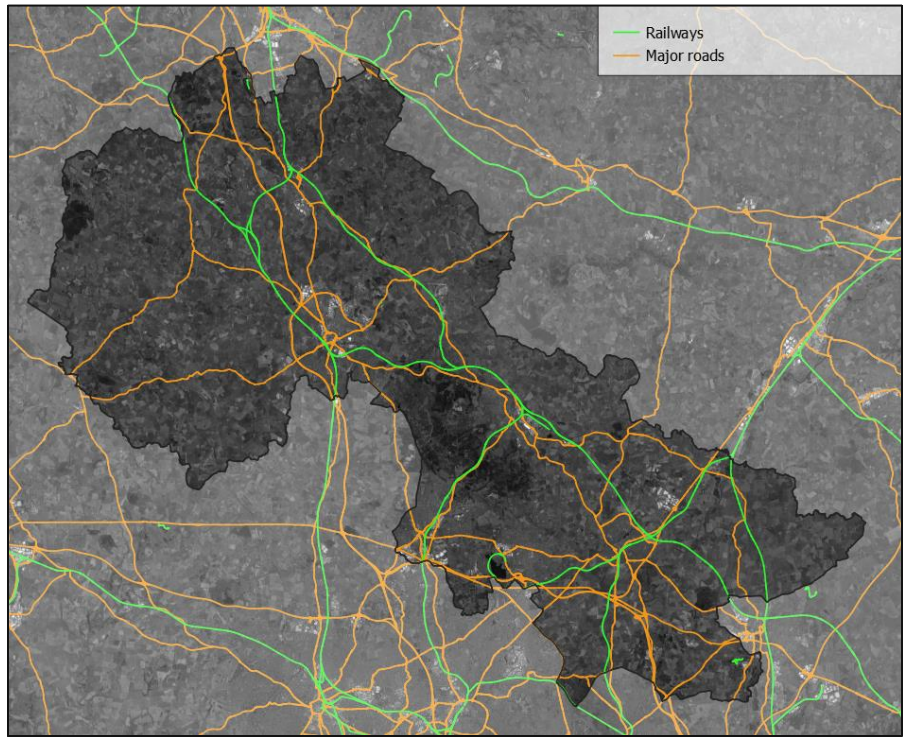


Figure 1—4 Major transport routes in the LAEP area. Basemap data from Google Satellite with rail and road routings from Ordnance Survey Crown Copyright.

The LAEP will focus on locally based transport. This is because it cannot be expected for the LAEP area to offset national transport emissions of vehicles travelling through. However, the presence of this major transport infrastructure, particularly the roads, means there is an above average number of HGVs registered and operating from the area – which will be captured in the analysis. Also, the location of the LAEP area between the large population centres of Stoke-on-Trent and Birmingham means commuting and car usage will be an integral part to the local energy system.

1.3 Current energy system

The current energy system baseline and carbon emissions for the three local authorities in the LAEP are assessed using data from BEIS sub-national statistics. **Error! Reference source not found.** and **Error! Reference source not found.** di splay a summary of the current energy consumption.

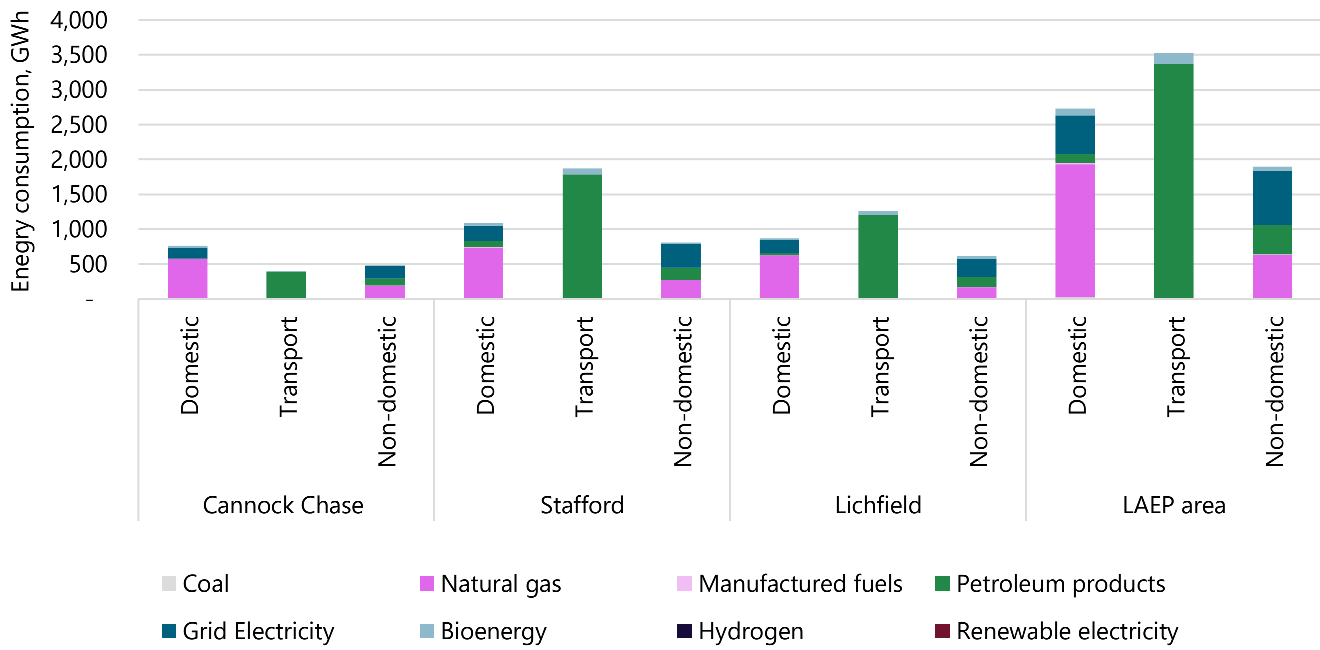


Figure 1—5 Current energy consumption summary for each local authority and the whole LAEP area (2020 baseline).

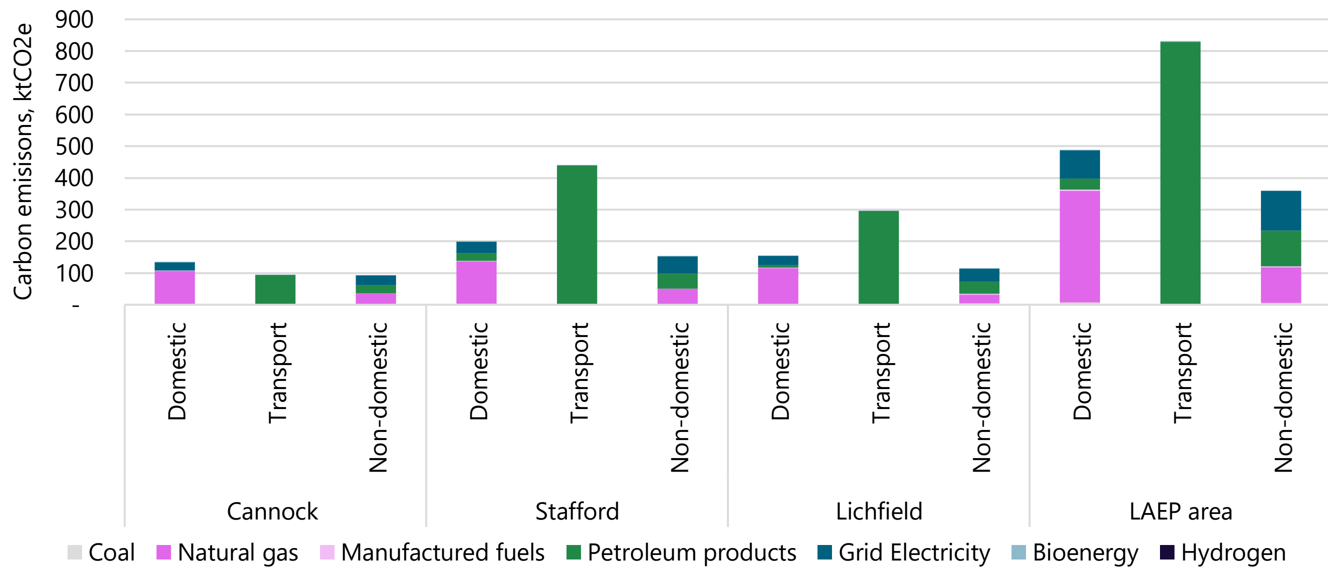


Figure 1—6 Current carbon emissions summary for each local authority and the whole LAEP area (2020 baseline)

Figure 1—5 and Figure 1—6 use 2020 data which is the most recently available year from the BEIS as a baseline and includes both scope 1 and 2 emissions[6] (tCO_2e) split by the domestic, transport and non-domestic sectors. The overall energy consumption and carbon footprint of the LAEP area equate to 8,155 GWh and 1,681 $ktCO_2$ respectively. The impact of COVID will have increased energy consumption and associated emissions in the domestic sector and reduced it in the non-domestic and transport sectors, this is reflected in the LAEP modelling approach but 2020 still gives a good indication of the energy system in the area.

[6] Scope 1 emissions covers emissions from sources directly controlled by an individual or organisation (e.g. from burning natural gas in a boiler or petrol in a car), scope 2 emissions are those caused indirectly when an individual purchases energy as a result of the manner this energy is produced (e.g. grid electricity whilst there are fossil fuel power plants operating).

1.4 Current Targets and Activity

At a county level Staffordshire has a 2050 net zero target aligning to national policy, however, it is rightly recognised that local action is required to meet to meet these targets. There is a strong thrust within the County's 'Climate Change: Strategic Framework' of using the public assets to help drive change – particularly in the early years towards 2050. This is also a core theme within the LAEP. The Staffordshire framework also aligns strongly in other ways with LAEP philosophy, as illustrated in Figure 1—7.

Figure 1—7 Staffordshire County Council – opportunities and levels of influence. Image taken from Staffordshire County Council Climate Change: Strategic Framework[7].

The five opportunities and levels of influence align with those in the energy system diagram in Figure 1—1, with the "areas that we directly control/guide" being the equivalent to building level solutions, through to the wider and more separated opportunities that are the levers that force the change. This is one of the strengths of the LAEP, as being of a larger scale than a town or even a local authority, it has a greater connection with national policy and influence - whilst keeping the local vision and requirements.

Whilst the county level view is key context for a LAEP the LAEP area is made up of three local authorities, so it is their buy-in and local policies and drivers which are the key focus.

1.4.1 Stafford Borough Council

Stafford Borough Council recognise the importance to mitigate the effects of climate change to limit Global Warming to less than 1.5 °C. As such the council have pledged to join other councils in declaring a Climate Emergency and work towards achieving carbon neutrality by 2040 by looking to adopt a united and holistic approach[8].

The reduction of associated emissions of greenhouse gases has been an important focus for the council in their own assets in recent years. Stafford are already purchasing 10% of green electricity and improving energy efficiency in their buildings in order to ensure long-term sustainability. Solar panel installation at various sites has also been implemented including facilities such as the Civic Centre and Riverway.

A new Local Plan is currently being prepared, with one of the key drivers being to achieve carbon neutrality – this report hopes to provide an evidence base to help support this. Stafford's strategy will look to reduce emissions from their own activities by promoting the following:

- Carbon saving through electrification of transport such as installation of electric vehicle charging points
- Policies to support the building of sustainable/carbon neutral homes and communities
- The installation of renewable energy infrastructure

Part of Stafford's strategy will also include working with other elected bodies to determine best practice methods to limit global warming to less than 1.5 °C and consider how this could be addressed through the Local Plan process.

The policies are all important components of reaching carbon neutrality, however, there are large challenges such as the retrofit of existing building stock to zero carbon energy solutions. These issues are complex and costly and need to be addressed within an LAEP in order for net zero to be reached.

1.4.2 Cannock Chase Council

Cannock Chase Council declared a Climate Emergency in 2019 and set a vision for the district to become carbon neutral by 2030[9], although recent stakeholder feedback indicates that this target may be shifted to a later date. The Council's initial plans for tackling climate change include producing a costed action plan on how to achieve its carbon neutral vision. It recognises that extensive engagement will be necessary to achieve the goal from which an action plan is currently being devised.

Two major steps towards net zero are the closure of the coal burning Rugeley Power Station in mid-2016 and the electrification of the Chase rail line. Cannock Chase has substantial natural assets which they are looking to maintain as part of their pathway to net zero, most notable of these is the Cannock Chase Area of Outstanding Natural Beauty (AONB). This contains extensive forests which are seen as having an important role in absorbing CO_2 and improving air quality.

Two climate change mitigation initiatives are currently being implemented by the district, the district are Zero Carbon Rugeley/SLES (Smart Local Energy System) and Chase Community Solar. The SLES scheme aims to take full advantage of the latest renewable energy technologies and smart control systems to deliver clean, affordable energy for residents. Furthermore, Chase Community Solar promotes the use of PV panels on domestic roofs through a local investment scheme.

Whilst these are important steps there will need to be a far wider transition than the current policies would result in, again heat and buildings outside the direct control of the council will present the greatest challenge – particularly given the current highly ambitious timeframe for net zero.

1.4.3 Lichfield District Council

Lichfield District Council declared a climate emergency in 2019 and support the Government's target of Net Zero Carbon Emission by 2050[10], the council are currently in the process will be launching a two-phase strategy for decarbonising Lichfield. The first phase sets a roadmap for Lichfield District Council to achieve a net zero status by 2035 through a mixture of directly reducing their emissions and offsetting their impact for remaining emissions. The second phase will be engaging with the rest of the district over the broader Lichfield carbon footprint and how they can achieve net zero status by 2050. Lichfield have recently made progress through carbon reduction opportunities including a £1 million decarbonisation project with Burntwood Leisure Centre as well as deployment of carbon sequestration through teaming up with Severn Trent and planting several forests around the district.

As part of developing Lichfield's energy and sustainability policies, AECOM were commissioned to establish a baseline and emissions reduction strategy[11]. The technical report identifies that in order to meet the UK-wide 2050 target for reaching Net Zero emissions, Lichfield will need to:

[7] https://www.staffordshire.gov.uk/environment/Documents/Climate-Change-Strategic-Development-Framework-15.03.21.pdf
[8] Climate Change Strategy (staffordbc.gov.uk)
[9] [Tackling Climate Change | Cannock Chase District Council (cannockchasedc.gov.uk)]
[10] Councillor Doug Pullen's New Year Message (lichfielddc.gov.uk)
[11] Lichfield Policy Summary (lichfielddc.gov.uk)

- Reduce energy demands from transport and buildings – such as switching to 100% ultra-low emissions vehicles and improving building fabric performance
- Seek to increase the provision of local renewable energy – including wind and solar opportunities
- Support for LZC energy developments – including switch to heat pumps and use of heat networks where appropriate.
- Carbon removal from the atmosphere through carbon sequestration on council owned land.

The two-phase plan recognises the greater ease of switching the directly controlled building stock but also addresses the need to retrofit existing buildings across all stock to hit net zero. It is notable that there is an emphasis on increasing carbon sequestration, this is an important element of any net zero strategy as there are some emissions which are far harder to avoid, sequestration measures are vital for balancing these locally.

1.5 Structure of the report

The following report summarises the modelling results and key findings of the LAEP study for Stafford, Cannock Chase and Lichfield. It starts by examining the National Grid Future Energy Scenarios and exploring these in a local context. These are then used to frame the key scenarios examined of the LAEP. The report then examines the key elements of the energy system: domestic buildings, non-domestic buildings, transport, low carbon generation, and energy network infrastructure (gas, electricity and heat networks). The report finishes with a next steps section, pulling out the key early opportunities identified in the LAEP and how to progress these.

2 Scenarios

This section examines national energy system scenarios and translates and adapts these to local scenarios for the LAEP. The latter half of the section provides a breakdown of the costs and carbon emissions associated with these scenarios.

2.1 Energy Demands

When determining different energy scenarios, it is important to establish what demands will be assessed in the LAEP. Whilst the majority of the challenge will come from existing demands, there will be growth in the LAEP area - particularly from increased demand for new housing. From a net zero perspective there are already highly promising signs that major new developments, such as the redevelopment on the Rugeley Power Station, are being approached with this as a requirement at the forefront of the design. This forward-thinking approach, with new developments already having low carbon solutions, such as high energy efficiency and district heating or building level heat pumps is key to all LAEPs. It stops adoption of technologies like gas boilers which are either dependent on future hydrogen (and will thus increase carbon emissions until the gas network transitions) or will require retrofitting to heat pumps or other low carbon technologies. This means that whilst gas boilers may be the current lowest cost solution choosing this technology will result in the need for further capital expenditure in the future.

It is assumed new builds, in the vast majority of cases, will adhere to this approach of zero or near zero energy solutions. Consequently, new demands are not seen as a major element of concern within the scenarios being examined but rather than transition of the existing demands being the key barrier.

2.2 Future energy scenarios

The scenarios used in this work are broadly based on the National Grid Future Energy Scenarios (FES), providing a national context for the decarbonisation strategy[12]. There are four core scenarios within the FES:

- **Steady Progression**
  - Slowest credible decarbonisation
  - Minimal behaviour change
  - Decarbonisation in power and transport but not heat
- **System Transformation**
  - Hydrogen for heating
  - Consumers less inclined to change behaviour
  - Lower energy efficiency
  - Supply side flexibility
- **Consumer Transformation**
  - Electrified heating
  - Consumers willing to change behaviour
  - High energy efficiency
  - Demand side flexibility
- **Leading the Way**
  - Fastest credible decarbonisation
  - Significant lifestyle change
  - Contains a mixture of hydrogen and electrification for heating
  - Hard to replicate at a local level due to infrastructure challenges

An illustration of the energy make-up for these scenarios in the LAEP area in 2050 is provided in Figure 2—1.

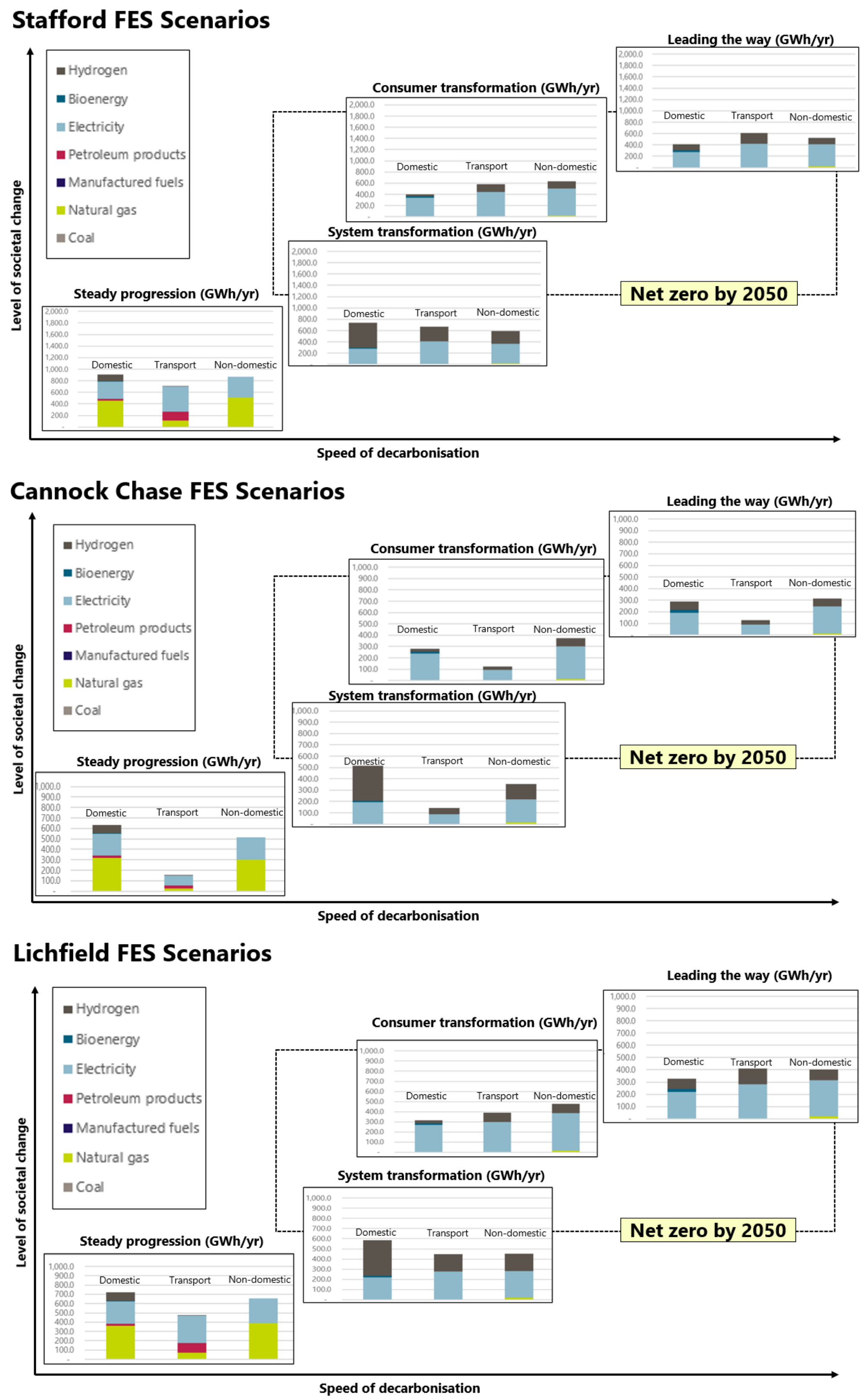


Figure 2—1 Energy make-up of the four FES scenarios for the three local authorities in the LAEP.

These four national Future Energy Scenarios are used to inform the five scenarios explored in this LAEP. However, it should be noted the analysis in Figure 2—1 is based on national datasets and does not use the same level of detailed analysis

[12] https://www.nationalgrideso.com/future-energy/future-energy-scenarios/fes-2021

that appears in the LAEP study (for example improved resolution of transport modelling appears in the LAEP). It does, however, provide an indication of the scale of scenario diversity, even among the scenarios that reach net zero in 2050.

2.3 Local scenarios

This section details how the FES are translated into local scenarios for use in the LAEP. The focus is on three core scenarios: Business as Usual, Hydrogen Heavy and Consumer Led. There are also two sub-scenarios of the Consumer Led: Target Led and Area Alignment. These vary the timescales for achieving net zero but otherwise follow the same technology decisions as the Consumer Led approach.

2.3.1 Business as Usual

The Business as Usual (BaU) scenario follows the Steady Progression scenario outlined in the FES. Key components of this scenario are:

- High retention of current heating systems
- Some fabric improvements of properties
- Decarbonisation of transport happens fully but slower than other scenarios
- Very limited demand management/smart energy systems leading to very little demand diversity
- Decarbonisation of electricity – this is driven by national decarbonisation through centralised low carbon generation but there is still substantial local generation

The timeline for this scenario is directly translated from the FES with the same level of deployment. This scenario will not meet net zero carbon targets, instead it provides an indication of the shape of a future energy system in the LAEP area where there is not a strong local or national drive towards zero carbon. It does, however, represent some action but not enough to achieve net zero.

2.3.2 Hydrogen Heavy

The Hydrogen Heavy scenario follows a similar approach to the FES System Transformation scenario, with mass domestic adoption of hydrogen boilers through the repurposing of the gas grid. Electrification of heat is thus focused in off gas grid areas, some elements of the non-domestic sector (particularly in the early years) and any areas suitable for district heating solutions. As the scenario is almost entirely contingent on national policy drivers, the timescales are kept in alignment with the System Transformation FES scenario. To align with how hydrogen networks would develop, i.e. whole areas would undergo a binary switch from natural gas to hydrogen due to the network layout, large areas of the local authorities in the model will switch at once (these tend to be in the most dense urban areas to start with).

Key components of this scenario are:

- Transition of existing heating systems – with a large focus on hydrogen
- High level of fabric improvements – this is particularly important in early years to create carbon savings before hydrogen starts to become available in the mid-2030s
- Decarbonisation of transport
- Some more demand management than the BaU scenario, however, this is still limited and as a result the impact on demand diversity is still low
- Decarbonisation of electricity – national level grid decarbonisation is key but substantial local generation, exceeding that in the BaU scenario, is also seen

This scenario in many ways represents taking some local measures whilst relying on a national or wider regional solution and is the main point of comparison to the following three scenarios.

The reliance on national policy and on a technology which is not as proven as the main alternative (i.e. heat pumps) is a risk associated with this scenario. The scale of the challenge also complicates the process, the most analogous example being the conversion from town to natural gas from 1967-1977[13], fitting of hydrogen ready boilers may help relieve some pressures. However, there is still the risk of inaction in terms of heating decarbonisation with any change being contingent on national pathways which are not yet decided. These national decisions cannot be made at an LAEP level, particularly when the LAEP area does not have a strong draw for hydrogen – which is the case in the Stafford, Cannock Chase and Lichfield area, due to the lack of heavy industry (this is discussed further in section 4).

2.3.3 Consumer Led

This combines the Consumer Transformation and Leading the Way scenarios from the FES, these have the greatest synergy with local area energy planning and is the basis of much of the scenario modelling carried out for this LAEP.

Key components of this scenario are:

- Transition of existing heating systems – with a large focus on electrification, with hydrogen only being seen in the non-domestic sectors for hard to electrify users
- High level of fabric improvements – this is considered for all properties, with a focus on creating properties where heat pumps will function efficiently
- Decarbonisation of transport – this happens fastest in this scenario
- Demand management is key in this scenario, with the greater diversity it creates being important with the high level of electrification seen
- Decarbonisation of electricity – national level grid decarbonisation is still important but very high levels of local generation are also seen

The same core assumptions are true for the following two scenarios, with a focus on analysing different deployment timings rather than technology choices. For the Consumer Led scenario timings align with the FES in terms of deployment, with net zero being hit in 2050.

2.3.4 Target Led

This scenario uses the Consumer Led scenario but with additional local drivers. As is not unusual, all three local authorities in the LAEP area have different net zero targets. This scenario explores the impact of pursuing these targets individually. To hit these targets, models are leveraged by local authority to account for these ambitions, with the different local authorities having zero carbon measures adopted at a rate which allows net zero target to be reached.

2.3.4.1 Stafford

Deployment of low carbon solutions aligns with achieving net zero by 2040 in line with local targets. This is for all sectors, with the scenario adapting the Consumer Led deployment in Stafford to hit the 2040 rather than national 2050 target.

2.3.4.2 Cannock Chase

Cannock Chase has the ambition of achieving net zero by 2030. To align with this full retrofit of homes with insulation energy efficiency measures will be required, as will full deployment of heat pumps and heat networks in suitable areas. Additionally, the entire transport fleet will require transition. This includes full adoption of electric vehicle technology for cars, LGVs and some buses, with the remaining buses and the large HGV fleet based in Cannock Chase transitioning to locally generated hydrogen or battery solutions.

[13] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/760508/hydrogen-logistics.pdf

2.3.4.3 Lichfield

Lichfield has two targets one for their own estate to be decarbonised by 2035 and the other for the whole of Lichfield by 2050. Other energy demands will transition at a rate to align with a 2050 net zero target, meaning for Lichfield this scenario strongly aligns with the Consumer Led scenario in terms of timings.

2.3.5 Area Alignment

This scenario is again based on the Consumer Led scenario, with variation in adoption timings. Instead of focusing on the individual local authority targets to the same extent as the Target Led scenario it brings them together to try and arrive at a middle ground. In this scenario decarbonisation is achieved in 2040, equating to the average of the three different local authority targets. It will be valuable to carry out a cost comparison between this and the Target Led scenario.

2.3.6 Summary of scenarios

A tabulated summary of the different underlying strategies for the scenarios modelled is provided in Table 2—1.

Table 2—1 Summary of the characteristics of the scenarios modelled.

	Business as Usual	Hydrogen Heavy	Consumer Led, Target Led and Area Alignment
Heating system	High retention of current heating systems. Some limited decarbonisation including adoption of heat networks.	Transition of existing heating systems – with a large focus on hydrogen. Includes a higher level of heat network deployment than the BaU. Electrification of heat largely confined to off gas areas.	Transition of existing heating systems – with a large focus on electrification, with hydrogen only being seen in the non-domestic sectors for hard to electrify users. Highest level of heat network deployment.
Fabric efficiency	Some fabric improvements of properties.	High level of fabric improvements – this is particularly important in early years to create carbon savings before hydrogen starts to become available in the mid-2030s.	High level of fabric improvements – this is considered for all properties, with a focus on creating properties where heat pumps will function efficiently.
Transport	Decarbonisation of transport happens fully but more slowly than other scenarios. Predominantly electrification for cars and vans, for larger vehicles there is a mix of technologies but a hydrogen focus.	Decarbonisation of transport. Predominantly electrification for cars and vans, for larger vehicles there is a mix of technologies but a hydrogen focus.	Decarbonisation of transport – this happens fastest in this scenario. Predominantly electrification for cars and vans, for larger vehicles there is a mix of technologies but a hydrogen focus.
Flexibility	Very limited demand management/smart energy systems leading to very little demand diversity.	Some more demand management than the BaU scenario, however, this is still limited and as a result the impact on demand diversity is still low.	Demand management is key in this scenario, with the greater diversity it creates being key with the high level of electrification seen.
Electricity	Decarbonisation of electricity – this is driven by national decarbonisation through centralised low carbon generation but there is still increased local generation.	Decarbonisation of electricity – national level grid decarbonisation is key but substantial local generation, exceeding that in the BaU scenario, is also seen.	Decarbonisation of electricity – national level grid decarbonisation is still important but very high levels of local generation are also seen.

The Consumer Led, Target Led and Area Alignment all have the same characteristics in terms of overall strategy, however, the timing of deployment varies across the scenarios.

2.4 Summary of scenario outputs

This section presents the key outputs from the LAEP modelling process in terms of overall costs, both capital expenditure and fuel and carbon costs. The carbon costs are very high, particularly in later years, and are based on BEIS Green Book figures.

2.4.1 Capital costs

The transition of the energy system is costly in all scenarios, this is even the case for the BaU scenario which does not reach net zero. The costing exercise was carried out based on final technology transitions, this means the Area Alignment and Target Led have similar capital cost as the Consumer Led scenario[14]. Figure 2—2 present the modelled capital costs of the components of the three core scenarios.

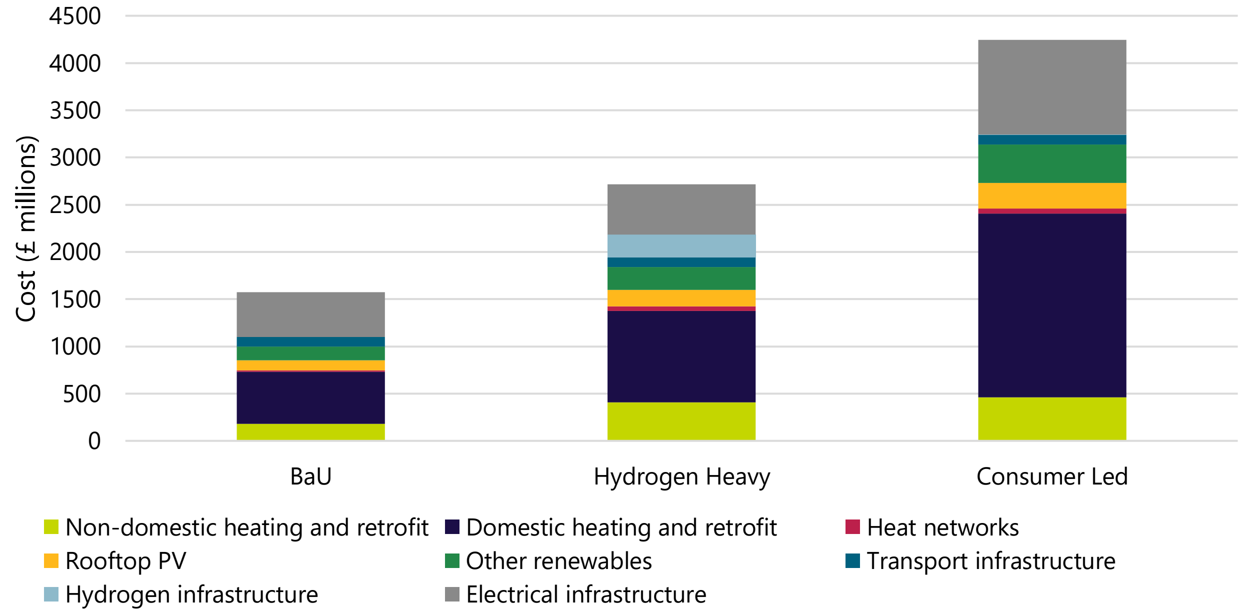


Figure 2—2 Capital costs for different aspects of the net zero energy system for the three core LAEP scenarios.

One of the reasons the capital expenditure in the BaU scenario is high (~£1.6 billion) is that existing gas boilers will be replaced between now and 2050. Even if these boilers are replaced with a new natural gas boiler it is important to capture these costs to ensure an equal cost comparison with the zero-carbon technology choice.

Domestic heating and retrofit along with electricity infrastructure are the dominant costs in all scenarios. Electricity infrastructure costs are high in all scenarios, not just the Consumer Led, mainly due to the introduction of electric vehicles across all scenarios. The electrical infrastructure upgrades are relatively high in the BaU and Hydrogen Heavy scenarios due to a lower level of smart charging and dispatchable demand in these scenarios.

For the Consumer Led scenario the domestic sector carries a total cost of nearly £2 billion, this is due to the very high penetration of heat pumps, which have a far higher unit cost than more traditional boiler technologies (this is still the case if the boilers are hydrogen rather natural gas). The greater stress this scenario places on the electricity network, given the electrification of heat, is in a large part responsible for the ~£1 billion expenditure on the electricity network. The majority of these costs come at the lower voltage levels due in a large part to this increase in distributed domestic electricity demand.

The modelling approaching means there is very little deviation in costs between the Target Led and Area Aligned scenarios and the Consumer Led presented in Figure 2—2. However, there are substantial challenges with such rapid

[14] If capital investment were explored, rather than costing the system as a whole, the application of discount rates would result in variations across these scenarios. With earlier decarbonisation carrying a high capital investment.

deployment that would in reality increase the costs, notably through lack of local management resource to oversee such large deployment and the supply chain readiness for this deployment. Also, to hit early targets not all equipment would have reached end of life, meaning there is wasted expenditure. It is also important to consider is the shorter period to raise the capital to invest, this is particularly challenging for Cannock Chase where by 2030, even without adding any costs due to the greater technical challenge, nearly £1.1 billion of capital costs would need to be realised by 2030 to hit the net zero target.

2.4.2 Fuel and carbon costs

Ongoing fuel costs greatly exceed the capital costs required to reach a net zero energy system; this is explored in the context of all five scenarios in Figure 2—3[15].

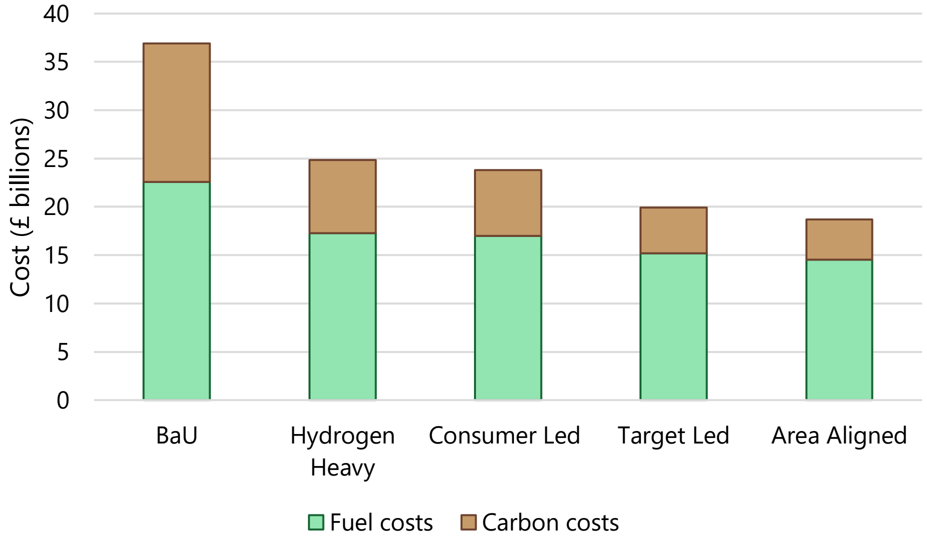


Figure 2—3 Total expenditure on fuel and carbon costs to 2050 (based on 2020 £s).

The BaU scenario carries with it the largest fuel costs in the LAEP modelling period. The reason behind this is system inefficiencies, the lower building energy efficiency combined with a slower adoption of electric vehicles. When these fuel costs are combined with carbon costs it is the most expensive scenario overall, including capital costs.

Figure 2—3 shows a lower carbon cost (a difference of £800 million) for the Consumer Led scenario over the Hydrogen Heavy pathway. This is due to the relative timings of the transition of buildings to low carbon heating systems. In the Hydrogen Heavy scenario there is a lag compared to the Consumer Led scenario - despite ambitious deployment rates for hydrogen taken from the Future Energy Scenarios. With the cost of carbon included, the Consumer Led scenario and Hydrogen Heavy scenario start to near cost parity, despite the higher capital costs of the former.

Figure 2—3 further highlights the substantial carbon value of switching to low carbon solutions early in the Target Led and Area Aligned scenarios. The latter represents a £2.6 billion carbon saving compared to the 2050 Consumer Led scenario and £3.4 billion compared to the Hydrogen Heavy scenario.

The difference in fuel and carbon costs between the BaU and other scenarios is even greater when compared for the final year of the scenarios – this is provided in Figure 2—4.

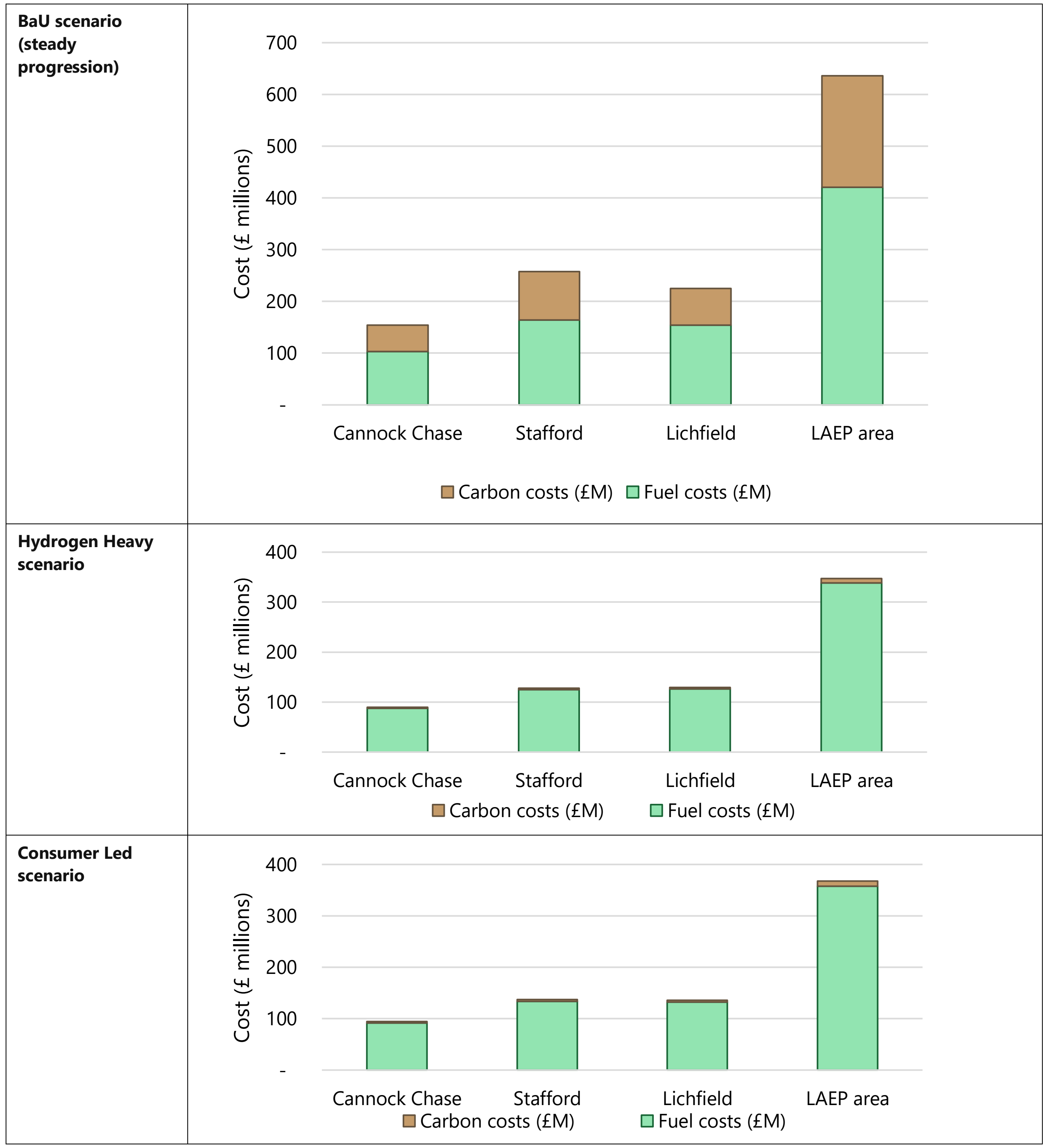


Figure 2—4 Summary of carbon (shown in brown) and energy (shown in green) annual costs for 2050.

In the year 2050 the carbon cost assigned, using central BEIS non-traded data (see Appendix A Figure 9—10), is very high for the BaU scenario equating to ~60% of the entire energy cost for either the Hydrogen Heavy scenario or the Consumer Led scenario in that year. For further context the £216 million carbon cost is also ~60% of the entire domestic energy efficiency retrofit capital costs in either the Hydrogen Heavy or Consumer Led scenarios. Fuel costs for that year are also higher for BaU because of system inefficiencies, such as low building energy efficiencies and higher reliance on inefficient internal combustion engines for transport.

[15] The fuel cost uses central BEIS forecasted retail fuel prices from 2020 to 2050 from which the data was updated from June 2021. Appendix A Figure 9—11 to Figure 9—13 displays the key fuel cost rates applied for domestic, non-domestic and transport. For transport, domestic electricity prices were used for electric vehicle charging.

Despite being quite different scenarios from a technical perspective, the final carbon and fuel costs in 2050 are very similar for both the Hydrogen Heavy and Consumer Led scenarios. The Hydrogen Heavy is slightly cheaper (£20 million per annum) but carries a higher set of risks to reach net zero, relying on national adoption of hydrogen. The fuel cost for the Hydrogen Heavy scenario is sensitive to the H_2 price which uses a 2030 price target of £2/kg[16]. Current H_2 prices are much higher than this[17], therefore significant investment is required from now until then to make this achievable (for example, reducing cost of electrolysers).

2.4.3 Carbon Summary

Figure 2—5 shows how this investment translates to carbon reduction performance by comparing the forecasted annual emissions in 2050 and comparing it to present day baseline emissions for each local authority. The carbon emissions have been calculated using forecasted BEIS emissions factors, these are detailed in Appendix A Figure 9—9.

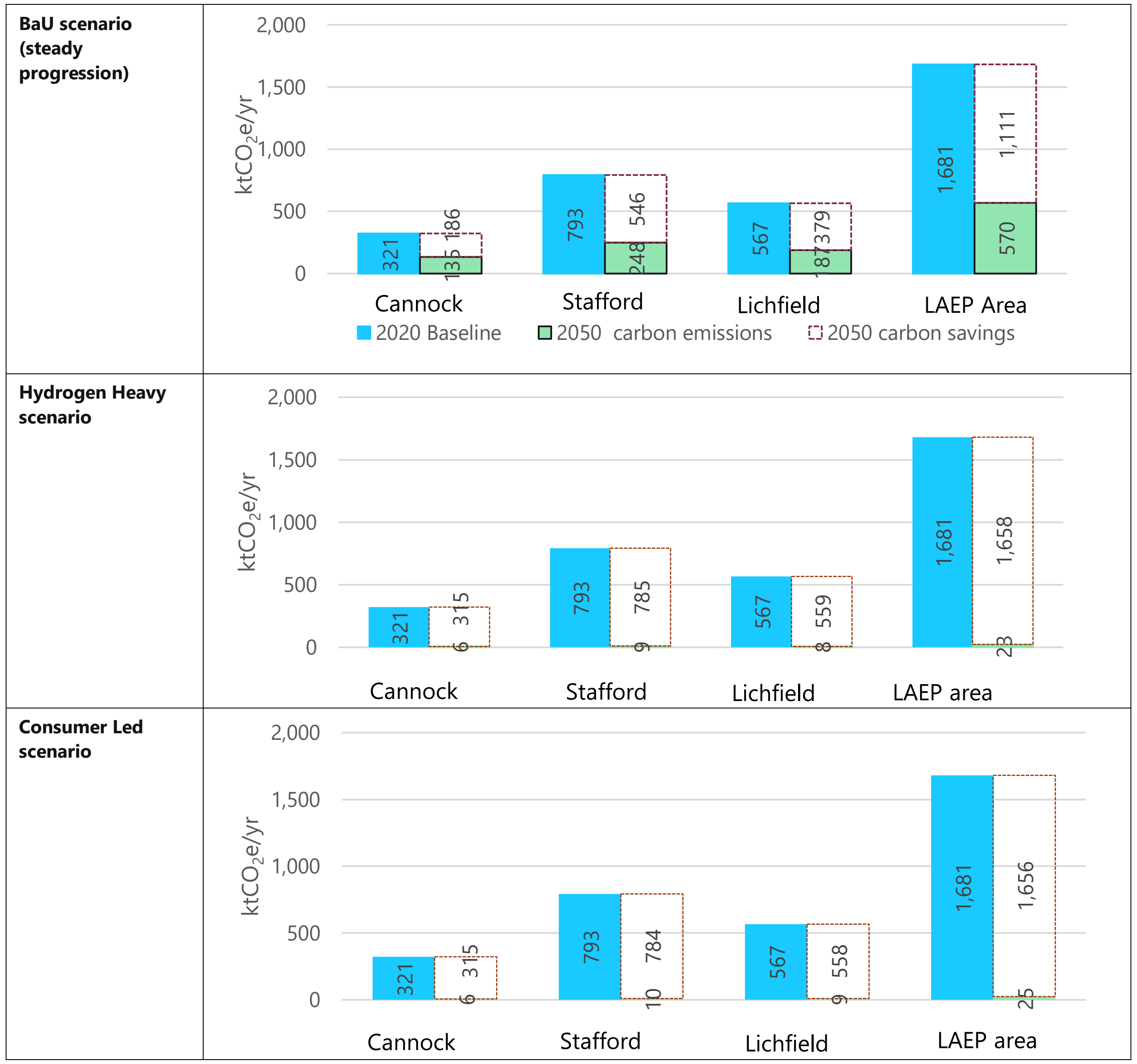


Figure 2—5 Carbon emissions for the three core scenarios modelled compared to the 2020 baseline year.

The BaU scenario demonstrates a small reduction of 13% across each local authority if nothing was done by 2050. This small reduction is attributed to the electricity grid decarbonising in future; however, a significant level of emissions remains from fossil fuel usage mainly used for heating, and transport.

Comparing this to the Hydrogen Heavy and Consumer Led scenarios, a significant carbon reduction is achieved of more than 98% across each local authority. The Hydrogen Heavy scenario sees an ever so slightly improved level of reduction versus consumer led. This is due to hydrogen being modelled as green with a scope 2 carbon factor of zero, which is lower compared to the forecasted low electricity grid factor in 2050 (0.007kgCO_2/kWh).

The greatest level of carbon reduction is seen for Stafford which has the highest baseline from an energy and carbon perspective. The level of carbon reduction for both of the core net zero scenarios has a positive impact on forecasted carbon costs as illustrated in Figure 2—5. Even in the Hydrogen Heavy and Consumer Led scenarios there are some carbon emissions retained (~23,000 tonnes of CO_2). Most remaining emissions come from grid electricity consumption for both low carbon scenarios. The natural capital of the area is therefore key to the LAEP, sequestering this remaining carbon to allow net zero to be reached. The alternative options would be offsetting residual grid emissions through purchasing renewable grid electricity through private purchase agreements.

Table 2—2 shows a comparison between the aggregated carbon emissions over 30 years from a 2020 baseline to 2050. The Hydrogen Heavy scenario has a higher level of aggregated emissions compared to the Consumer Led scenario due to green hydrogen expected not to be available until after 2030, thus, natural gas would take longer to decarbonise versus a consumer led approach.

Table 2—2 Aggregated carbon emissions in 2050 (ktCO_2e)

	BaU	Hydrogen Heavy	Consumer Led
Cannock	6,825	5,389	4,579
Stafford	15,457	12,393	11,451
Lichfield	11,274	9,102	8,255
LAEP area	**33,555**	**26,884**	**24,285**

[16] This is based on several sources including UK industry (http://www.ukhfca.co.uk/wp-content/uploads/Green-Hydrogen-final-21-02-21.pdf), academia (https://onlinelibrary.wiley.com/doi/full/10.1002/solr.202100487) and the European Union (https://ec.europa.eu/commission/presscorner/detail/en/SPEECH_22_3123)

[17] Approximately three times higher according to industry sources, e.g. https://home.kpmg/xx/en/home/insights/2020/11/the-hydrogen-trajectory.html

3 Domestic Building Level Analysis

Domestic demand makes up the largest proportion of energy demand in the LAEP area. Across the LAEP area there are ~156,000 houses with different heat systems, insulation, construction type and tenure. Consequently, there will not be one fits all solution and some properties are likely to adopt low carbon solutions earlier; for example, local authority owned and social housing is likely to see earlier adoption[18]. The modelling approach used takes into account that different occupiers are likely to make different choices, but these choices are still bound in various technical considerations. To reach net zero nearly all properties will need to transition, regardless of tenure, but by accounting for tenure hotspots for social or local authority owned housing can be identified to pursue first.

The domestic level zero carbon transition is the area where wider social factors should be noted, for example fuel poverty (see Figure 3—1) and Indices of Multiple Deprivation.

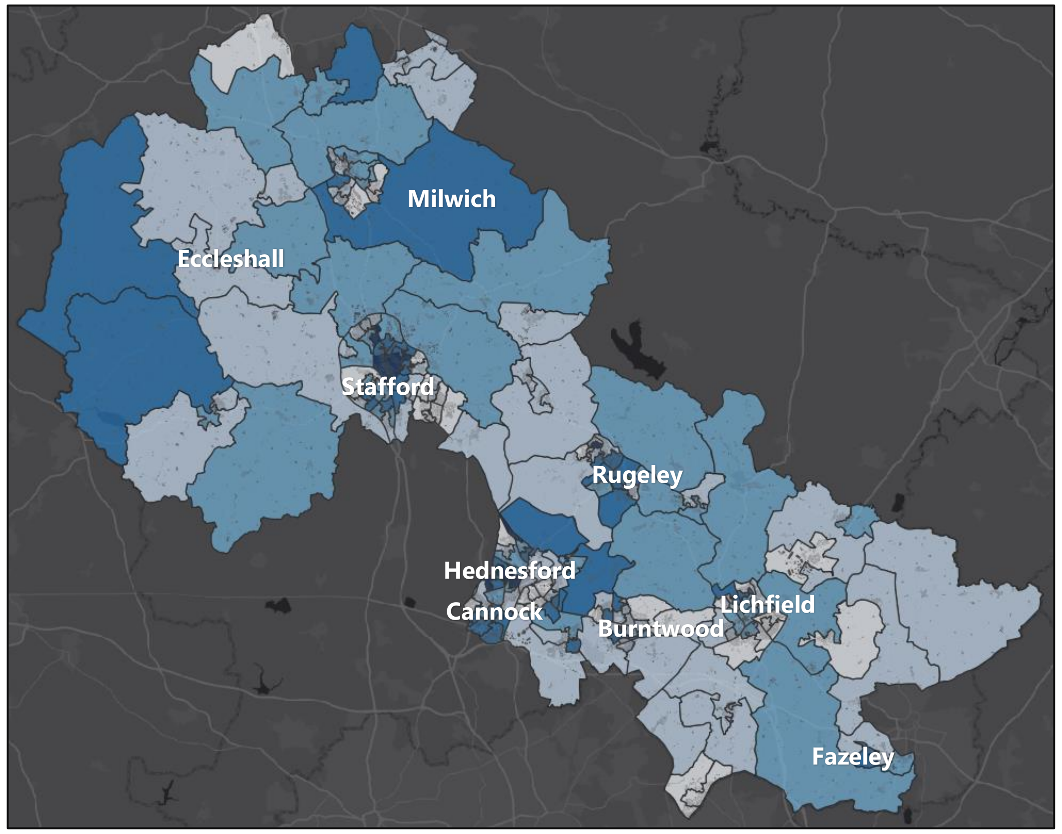


Figure 3—1 Fuel poverty by LSOA across the LAEP area. Darker blue areas indicate a higher level of fuel poverty. Basemap from ESRI.

Whilst these are not significant factors within the modelling, due to a lack of precise policy drive towards these properties, analysis is considered in the context of these to help highlight areas where net zero can be used to help address wider issues.

3.1 Strategic Level Summary

The modelling approach draws on both fabric and current heating system type to determine the low carbon transition for all buildings in the local area. For the scenarios which follow a Consumer Led approach heat pump-based solutions either through large heat networks or, more frequently, individual building level heat pumps are the dominant technology. The latter being adopted in nearly 90% of the properties. The vast majority of the remaining properties either use electric resistive heating or heat networks. The Consumer Led scenario incorporates a slight drop in thermostat set point, creating an energy saving. Another change in behaviour for some households in the Consumer Led scenario is the switch to heat pumps means heating is more constant rather than the bursts of heating – that is more suited to fossil fuel systems. To ensure the new heat pump technology is used in a suitable and efficient manner there is a large educational element to these scenarios. Such education programmes are best enabled by local actors, be that local authorities or community energy groups. However, this and other behaviour change is key to the Consumer Led scenario approach and although they are not technical factors they are equally important to a successful LAEP.

In the Hydrogen Heavy scenario nearly all the properties on natural gas (this is 86% of the properties) make the switch to hydrogen boilers. It is, however, anticipated in the modelling that a small percentage of these will be more economic to be part of district heat networks. For more detail about potential heat network zones and demands see section 5.

As well as the change in heating system for reaching net zero the energy efficiency savings from changes in building fabric are also considered. In the Consumer Led scenario approximately half the homes in the LAEP area have energy efficiency improvements to help the technology function most effectively.

In the Hydrogen Heavy scenario improved energy efficiency helps achieve carbon savings before the role out of a hydrogen network. In both the Consumer Led and Hydrogen Heavy scenarios ~6% improvement in overall fabric efficiency is needed across the LAEP area. Whilst 6% does not seem a very high number this normally results in over a 12% saving in the thermal energy demand.

It should be noted that all the modelling in this section use the Home Analytics dataset purchased from the Energy Savings Trust as the base dataset for the current building stock. This is a modelled dataset based on domestic EPCs and thus although useful to provide an indication of solution and readiness for low carbon technologies they are indicative only. The analysis does, however, present useful geographic hotspots to focus on for transitioning to a zero-carbon energy system.

3.2 Fabric Retrofit Overview

The general state of the building stock in the LAEP area was relatively efficient. This was particularly noticeable in terms of wall construction and insulation which is often one of the more challenging measures to change. As well as walls, windows, loft insulation and floor insulation were examined. The latter is not deployed to as great an extent, due to relatively high costs but also the disruptive nature of the installation process. An overview of the number of energy efficiency/fabric retrofit measures is provided in Figure 3—2.

[18] Increased political leverage and support schemes are key factors behind this earlier adoption in the modelling.

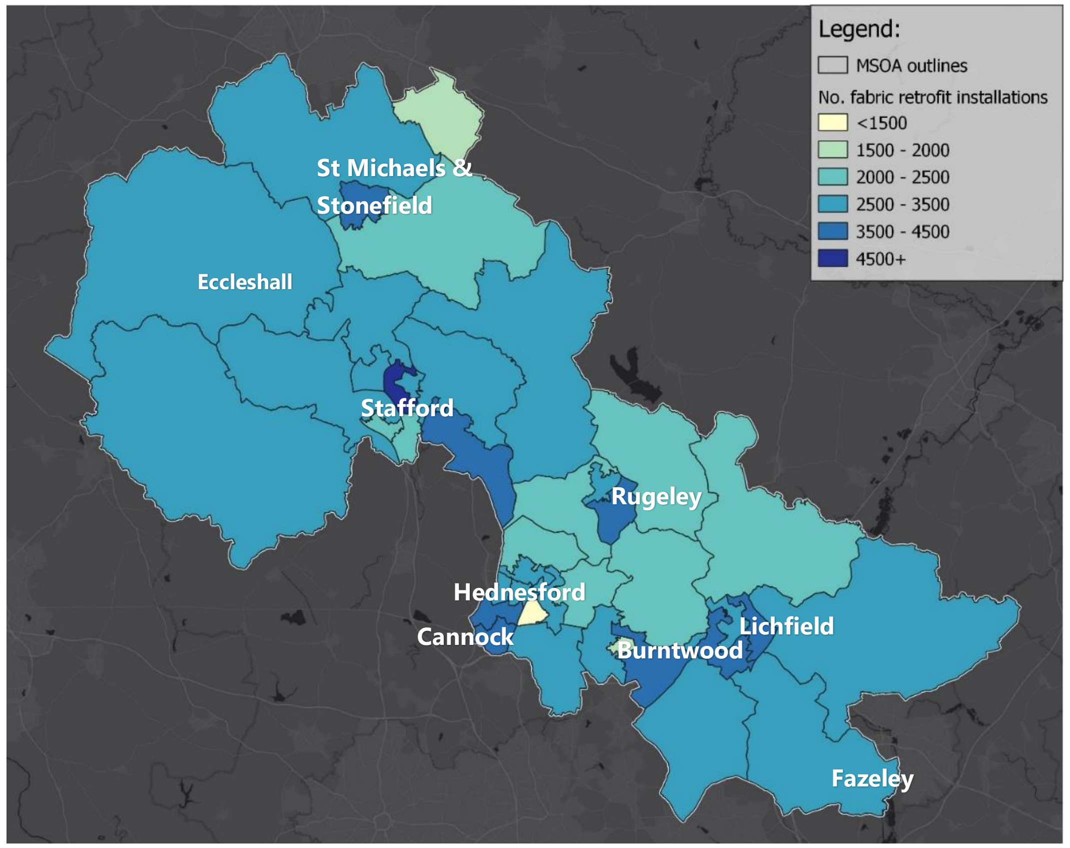


Figure 3—2 Strategic level areas with the number of domestic building fabric retrofit installations required to achieve the Consumer Transformation Scenario at an MSOA level. Image uses ESRI, Ordnance Survey (Crown Copyright) and OSM data.

The analysis highlights some areas in the main population centres (Stafford, Cannock and Lichfield) as having some high levels of required building fabric improvements. The total number of retrofit measures spread across the area is 121,000[19] in the Consumer Led scenario (this is slightly higher for the Hydrogen Heavy scenario). This is generally associated with older building stock and thus generally has a focus in settlements like these, which have historic areas. It is important to note that the area of Stafford that has the highest level of energy efficiency interventions in the LAEP is also an area with one of the highest levels of fuel poverty (see Figure 3—1). Treating the poor building energy efficiency in this area in the pursuit of a zero-carbon energy system will thus also have wider societal benefits.

Interestingly, one area of Cannock has a very low number of energy efficiency improvements required, this is due to the relative age of the building stock and related efficiency (25% being built post 1996 and 79% after 1983). It should be noted that data presented in Figure 3—2 often relates to more than one fabric improvement measure for some dwellings, so the total number of buildings which require energy efficiency interventions are lower than the interventions themselves.

Of the different fabric improvement measures explored, cavity wall insulation is one of the most frequently seen. A summary of the prevalence of uninsulated cavity walls across the LAEP area is provided in Figure 3—3. The total number of cavity wall retrofit measures identified for the area equates to 21,640 (14% of total)[20].

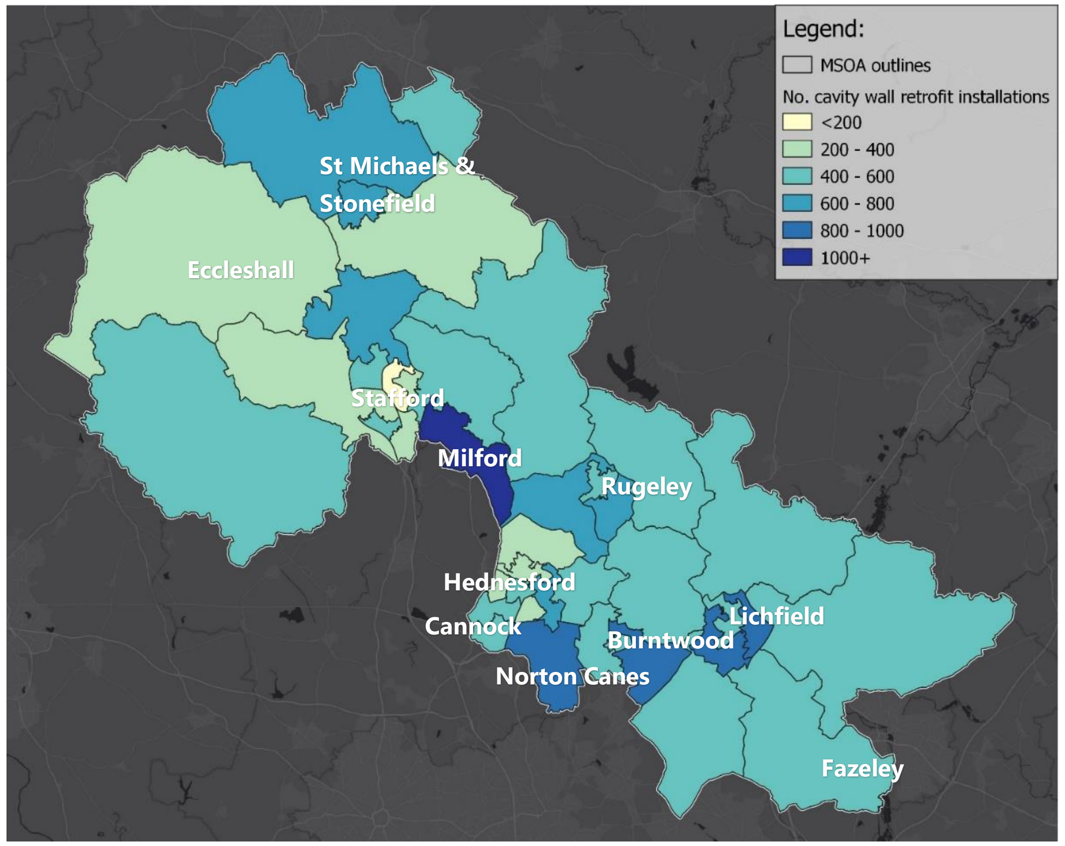


Figure 3—3 Strategic level areas with the number of domestic cavity wall retrofit installations required to achieve the Consumer Transformation Scenario at an MSOA level. Image uses ESRI, Ordnance Survey (Crown Copyright) and OSM data.

Identifying specific areas such as those seen in the south of Cannock, the Burntwood area and Lichfield city can help target specific retrofit programmes. Cavity insulation is a relatively low-cost energy efficiency measure and as such is a good area to focus on initially for high impact and low spend. The data summaries for energy efficiency measures at MSOA level will be provided alongside this report to allow other factors to be explored in the same level of detail.

3.3 Heating System Overview

Some properties in the LAEP area already have low carbon heating systems, this includes heat pumps, already being connected to heat networks/communal heating systems (these are seen to need very limited building level changes to transition to zero carbon solutions) and in some instances direct electric heating also falls into this category (in some cases, due to higher fuel costs, alternative solutions to direct electric heating are also considered). The total number of domestic properties that already have a low/zero carbon heating solution is estimated to be 1,990 (1.2% of total)[21] and the distribution of these properties is provided in Figure 3—4.

[19] Total number of retrofit measures split for each LA: Stafford = 48,840; Lichfield = 34,570; Cannock Chase = 37,860
[20] Total number of cavity wall insulation measures split for each LA: Stafford = 8,040; Lichfield = 7,380; Cannock Chase = 6,220
[21] Existing properties with low carbon heating systems split for each LA: Stafford = 990; Lichfield = 600; Cannock Chase = 400

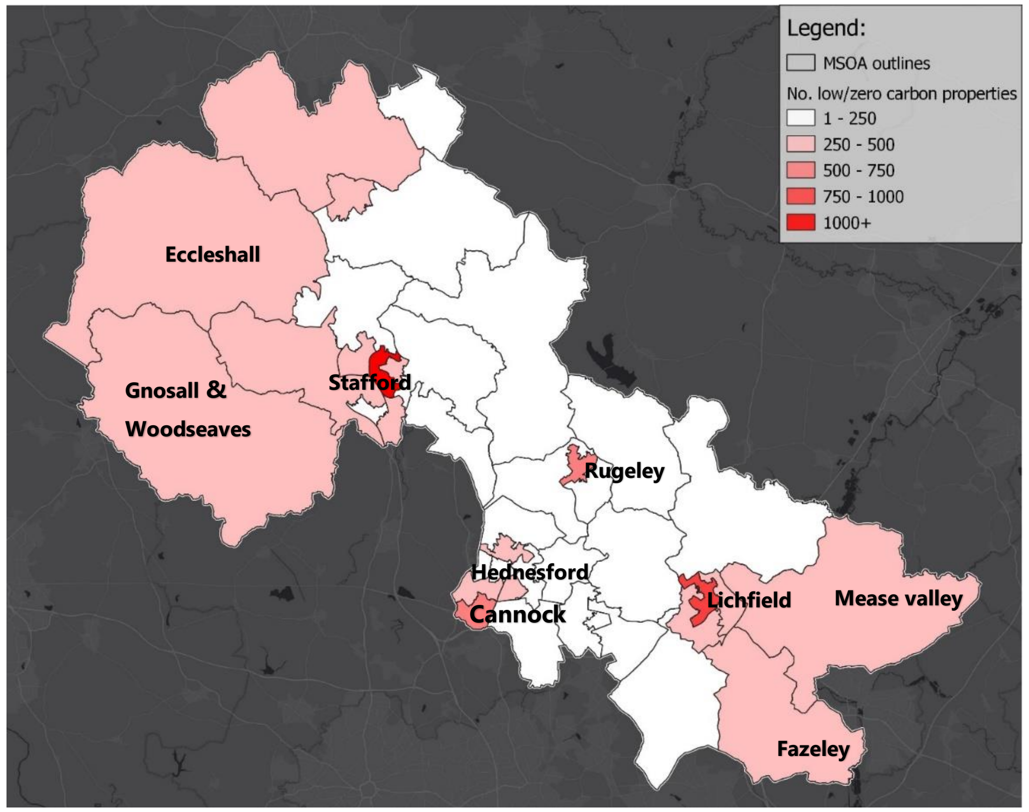


Figure 3—4 Strategic level areas with the number of domestic properties that already have a low/zero carbon heating solution. Image uses ESRI, Ordnance Survey (Crown Copyright) and OSM data.

Stafford, Rugeley, Cannock and Lichfield all dominate these existing low carbon system types. More common than properties already with a low carbon heat solution are those ready for one. These properties and those which are more challenging to install a low carbon heating solution are explored in the two following subsections, one focusing on off gas grid properties and the other on gas grid properties.

3.3.1 Off Gas Grid Properties

The majority of the LAEP area is on the gas grid, however, there are several rural areas which are dominated by off gas grid properties. These off-gas grid areas often represent some of the best early opportunities to make the switch from fossil fuels (generally oil or LPG) to heat pumps. This is due to the relatively high cost and carbon footprint of these fuels that making the switch to heat pumps more economically and environmentally attractive, when compared to natural gas properties. More importantly, all scenarios (including Hydrogen Heavy and the BaU) have adoption of heat pumps in these areas. Consequently, from a technology choice perspective it is considered a low regrets option. The total number of off gas properties already suited to heat pumps without fabric retrofit is estimated to be 4,350 (2.7% of total)[22]**.** A map showing the largest opportunity areas is provided in Figure 3—5.

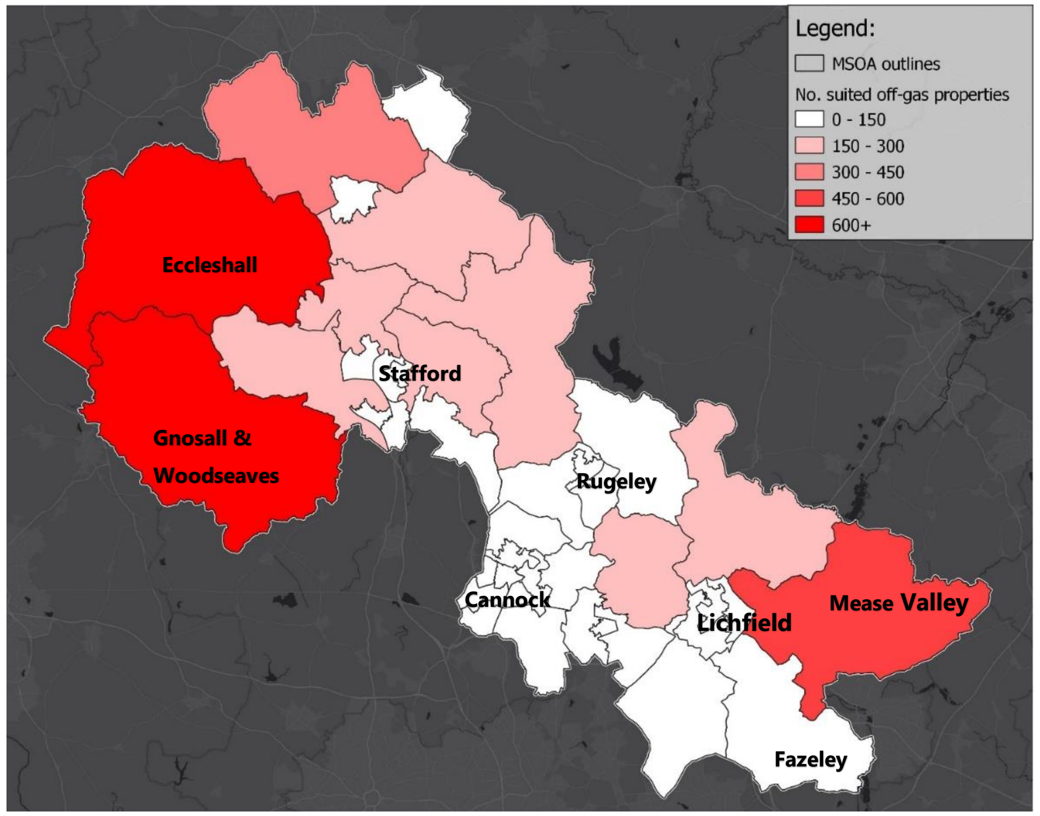


Figure 3—5 Strategic level areas with the number of off gas properties already suited to heat pumps without fabric retrofit. Image uses ESRI, Ordnance Survey (Crown Copyright) and OSM data.

Although the areas in the northwest of Stafford show a high number of buildings ready for heat pumps in terms of current heating system type and energy efficiency standard, these could be challenging to convert due to the current capacity available of the electricity network in the area (for more detail see section 8.1). As a result of this the area to the east of Lichfield containing Mease Valley is probably the best initial area to consider.

Certain tenure types are more likely to switch to low carbon heating solutions, properties which are either local authority owned or are social housing are generally some of the best opportunities for this early switch. A count of off gas grid properties with these tenure types is provided by MSOA in Figure 3—6, which overall reflects a total dwelling count of ~280[23].

[22] Total number of off gas properties heat pump ready that do not require fabric retrofit split for each LA: Stafford = 2,870; Lichfield = 1,270; Cannock Chase = 210

[23] Local authority/housing association off gas properties suited for heat pumps without needing fabric retrofit split for each local authority: Stafford = 145; Lichfield 75; Cannock Chase = 60

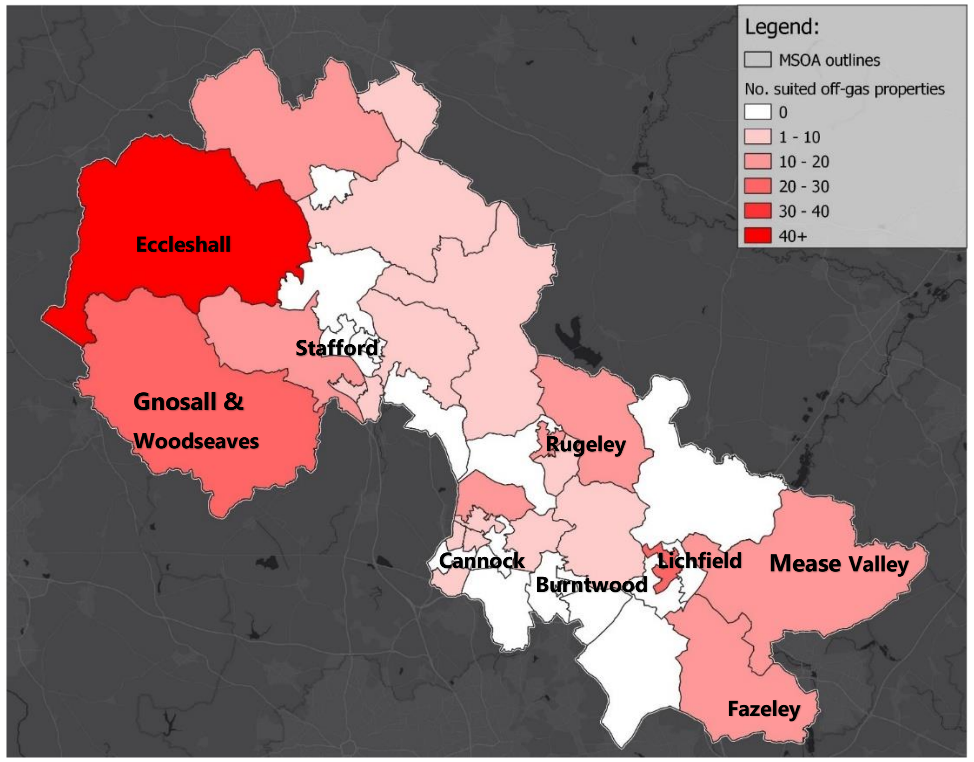


Figure 3—6 Strategic level areas with the number of off gas properties already suited to heat pumps without fabric retrofit and whose tenure is listed as owned by the Local Authority or a Housing Association. Image uses ESRI, Ordnance Survey (Crown Copyright) and OSM data.

There are not many opportunities for local authority or social housing tenure types for the immediate transition to heat pumps in off gas grid areas. Given the relatively high numbers, the focus area in the northwest of Stafford could be viable to consider as the most obvious priority area for these properties. Instead of relying on buildings under greater influence of the local authorities for off gas grid areas owner occupied properties are the most significant tenure to target. Historically such properties have been hard to switch but new central government schemes, notably the Heat Pump Ready Programme[24] could provide a useful means to better enable the switch of such properties.

As well as properties currently ready to switch to heat pumps there are properties which require some level of fabric retrofit to increase their thermal performance to a level suitable for heat pumps. The total number of off gas properties suitable for heat pumps with limited retrofit of building fabric is estimated to be 2,180 (1.4% of total)[25]. The distribution of these broadly follows that of the properties already suitable to heat pumps, see Figure 3—7.

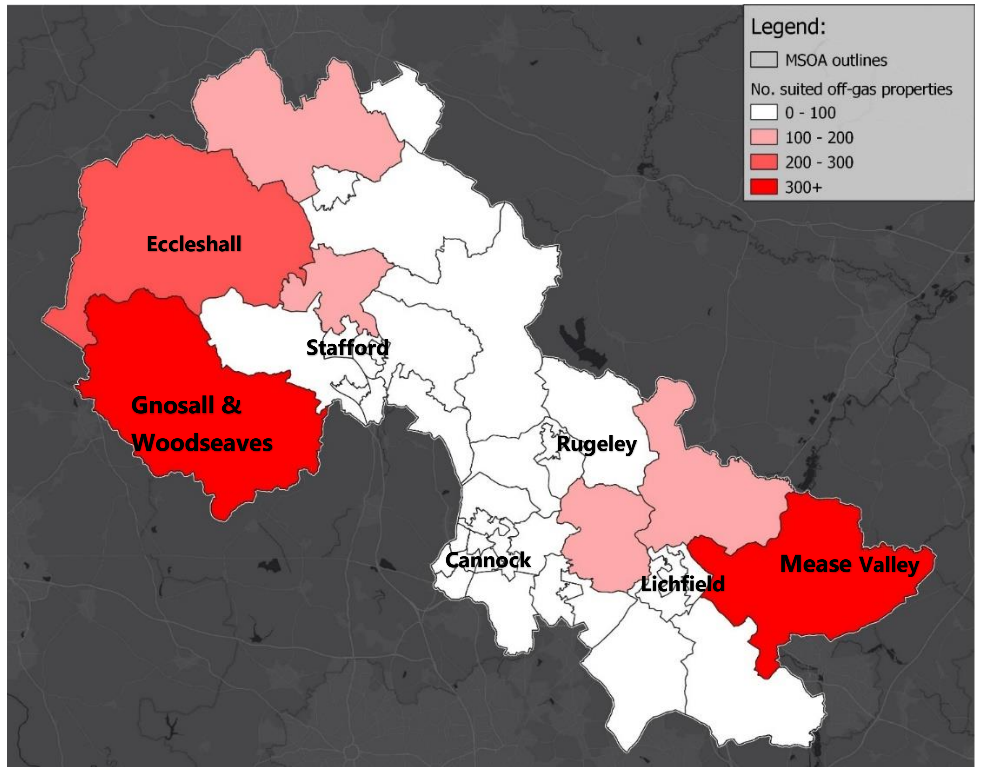


Figure 3—7 Strategic level areas with the number of off gas properties suitable for heat pumps with limited retrofit of building fabric. Image uses ESRI, Ordnance Survey (Crown Copyright) and OSM data.

The number of properties needing a low level of fabric improvement before switching to heat pumps is noticeably lower than those that need no addition fabric improvement. This is a sign of relatively good fabric efficiency in most of the housing stock. This level of fabric improvement is often a case of just one fabric improvement measure (e.g. cavity wall insulation) being required to improve the energy efficiency enough to make heat pumps function effectively and also being among the less invasive or costly measures[26]. These assumptions are also true for on gas properties.

Some properties would require a much more extensive retrofit to be considered for heat pumps, these are explored in Figure 3—8.

[24] https://www.gov.uk/government/publications/heat-pump-ready-programme
[25] Number of off gas properties suited for heat pumps with limited retrofit of building fabric split for each LA: Stafford = 1,250; Lichfield = 770; Cannock Chase = 160

[26] These more invasive and costly measures would include internal wall insulation on non-cavity properties or floor insulation, which although effective has a relatively large impact on residents during installation.

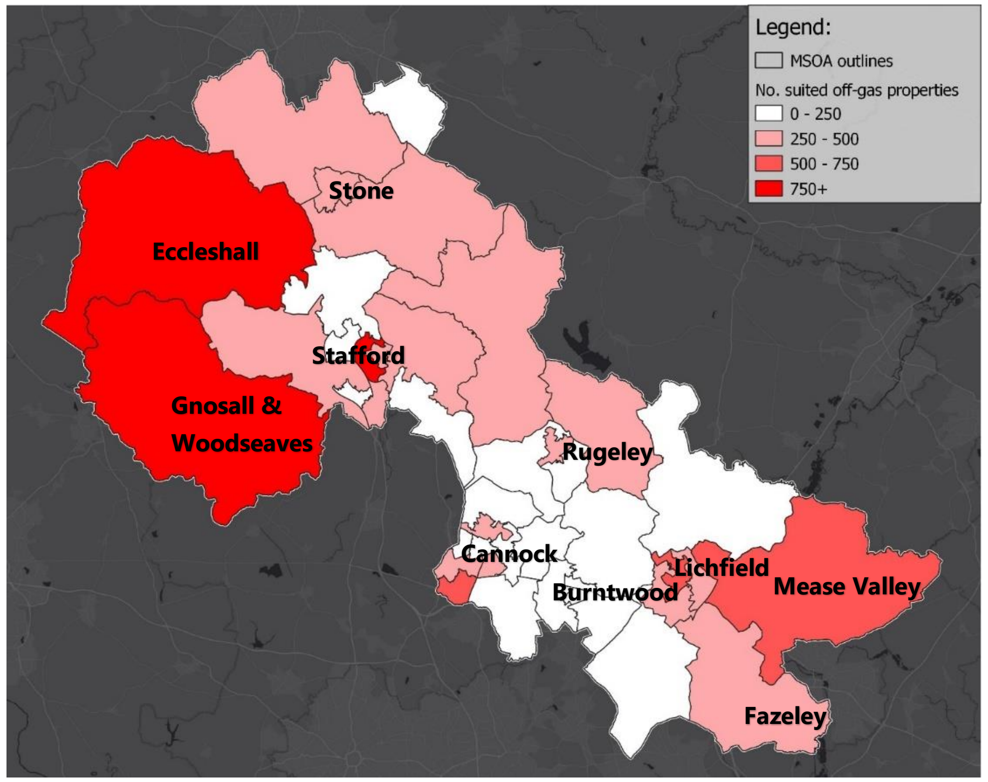


Figure 3—8 Strategic level areas with the number of off gas properties suitable for heat pumps with significant retrofit of building fabric. Image uses ESRI, Ordnance Survey (Crown Copyright) and OSM data.

Figure 3—8 represents a total number of 13,130 (8.4% of total)[27] off gas properties categorised suitable for heat pumps but requiring extensive retrofit measures[28]. The buildings which require a high level of retrofit for consideration for heat pumps also include properties which already have direct electric systems. It is because of this the numbers are generally higher. These electric based systems can include areas which are already on the gas network, which is why an area in central Stafford is highlighted. Not all of these direct electric systems are modelled as switching to heat pumps, particularly in properties in urban areas which tend to be smaller – making direct electric solutions more viable. However, in rural areas the switch is more likely to be considered. The improved efficiencies of heat pumps over direct electric means switching increases electricity grid capacity, making these the most promising areas to explore for this higher efficiency solution. It should be noted that such a change is not so much based around reaching net zero (as having electricity as the main heat source already enables this) but a wider transition to a more efficient energy system.

3.3.2 On Gas Grid Properties

Despite the recent increases in current market prices, on gas properties still represent a harder transition from an operational cost perspective to a zero-carbon heating system than off gas grid properties, however, the switch is still vital for zero carbon targets to be hit. This means either waiting for a national scale transition of gas grid to hydrogen (even the most ambitious timeframes for this makes 2030 targets impossible and 2040 highly unlikely) or in the majority of cases heat pumps. Even in the Hydrogen Heavy scenario there are substantial numbers of heat pumps present, although they are predominantly assumed to hybrid – meaning hydrogen heating is also used. Given the uncertainties associated with hydrogen, heat pumps are the focus for domestic heat decarbonisation in this LAEP.

As with off gas grid properties, analysis has been undertaken to identify areas where properties are ready to switch to heat pumps immediately with no obvious need for fabric improvements. These are highlighted in Figure 3—9, which represents a total number of 78,320 (50.2% of total)[29] on gas properties suited to heat pumps that do not require fabric improvements.

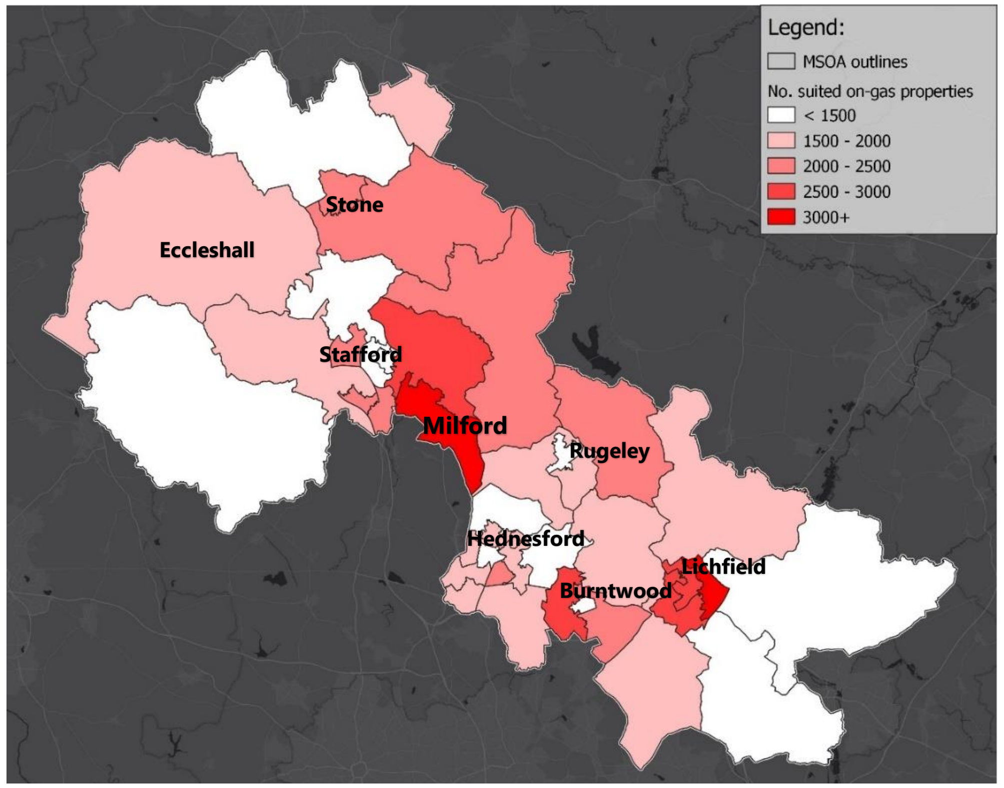


Figure 3—9 Strategic level areas with the number of on gas properties already suited to heat pumps without fabric retrofit. Image uses ESRI, Ordnance Survey (Crown Copyright) and OSM data.

The west side of Burntwood the whole of Lichfield city, the eastern edge of Stafford and the MSOA containing Walton-On-The-Hill (in Milford) are all flagged as areas with a high number of properties already suitable for heat pumps. A high-level assessment of the electricity network indicates that there is likely to be capacity in the area to deploy at least some of these heat pumps without substantial network upgrades.

As with the off-gas grid properties a summary of how these heat pump ready properties are distributed among social and local authority housing tenures is also explored (see Figure 3—10).

[27] Number of off gas properties suitable for heat pumps with significant retrofit of building fabric spit for each LA: Stafford = 6,250; Lichfield = 3,600; Cannock Chase = 3,280

[28] This includes multiple measures per property and also the more disruptive insulation measures.

[29] Total number of on gas properties heat pump ready that do not require fabric retrofit split for each LA: Stafford = 31,850; Lichfield = 24,810; Cannock Chase = 21, 670,

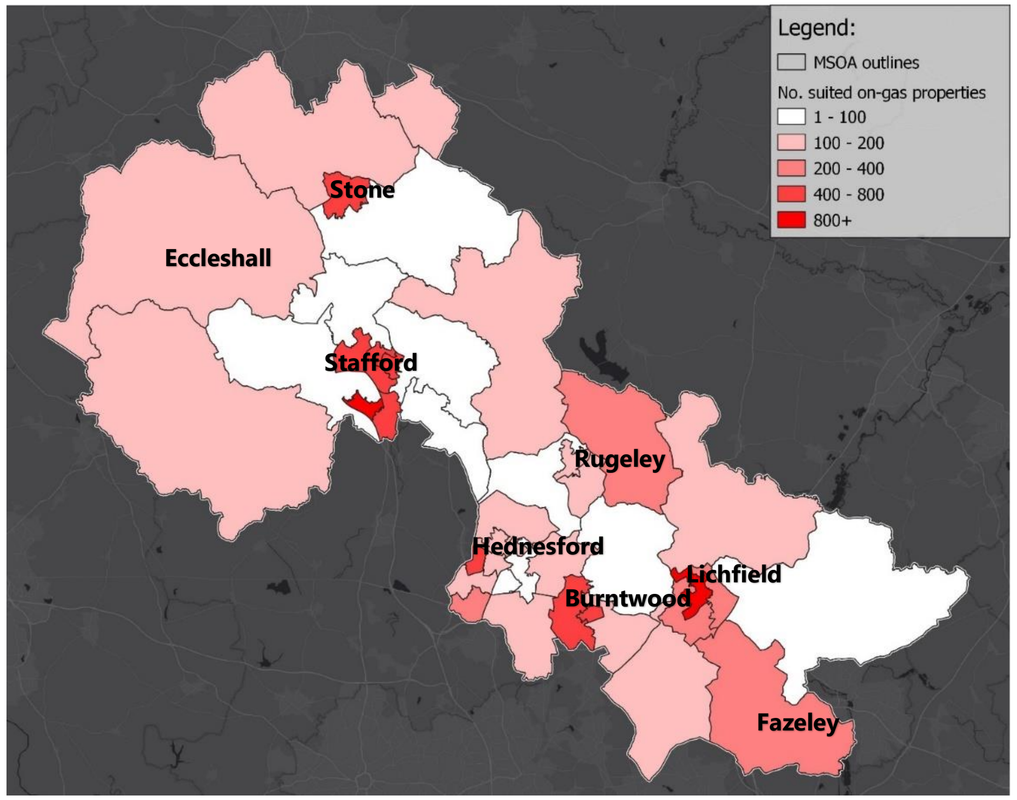


Figure 3—10 Strategic level areas with the number of on gas properties already suited to heat pumps without fabric retrofit and whose tenure is listed as owned by the Local Authority or a Housing Association. Image uses ESRI, Ordnance Survey (Crown Copyright) and OSM data.

Considering tenure types which have historically been easier to influence with low carbon policies creates a noticeably different map to when only technical factors are considered. Figure 3—10 captures 11,330 properties (7.3% of total) on gas local authority/housing association properties identified as being suitable for heat pumps without fabric improvement. The centre of Lichfield remains a priority area and Burntwood also remains an area with large opportunities, the biggest change is in Stafford where much of the town now presents a high level of opportunity as does Stone. This highlights there is substantial opportunity from a technical and stakeholder perspective to switch to zero carbon technologies in the near term.

The more medium-term opportunities for heat pumps, represented by those properties which need some limited fabric improvements, are mapped in Figure 3—11, these properties have a count of 34,010 (21.8% of total)[30].

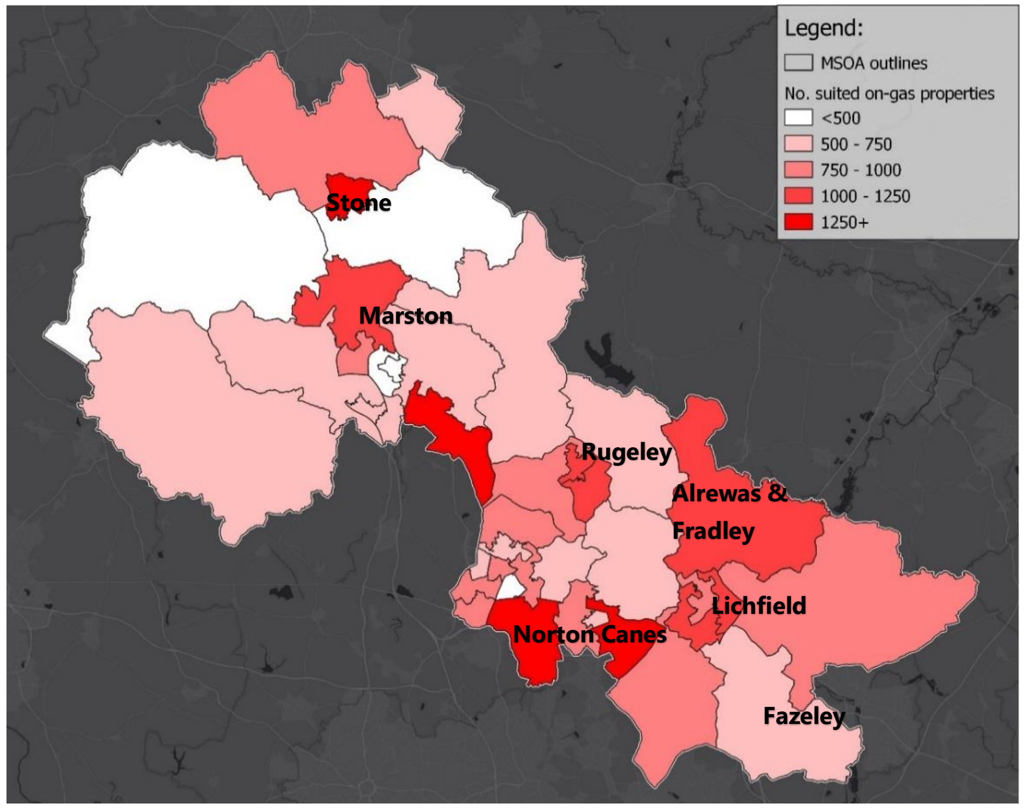


Figure 3—11 Strategic level areas with the number of on gas properties suitable for heat pumps with limited retrofit of building fabric. Image uses ESRI, Ordnance Survey (Crown Copyright) and OSM data.

Several areas highlighted in this map (i.e. the white areas) did not appear as good opportunities for immediate transition to heat pumps, these include the MSOA to the north of Stafford (which includes villages such as Marston), the area around Burntwood and Norton Canes, Stone, Alrewas and Fradley, as well as Rugeley. In these areas a joint approach to energy efficiency and heat pumps is considered key to fulfilling the ambitions of the LAEP.

The final, most challenging properties to retrofit to heat pumps are mapped in Figure 3—12, which represents a total number of 21,600 (13.8% of total)[31] on gas properties deemed suitable for heat pumps but require extensive retrofit measures.

[30] number of on gas properties suitable for heat pumps with limited retrofit of building fabric split for each LA: Stafford =11,770; Lichfield = 11,160; Cannock Chase = 11,080

[31] Number of on gas properties suitable for heat pumps with significant retrofit of building fabric split for each LA: Stafford = 8,800; Lichfield = 4,610; Cannock Chase = 8,190

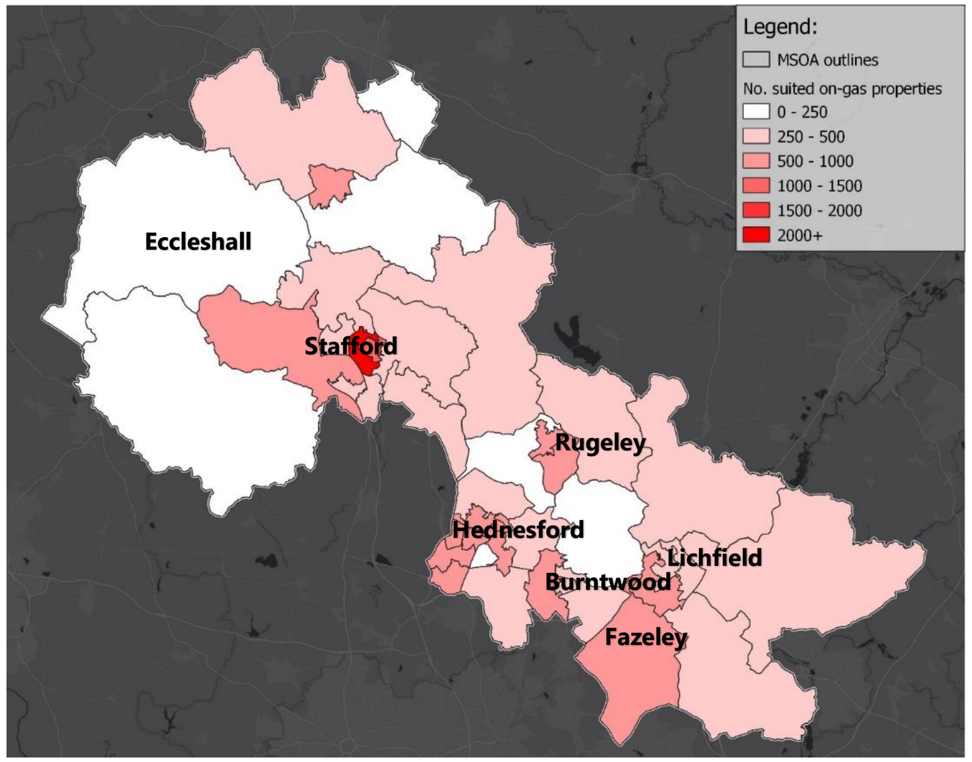


Figure 3—12 Strategic level areas with the number of on gas properties suitable for heat pumps with significant retrofit of building fabric. Image uses ESRI, Ordnance Survey (Crown Copyright) and OSM data.

An MSOA in the centre of Stafford is highlighted as the most significant concentration of these hardest properties to switch to heat pumps. This is to be expected given the low energy efficiency highlighted in this area in Figure 3—2. This priority for fabric improvement means there could be an opportunity to switch to heat pumps at the same time. However, as previously highlighted this is an area which has a high level of fuel poverty and whilst improved energy efficiency may help to address this it also suffers from some of the highest levels of deprivation in the LAEP. It is therefore important that any scheme which does target heat pumps in this area is carefully considered given the potentially vulnerability of the households. As an alternative to heat pumps the heat network modelling (see section 5) did highlight some of the properties in this area as being suited to heat network connection.

It is important to note that from the analytical modelling behind the scenario outputs the easiest to switch properties are generally modelled to switch first. However, at the end point in the scenarios based on the Consumer Led technologies, nearly all the properties switched to heat pumps, so if there are wider non-technical reason for tackling a more challenging area first it will still align to the overall goal and end point of the LAEP.

3.4 Domestic building first steps

The scale of the challenge for domestic properties is perhaps the largest for the LAEP, with over 155,000 domestic properties it represents an extensive stakeholder challenge and the largest number of individual interventions of all sectors. Nearly all of these properties (~153,000) require a change in heating system to be zero carbon and ~72,000 have some form of fabric improvement in the consumer led scenario, costing ~£1.6 billion and ~£355 million respectively. There are, however, some easier areas to target than others which would make useful first steps, some of these are highlighted in Table 3—1.

Table 3—1 Summary of early actions for the domestic sector.

Tenure	Action
Social/public	Targeting of **housing association and local authority owned buildings**. Across the three local authorities there are estimated to be over **4,000 such properties requiring fabric improvements** and **nearly 17,000 with oil or gas boilers** to transition heat pumps at end of current heating system life. The **fabric improvement would cost ~£20 million** and the equipment cost for switching all oil and gas boilers to **heat pumps ~£194 million**.
Private	Fabric first is suggested with private tenure, with **uninsulated cavity walls** being the easiest win; **20,000 owner occupied and private rented** fall within this group. This low-cost intervention would equate to **~£13 million**. More challenging insulation will be required (such as solid wall) and window but the low cost and relatively high impact cavity is seen as an easy win. **71,000 properties have fabric suitable for heat pumps** without any improvements (4,000 in off gas areas and 67,000 on gas). Off gas areas are a priority, due to relatively better economics associated with switching to heat pumps and better carbon savings. The equipment cost from switching these **fabric ready off gas properties to heat pumps would be ~£46 million**. On gas properties will also need to be addressed at an early stage of the LAEP, due to their high number. It is suggested each of the three local authorities should pursue funding to take such projects forward - the Heat Pump Ready Programme (see Appendix B for more details) is currently helping progress such projects.

4 Non-domestic Building Level Analysis

Non-domestic buildings cover the commercial and industrial sector, energy demand data is of poorer quality than for the domestic sector in these buildings - which reduces the accuracy and precession of modelling. However, demand data is provided at a local authority level which can be used to cross check demands meaning they are correct for the overall LAEP area but for precise local projects local insights will be key.

4.1 Current System Summary

The non-domestic demand in the LAEP is typified by industrial estate/business park/distribution centre demands (some of which represent very large buildings) and the demands typically seen in urban areas such as retail, offices, educational and medical sites. The two non-domestic demands flagged in the National Atmospheric Emissions Inventory database as being nationally significant sources of carbon are the Stone Data Centre (which is the largest single electricity demand in the area as well) and the Beacon Barracks MOD site in Stafford. The general absence of heavy industry means decarbonisation of the non-domestic demand is not overly reliant on hydrogen, due to the lack of process heat requirements.

The distribution of non-domestic demand assumed for heat is provided in Figure 4—1.

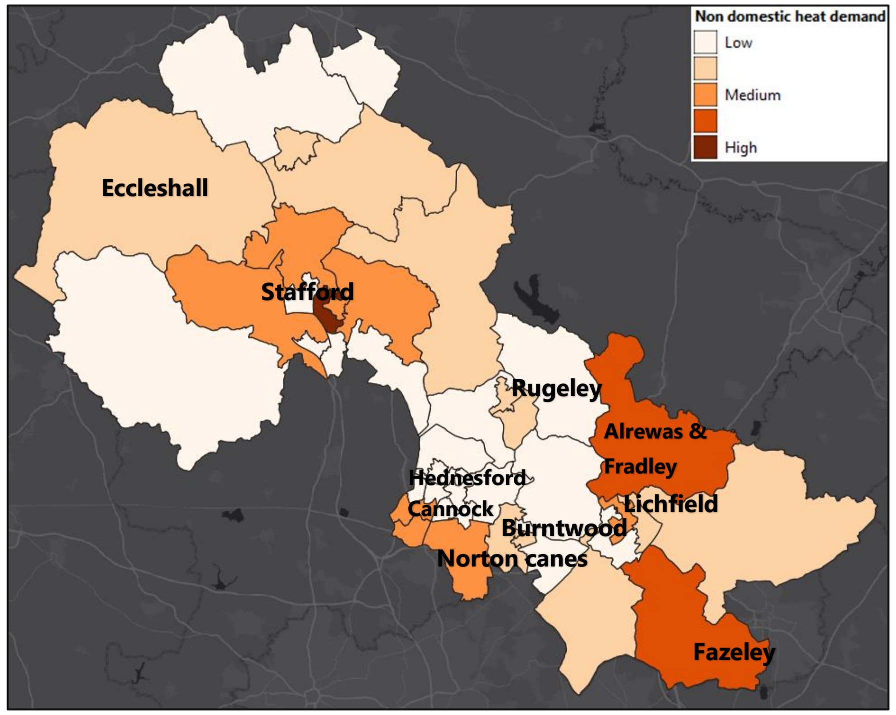


Figure 4—1 Non-domestic heat demand across the LAEP area. Basemap from ESRI.

The distribution of demand for heat is modelled as remaining the same in the LAEP analysis. Any new non-domestic demands are assumed to be built to higher energy efficiency standards and be developed in existing hotspots for the non-domestic sector. It should be noted the substantial agricultural sector in the area is relatively poorly captured in terms of energy and could result in some errors in terms of precise geographic allocation of demands for this sector, however, at the LAEP area level values have been validated against national data and they align across the area as a whole.

The distribution of electricity demand in the non-domestic is considered in the same manner, with the distribution of demand being presented in Figure 4—2.

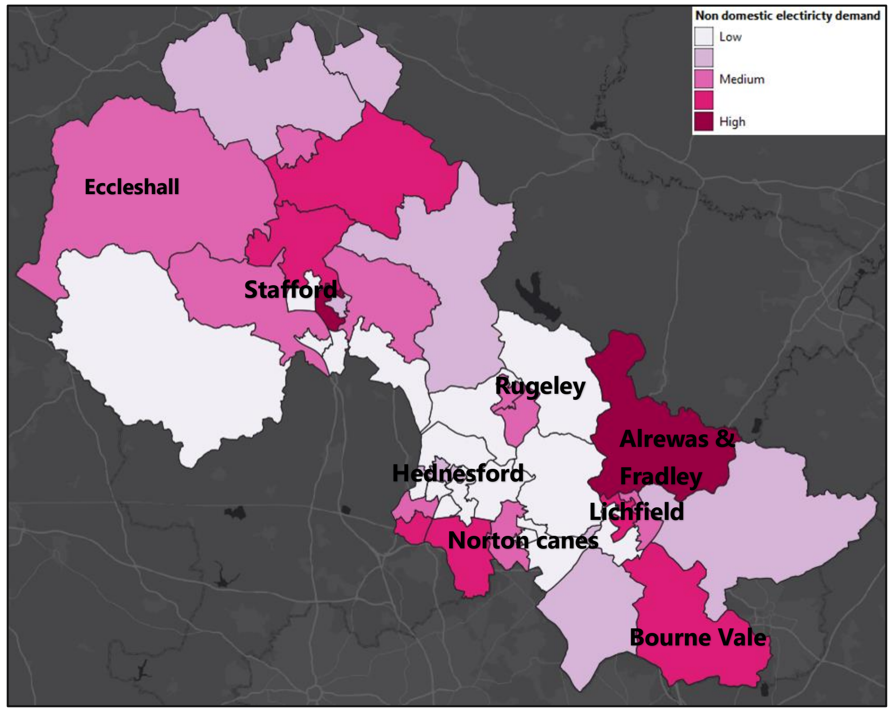


Figure 4—2 Non-domestic electricity demand (excluding electricity used for space and hot water heating). Basemap from ESRI.

Although, the overall distribution of heat and electricity is broadly the same in the non-domestic sector there are some slight differences. This is due to the difference in demand typology, for example, areas with a higher level of cooling demand can be emphasised in the electricity analysis compared to the heat demands – this is the case in the MSOA which contains the Stone Data Centre. With the electrification of heat demand these differences will become slighter across the LAEP area.

4.1.1 Demand by sector

Demand type, building construction and tenure can vary substantially across different non-domestic use types, a summary of the energy demands from some broad non-domestic typologies is provided in Figure 4—3[32].

[32] The non-domestic data classifications have a high level of uncertainty due to underlying data and the mix of sources.

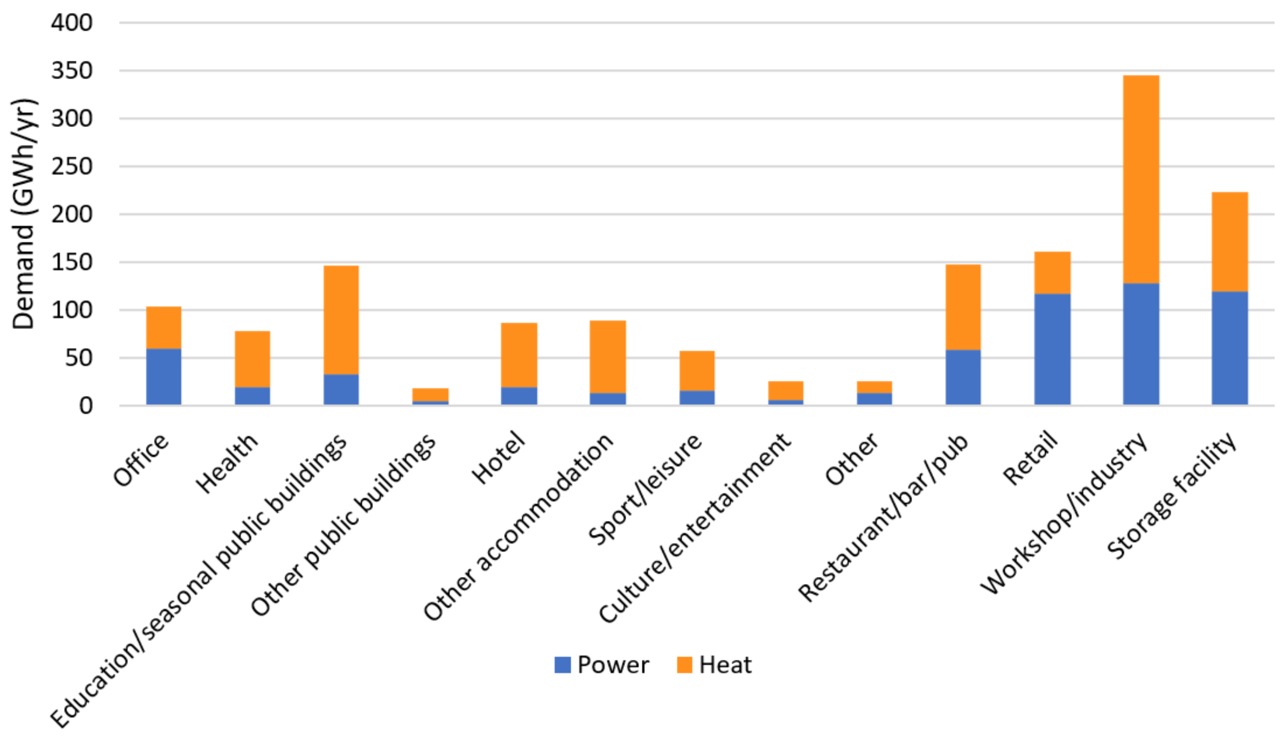


Figure 4—3 Indicative demand for different key commercial sectors.

Workshop[33]/industry and storage facility typologies make up a high proportion of total energy in demand (characterised by the extensive industrial estates and distribution centres in the LAEP area). These buildings can vary in suitability for some low carbon technologies – such as heat networks (this is considered in the heat network analysis in section 5). There is a large share of workshop/industry energy demand, but this is generally light rather than heavy industry. This is important as heavy industry tends to be the biggest driver for the requirement for hydrogen technology as electrical solutions are not generally as suitable. This means the LAEP area is not seen as a priority area for hydrogen in the modelling, however, stakeholder insights highlighted that the surrounding areas could be significant drivers of industrial hydrogen[34] and this could in turn build a supply chain to help address any more challenging buildings in the LAEP area.

Health, education/seasonal public buildings and other public buildings are three of the typologies that are likely to decarbonise first. Rather than necessarily being due to ease of decarbonisation this is due to a higher level of public sector ownership among these typologies, which based on the local authority strategies discussed in section 1.4 will drive early decarbonisation.

4.2 Transition Overview

The same level of data detail is not available for much of the non-domestic building stock, as was seen in the domestic sector. The LAEP outputs for this analysis are based on the national FES scenarios adapted to the local authorities. This is suitable for the LAEP area due to the lack of heavy industry and manufacturing, the energy demands associated with these are generally harder to decarbonise. This relative simplicity helps to keep the cost of the non-domestic transition relatively low.

4.2.1 Fabric Retrofit

As with the domestic properties the energy efficiency focus is on improving the heating performance of non-domestic sector, as it is the heating vector that is the hardest to transition to a zero-carbon system, due to the decarbonisation of the electricity grid naturally driving down the emission associated with electricity consumption. A summary of the level of energy efficiency improvements is provided in Table 4—1.

Table 4—1 Energy efficiency improvements modelled in the non-domestic sector for the three core scenarios.

Scenario	Energy efficiency improvement (%)	Cost (£ million)
Hydrogen Heavy	11.5	183
Consumer Led	10.6	170
BaU	2.1	34

It is noticeable that the level of energy efficiency uplift is higher than the domestic sector, which is a reflection of the generally lower energy efficiency ratings in these non-domestic buildings compared to the domestic sector. The public sector stock is assumed to implement these savings first. Other than public buildings there is an opportunity for a LAEP wide approach to large warehouse/distribution buildings. This is a common building typology in the area and developing a strategic approach and supply chain to improving the performance of these buildings is seen as a key opportunity due to the scalability of the solutions.

4.2.2 Heating Systems

The heating systems in the LAEP area are assumed to have a relatively high share of natural gas ~70% by number, ~23% of the rest are some form of electric heating and the remaining 7% predominantly oil. A summary of the different technologies adopted for the three core scenarios is provided in Table 4—2.

Table 4—2 Percentage breakdown of the number of properties for different heating solutions across the three core scenarios and modelled costs.

Technology	Consumer Led (%)	Hydrogen Heavy (%)	BaU (%)
Heat pump	55	35	15
Direct electric	14	8	24
Hydrogen boiler	2	19	0
Heat networks	12	10	3
Hybrid heat pumps	17	28	4
Natural gas	0	0	54
Total cost (£ millions)	**292**	**224**	**144**

The hybrid heat pumps include a mix of several different combinations of technology, the two key options being hydrogen and direct electric, the former can help reduce stress on the network and both can help achieve higher temperatures than are typical with standard heat pump units.

The Hydrogen Heavy scenario has a relatively high number of heat pump and hybrid heat pump installations. This allows reduction in carbon emissions prior to hydrogen adoption. Fewer stakeholders than the domestic sector and greater control/policy levers[35], means substantial adoption of low carbon technologies takes place in the modelling of these scenarios prior to the availability of hydrogen. This is enabled in the LAEP area by the relatively low share of heavy industry.

[33] Workshop is an industry standard classification covering large numbers of non-domestic buildings, it is a broad category – referring to properties where the space is generally used for light mechanical work. This can be somewhat similar to light industry and storage in terms of energy usage and spaces.

[34] A project in Stoke-on-Trent, for example, received £300k of government funding to explore hydrogen in the ceramics sector https://www.gov.uk/government/publications/industrial-fuel-switching-programme-successful-projects/industrial-fuel-switching-programme-phase-1-summaries-of-successful-projects

[35] One example being the higher proportion of public sector buildings or buildings with a public sector influence.

As with the energy efficiency measures the public building stock is identified as the initial focus for adopting new low carbon heating solutions. Given the type of stock heat pumps are a favoured solution in many instances across all three scenarios as are heat networks, where public buildings can provide a vital catalyst for deployment – this is explored further in section 5.

4.3 Non-domestic buildings – first steps

The non-domestic sector has a wider variety of building and use types than the domestic sector, coupled with poorer data quality this makes precise zero carbon solutions challenging to address. However, the area does not have a high proportion of heavy industry. As a result, the National Grid FES and the modelling undertaken for the LAEP finds that even in the Hydrogen Heavy scenario decarbonisation is not contingent upon hydrogen in the majority of buildings. The general shift in the non-domestic sector shift towards heat pumps is relatively similar for the Hydrogen Heavy (63% have some form of heat pump) and Consumer Led scenarios (72%), highlighting a low regrets decarbonisation pathway in many cases.

Public sector buildings should be the first targets, in line with the UK Government Heat and Buildings Strategy[36] which targets a 75% reduction from this tenure based on a 2017 baseline. Figure 4—4 provides an indication of how these buildings are distributed across the LAEP area, to help understand where the greatest initial focus will be.

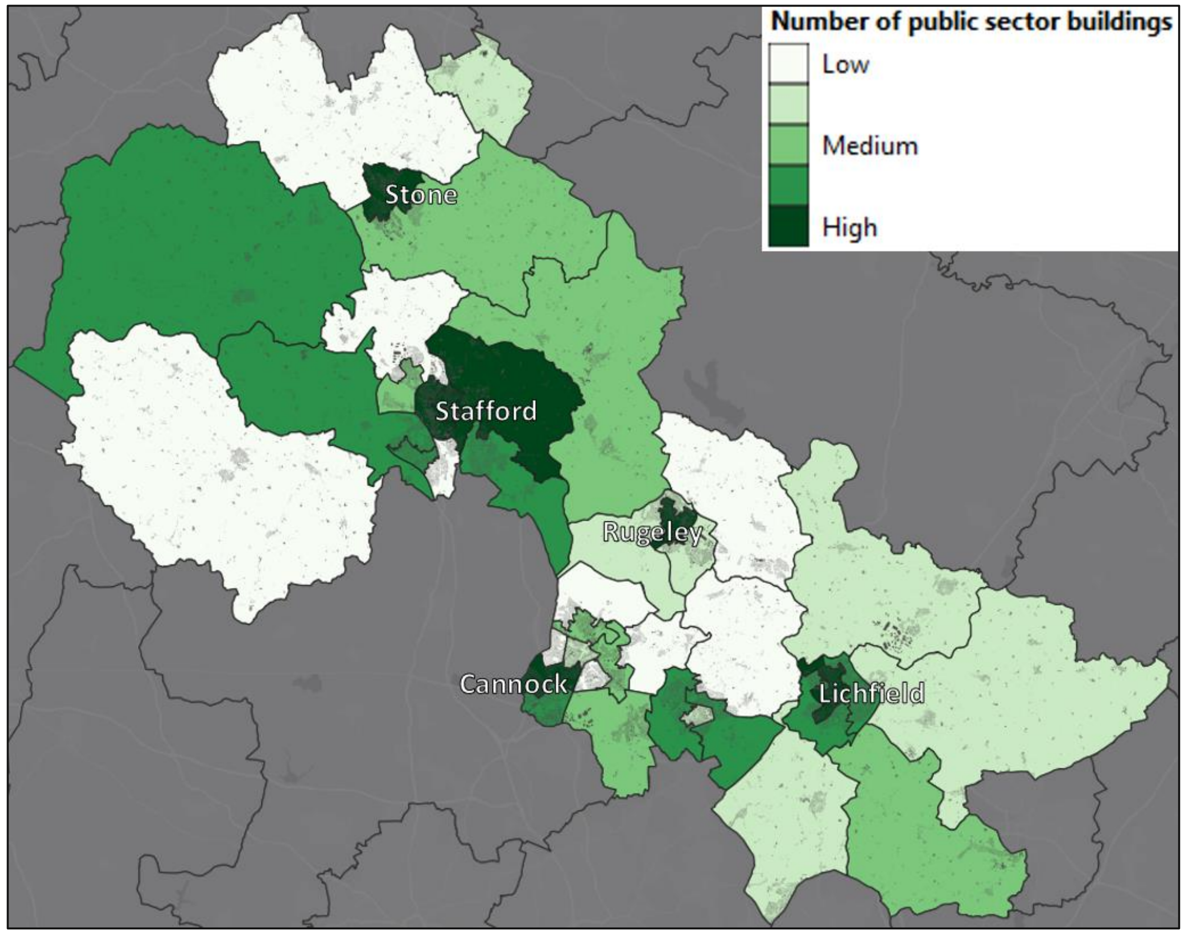


Figure 4—4 Indication of number of public sector buildings by MSOA – based on Display Energy Certificate data.

As would be expected the greatest density of public sector buildings is centralised in large population centres. One enabling technology for decarbonisation, particularly in these geographies, is heat networks. These are explored in section 5 below.

36 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1044598/6.7408_BEIS_Clean_Heat_Heat___Buildings_Strategy_Stage_2_v5_WEB.pdf

5 District Heat Networks

This section explores the potential of heat networks across the LAEP area. This identifies specific heat network zones for consideration based on the current drivers of heat network viability. The zones identified could be useful to pursue in more detailed specialist studies; central government support can help fund such work.

5.1 Heat Network Zone Identification

The basis of the analytical approach to potential heat network zone identification is in the buffering on the heat demand of properties, using a metric known as linear heat density (LHD)[37]. Using LHD in strategic analysis gives a proxy for the connectable distance from a building, this is undertaken by dividing the annual heat demand of the property by specific LHD benchmark figures. The "buffering" approach sweeps this connectable distance (radius) around a potential heat load point to create a circular buffer, and where buffers overlap, these form potential zones where other criteria are also met. It should be noted that the buffer radius is capped to 250 meters to avoid very large heat demands indicating connection viability over unrealistic distances. An illustration of LHD 'buffering' and connection distances for three example heat loads is presented in Figure 5—1.

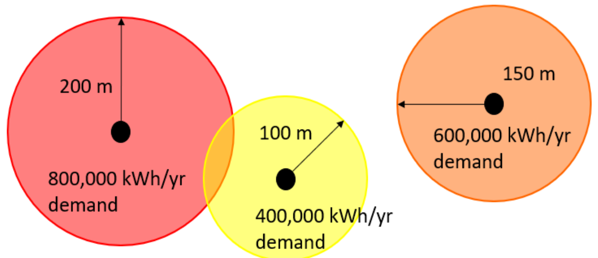


Figure 5—1 Example for LHD buffering using a 4,000 kWh/yr/m benchmark, with the three central points representing heat demand points.

The first two demands (from the left) in Figure 5—1 would be viable connections to each other due to their LHD 'buffers' overlapping, while the third property is not viable for connection. Three different LHD levels are examined in this analysis, the first is 4,000 kWh/yr/m of connection, the second 8,000 kWh/yr/m and the third 16,000 kWh/yr/m. The higher the LHD used the more viable the zone identified. This viability is used in the modelling to help determine the likelihood of a building connecting to a heat network.

Currently in the UK the viability of potential heat network zones is generally determined by anchor loads, these are high heat demand buildings and key connections on a heat network that usually drive the economics of a project. For the purposes of this analysis they are taken to be buildings with an annual heat demand of at least 500 MWh/yr. For a potential zone to be considered in this high-level analysis at least two anchor loads must fall within the zone.

Consideration of demand size in general is also important for heat network planning. Generally, only large buildings are viable for heat network connection, the recent BEIS National Comprehensive Assessment of heat networks[38] excludes buildings with a demand of under 73 MWh/yr. This means domestic properties will generally be excluded, so a hard exclusion is not undertaken for smaller properties in this work but the relative contribution from larger demands is considered within the analysis.

[37] Linear heat density is a means of relating heat demand to distance. For a heat network, it is defined as the total annual heat demand of connected buildings per meter of distribution pipework to these connections.

5.2 Heat Sources

There are multiple potential low carbon heat sources for heat networks in the LAEP area. These are important to consider, as a high-grade heat source can help improve the viability of a heat network beyond a building level solution, such as heat pumps being deployed on every building. The heat resources are split into two groups waste heat sources (such as those form waste-water treatment plants, large industrial plants or energy from waste incineration) and renewable resources – which are generally large-scale heat pump opportunities (such as ground or water source technologies).

5.2.1 Waste heat sources

Multiple datasets were examined to identify waste heat sources these included:

- National Atmospheric Emissions Inventory (NAEI) point source data. This shows the single largest sites for any emissions, this can include carbon dioxide (normally associated with combustion) which is a good indicator of heat at a site but also other emissions such as those associated with refrigerants, which are also an indicator of waste heat.
- Transformers at large substations generate high volumes of heat, which can be harvested to provide heat. With the increased electricity demand in all scenarios this resource is likely to increase, making an interesting heat resource to consider in many heat network developments.
- Combined Heat and Power (CHP) generators are excellent sources of high-grade heat. Whilst this is often utilised on site there is often excess heat available which could feed heat networks. The renewable planning database and UK biogas map are useful sources to identify such sites.
- Ordnance Survey and other mapping datasets were also examined in the proximity to identified major heat network zones. This can help capture information such as wastewater treatment plants, which are not readily available in a centralised dataset.

Some of these potential waste heat sources are examined in the context of potential heat network zones in section 5.3.

5.2.2 Renewable resources

Alongside the waste heat sources renewable resource are also considered. These tend to be based around water sources, providing opportunities for water source heat pumps, both the Tame and the Trent represent particularly good opportunities.

Ground source heat pumps are also considered, any available land in close proximity to a potential heat network can be considered for this (for example playing fields) but underlying geology can also be used to better understand the opportunity. A key resource for the LAEP area is historic mine workings, which cover larger areas of LAEP – see Figure 5—2.

[38] https://www.gov.uk/government/publications/opportunity-areas-for-district-heating-networks-in-the-uk-second-national-comprehensive-assessment

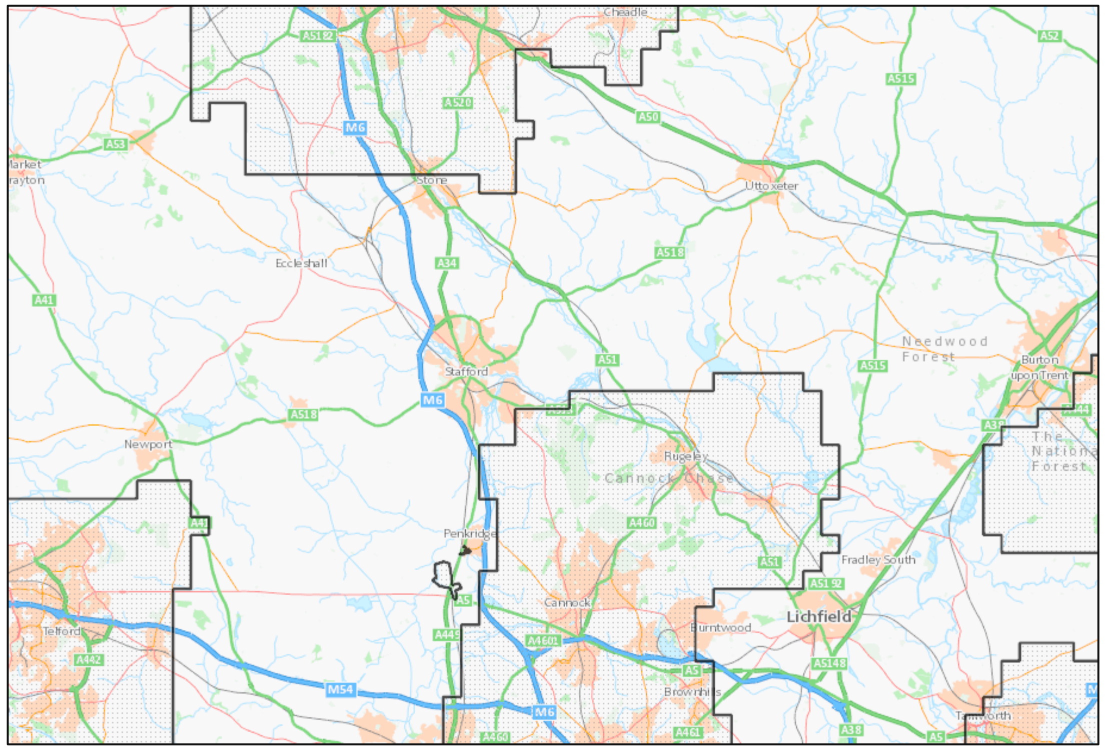


Figure 5—2 Coal mining reporting areas. Image taken from The Coal Authority https://mapapps2.bgs.ac.uk/coalauthority/home.html the background map uses OS Crown Copyright data.

These old coal mines could provide a potential source of heat for networks particularly in the Cannock Chase area. However, previous projects have shown that whilst the resource from mine workings can be good such schemes are often technically challenging and have a higher level of uncertainty than more traditional ground source systems.

5.3 Potential Heat Network Zones

Whilst heat sources are considered the primary identification of potential zones is based on the demand analysis described in section 5.1. The potential heat network zones this approach identified are displayed in Figure 5—3.

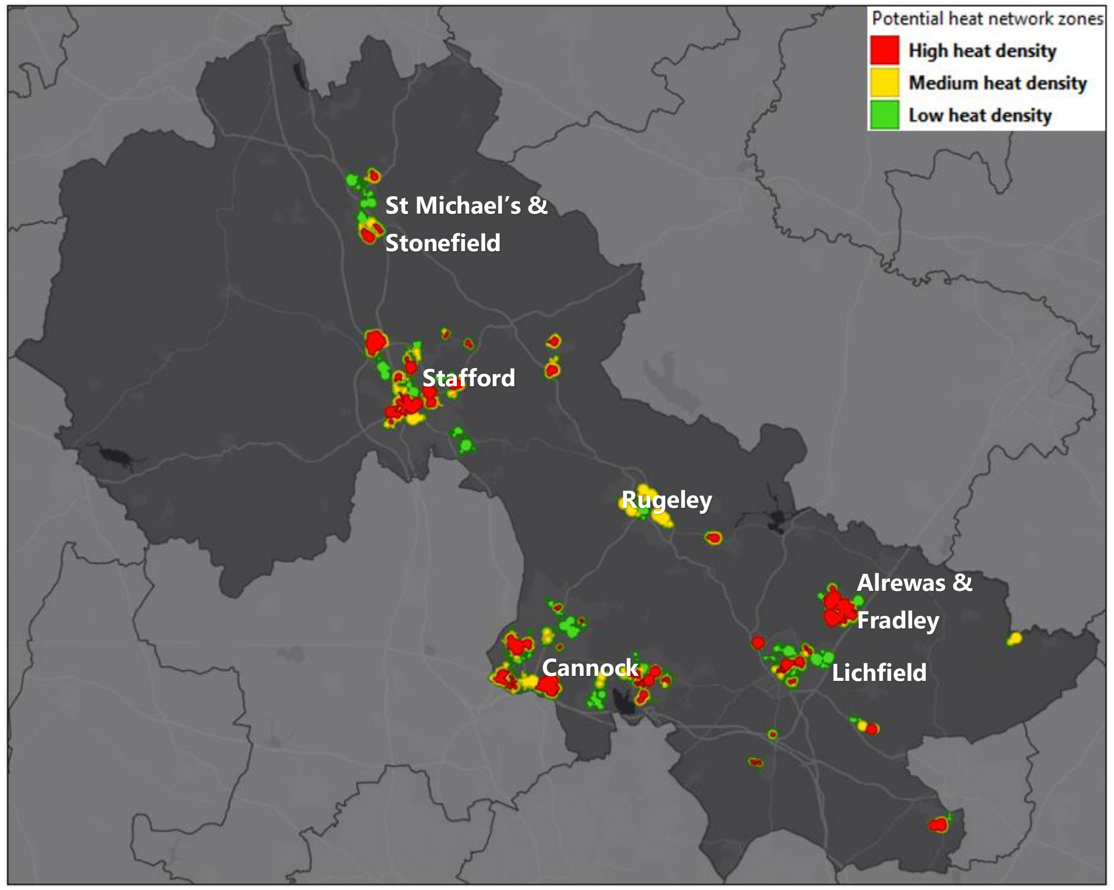


Figure 5—3 Potential heat network zones identified. Image uses ESRI, Ordnance Survey (Crown Copyright) and OSM data.

The largest settlements of Stafford, Lichfield and Cannock all contain substantial heat network opportunities. Outside of these areas Burntwood, Stone, Fradley and Rugeley all have large potential zones flagged. In the case of the latter this is near the major redevelopment site at the power plant so connection to a wider heat network could be considered for this development. However, the high energy efficiency currently being incorporated into the building design means that a heat network may not be the most economic approach. This high efficiency first is core to net zero and should thus be pursued before consideration of potential heat networks.

Whilst the centres of large urban areas often identified as potential heat network zones it is important to look at these in more detail. Industrial estates and large distribution centres are also frequently captured as potential heat networks. Whilst buildings in these areas are often associated with large heat demands the building spaces and fabric may not be well suited to heat network options. The heat network opportunities identified were given a high-level assessment (this does not replace a more detailed feasibility study). Three potential heat network zones to explore further are identified for each local authority in the LAEP, these are displayed in Figure 5—4.

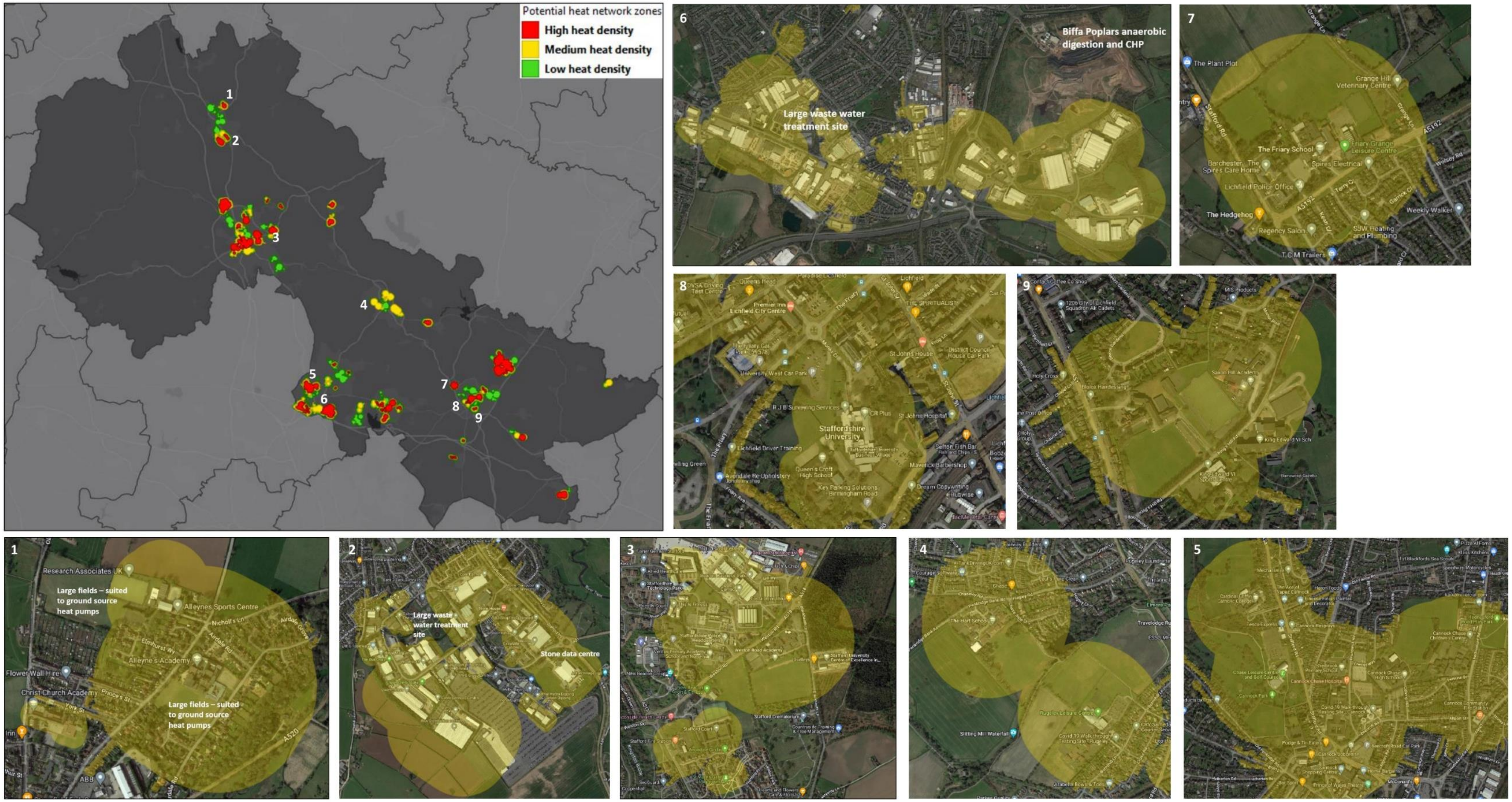


Figure 5—4 The location and satellite imagery of nine of the potential heat network zones identified. The yellow areas on the satellite imagery correspond to the medium heat density criteria for heat network zones. Image uses ESRI, Ordnance Survey (Crown Copyright), Google and OSM data.

The heat networks identified are not always the largest by demand, however, they have various aspects which makes them worthy of further consideration. As is typical with heat network zones the zones identified in Figure 5—4 are dominated by non-domestic demands.

Site 1 identified in Figure 5—4 is based around 3 non-domestic demands: Alleyne's Sports Centre, Alleyne's Academy and Christchurch Academy. The buildings would be relatively to connect with few hard constraints and there is extensive green space where ground source heat pumps could be considered.

Site 2 is of interest as there are very large potential waste heat sources in the area from the data centre and wastewater treatment plant. There is also substantial heat demand in the area from the surrounding business park and distribution centre. Whilst the larger distribution warehouses may not be well suited to a heat network some of the buildings with a denser heat demand should be considered. The attractiveness of this scheme is likely to be increased by potentially low heat prices due to the waste heat sources.

Site 3 is probably the best of the opportunities identified in Stafford. It includes Weston Road Academy, Stafford University Centre for Excellence, Staffordshire Police Headquarters, Veritas Primary Academy and a sport centre. It is also near the Stafford Court Student Halls and Stafford Fire Station. Stakeholder insights suggested that change of use at Stafford Court means it is unlikely to be a suitable future connection. In terms of heat sources there is significant green space for ground source heat pumps and the nearby Stafford Crematorium could be considered as a waste heat source.

Site 4 is a small potential network considered primarily because of the low dig cost. It would connect the Rugeley Leisure Centre and the Hart School. This site would not necessarily need to be developed as heat network instead a shared ground source heat pump system in the field between the two key buildings could be appropriate. This is an instance where considering the two large heat demands together could provide a low cost transition to net zero for both buildings. The heat network zone is in an area with mine water heat potential, but the relatively small scale of the scheme would mean such technology is unlikely to be economically viable in this case.

Site 5 is split by the A34 so may be better to consider as multiple networks, the best opportunity being to the east of the A34. This includes Cannock Chase Hospital, Sherbrook Primary School, Cannock Chase District Council offices and Cannock Chase High School. Again, extensive greenspace in the area could be used for a ground source heat network whilst still being retained for its current use (e.g. the playing fields for Cannock Chase High School).

Site 6 is another large potential zone which is best considered as two separate opportunities, the first surrounding the wastewater treatment works, which could be a potential low-cost source of heat. The second which has been considered before as a heat network (carbon pricing and net zero ambitions may make it a more attractive option now) is to the south of the Biffa Poplars site. The CHP on the site could potentially supply high grade heat to the nearby business and retail parks. This area is also considered as a potential renewable generation opportunity (see Section 7.2.2) making it key opportunity for multiple vectors.

Site 7 although spatially small is from a high-level assessment one of the most promising opportunities identified. The Friary Grange Leisure Centre, the Friary School, the Spires Care Home and Lichfield Police Office are all in very close proximity with no major constraints between them. This makes them very well suited to a heat network with the large playing fields providing an excellent location for a potential ground source heat pump array.

Site 8 is part of a much larger potential network that has been identified. The area of primary interest includes the Lichfield Campus of Staffordshire University, a large block of retirement homes, Queens Croft High School and Lichfield District Council offices. Again, ground source heat pumps appear to be the most suitable low carbon solution.

Site 9 is to the south of site 8 and a small potential zone. It based around the Saxon Hill Academy, King Edward VI School and the King Edward VI Sports Centre. No waste heat sources were identified in the area, so again a ground source solution is the primary option considered at this stage.

5.4 Deployment

Without more detailed assessment the type of heat network suitable to the potential zones cannot be accurately assessed, however, for the LAEP only 4th and 5th generation heat networks are considered. These are based on low carbon technologies and necessary for the net zero ambitions. A full feasibility assessment is also required to assess the relative viability of heat networks over individual property and building level solutions, however, the potential zones identified in Figure 5—4 are of a scale that broadly aligns to the ambitions of the FES (particularly when considering non-domestic stock). These levels of deployment are summarised in Table 5—1, along with an indicative cost. These costs are likely to vary substantially from scheme to scheme with the ranges taken into account in the cost analysis.

Table 5—1 Summary of heat network ambitions for different scenarios. This includes any existing heat networks.

Scenario	Heat demand met by heat networks and shared systems (GWh/yr)	Indicative cost (£ millions)
Consumer Led, Target Led and Area Aligned	92	46 – 64.4
Hydrogen Heavy	83	41.5 – 58.1
BaU	24	12 – 16.8

The priority areas to focus on to reach these demands are highlighted in Figure 5—4, three of the smaller sites (e.g. 1, 7 and 9) would be of a scale similar to that of the BaU, along with several smaller local networks incorporating a higher percentage of domestic properties. With larger targets in the other scenarios larger heat networks will be required to meet these.

District heating is one of the vectors considered in the LAEP that will be deployed before the various end points considered for scenarios. Whilst this is challenging for Cannock Chase and its 2030 target, it is one of the few areas within the heating decarbonisation sector that could potentially be met - but it is still a very challenging.

5.5 Heat networks first steps

There are substantial heat network opportunities across all three local authorities, there are well established routes to supporting these. An internal local authority review of the different zones highlighted in section 5.3 is the first step, based on what is known regarding stakeholders and any likely changes to key demands identified. These should then be considered for more detailed feasibility studies, funding mechanisms to support this process are explored in Appendix B. After these initial opportunities are explored there are many identified in Figure 5—3 that would merit further investigation.

Heat networks represent a relatively mature low carbon heating solution. Local authority and wider public assets can be highly useful for helping to support heat network developments, providing anchor loads guaranteed to connect and use of land for borehole arrays or pipe routing. These make heat networks suited to early deployment, helping to make early progress towards decarbonisation targets. This is particularly important with the ambitious targets of Cannock Chase and the early public sector decarbonisation target of Lichfield.

6 Transport

Transport is one of the most consistent sectors across all scenarios. This is due to the stronger national policy guidance, with the banning of new petrol and diesel cars by 2030 and hybrids by 2035. Electric vehicles (EVs) are the standard choice for net zero for these smaller vehicles, in the case of larger road vehicles (i.e., coaches, buses and HGVs) there are more varied solutions, generally a mixture of hydrogen based and electric vehicles.

For cars and vans in particular the different scenarios all present a large modal shift in the transport system, moving away from centralised refuelling solutions and towards distributed household, car park and workplace charging.

Within the LAEP area there are very significant national transport routes (e.g. the M6, A38, A5 and A51) generating very high carbon emissions – see Figure 6—1.

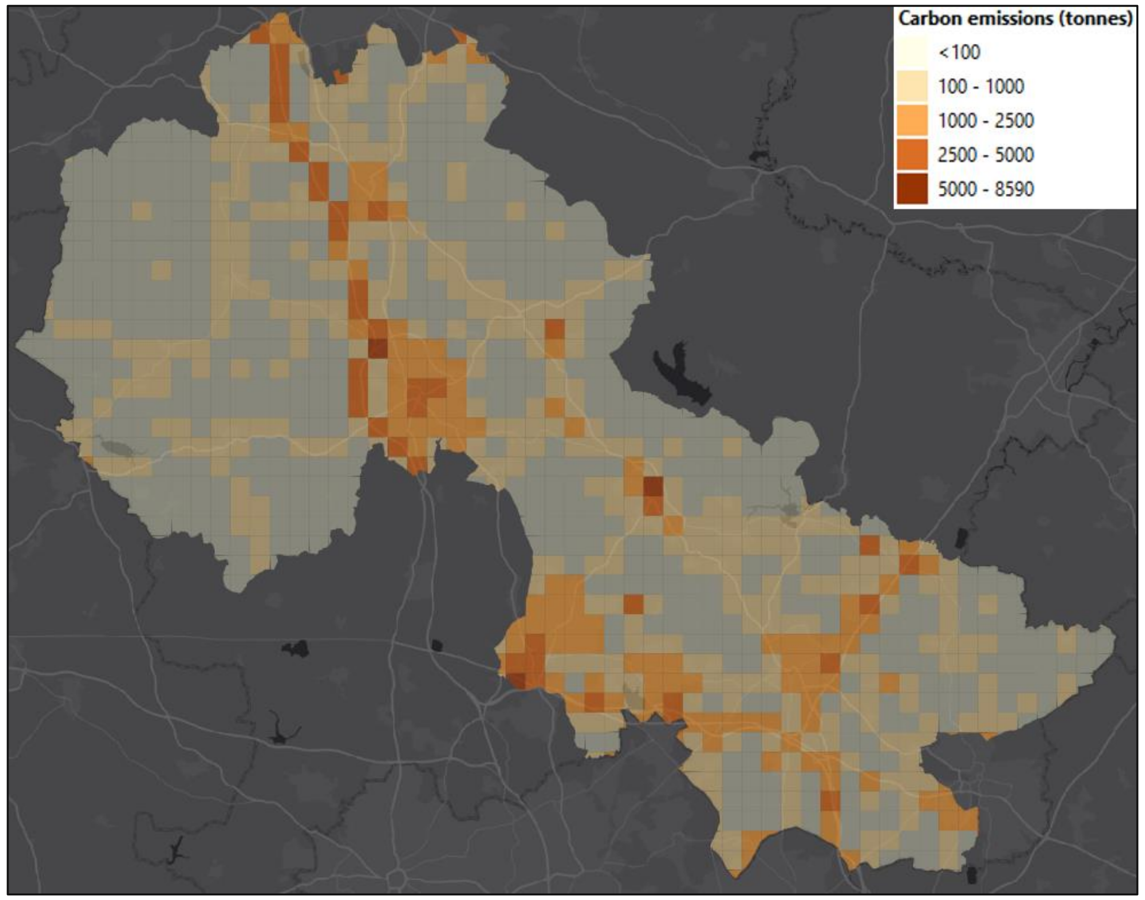


Figure 6—1 Carbon emissions in the LAEP area from all sectors. Data from the National Atmospheric Emissions Inventory with the basemap from ESRI.

The highest carbon emissions are either in the town centres or following these major transport routes, highlighting their significance to local carbon emissions. Within the LAEP, however, only traffic for vehicles based in the LAEP area are considered. This is applied to both domestic and non-domestic vehicles particularly HGVs.

There are also significant rail routes in the area, however, they are not considered in the analysis as they are better suited to national rather than local strategies. One of the key national strategies being HS2, which was noted by stakeholders to be bringing investment to the Stafford station area. Although, the rail element of this is excluded from the LAEP the increased funding and development in the area can help with momentum to move other transport projects forward in the area, such as EV charging in car parks.

6.1 Cars and Light Goods Vehicles (LGVs)

A summary of electric vehicle (EV) uptake in the car and LGV sectors assumed for the three core scenarios is provided in Figure 6—2.

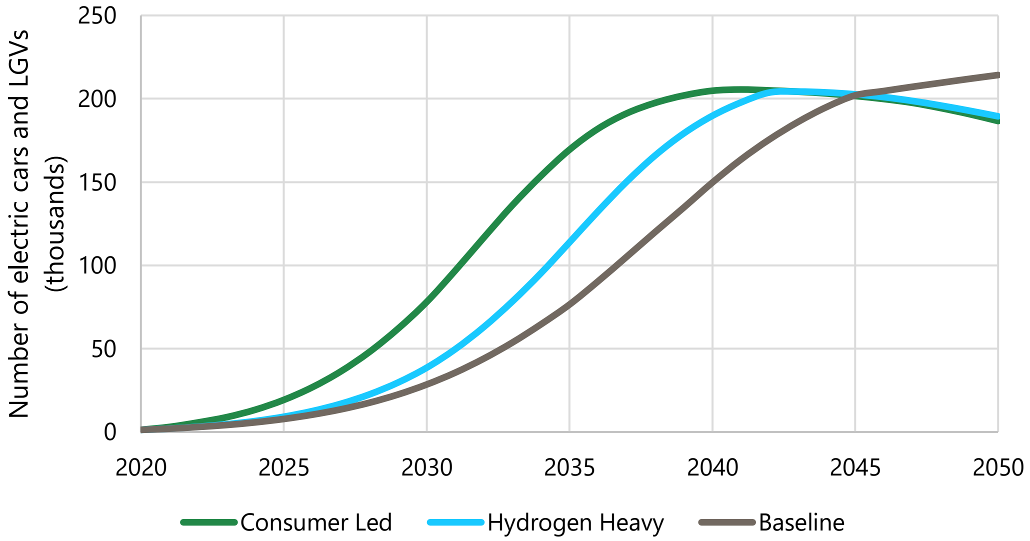


Figure 6—2 Number of electric cars and LGVs in the LAEP area, based on the three National Grid Future Energy Scenarios explored in this study.

The Consumer Led scenario hitting full EV deployment in 2040 means that Stafford's 2040 target in the Target Led scenario does not require a change to this national model for EV role out, with the same being true for the area aligned scenario.

By 2040 the Consumer Led scenario reaches full uptake and then drops off slightly, with the Hydrogen Heavy scenario following the same pattern but with a slight lag. The reduction in numbers is due to a slightly higher uptake of public transport and lower levels of car ownership. Whilst these trends are important to consider at a UK level, at a local level the number of EVs is assumed to remain constant once the peak value is reached. This is due to the relatively high commuter population in the LAEP and large planned housing expansions. From a carbon perspective this change from the national scenarios is negligible – due to grid decarbonisation – however, it is used to represent what would be required from the electricity infrastructure perspective if similar levels of car ownership were seen in the future. Whilst the ownership of cars remains at a constant level once the peak is reached public transport use is still assumed to be higher than today, so journeys are replaced but the same option of using a car remains.

The average age of cars in the UK is 8.9 years. This makes the Cannock Chase net zero by 2030 target highly challenging as even if only electric vehicles were purchased from this point on combustion engine vehicles would still be within the vehicle fleet. Replacing vehicles before the end of life can have relatively higher carbon emissions due to the embodied carbon within the vehicle. Also, a policy mandating this shift to EVs ahead of the national policy seems impractical. However, focusing on the local authority own fleet and achieving full EV uptake for LGVs and cars would be highly viable within the 2030 timeframe.

6.1.1 Domestic Charging

To support this extensive EV uptake there will also need to be substantial charging infrastructure. The majority of chargers will be deployed at a household level. The number of dwellings which have off-street parking were analysed against national deployment scenarios, resulting in the model identifying ~116 thousand charge points at a household level in each scenario. See Figure 6—3 for the distribution of these charge points.

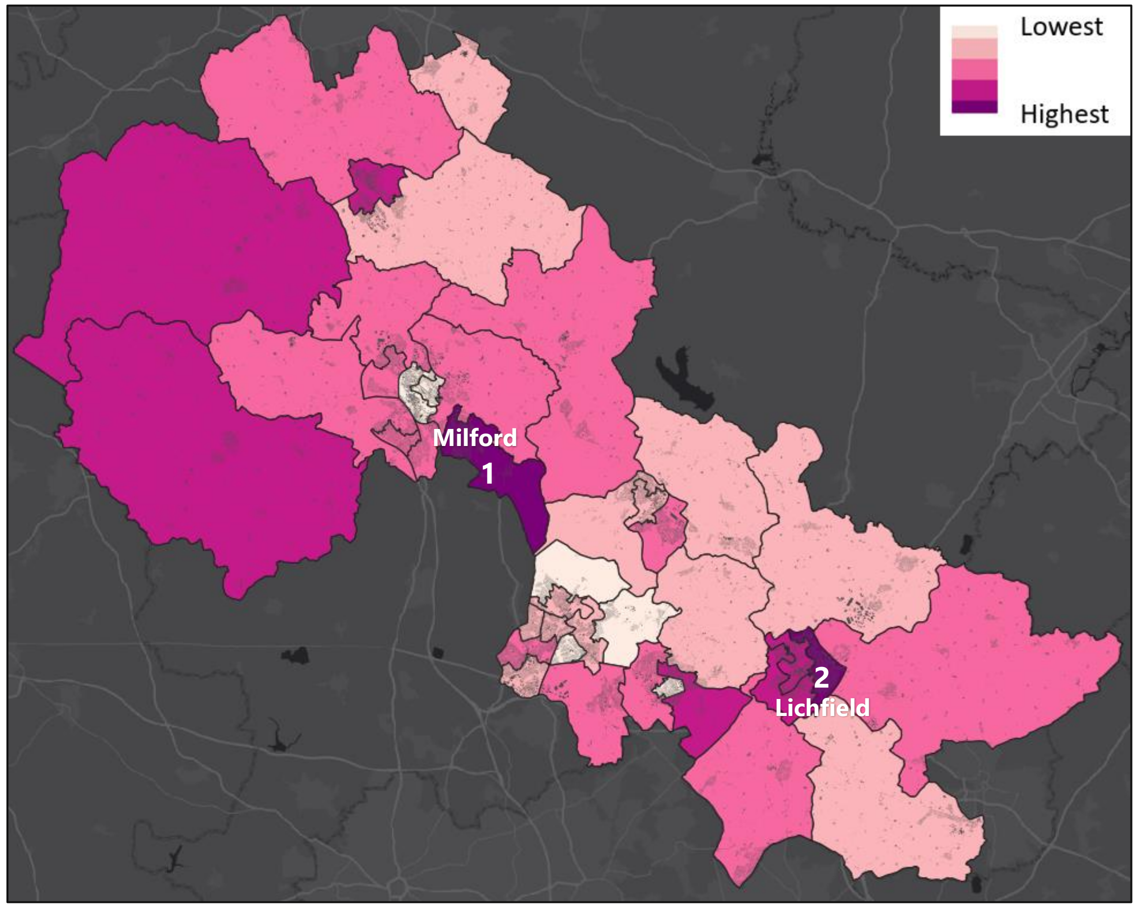


Figure 6—3 Off-street home based charge point hotspots. Basemap from ESRI.

The number of houses with off street charging points ranges in the MSOAs across the LAEP from 1900-4500 depending on the availability of off street parking (this is for the main Consumer Led scenario but is similar for all scenarios), meaning in all instances there are significant numbers of off-street chargers installed. Rural areas tend to have more off street parking in general, aligning to UK trends, meaning these tend to have more off-street charging points. The relative lack of off-street parking in urban areas is highlighted by both Cannock and central Stafford having a relatively low level of off-street parking. Lichfield, however, has a high density of off-street charging to the east of the city centre (the MSOA labelled with a 2). The other highest density area for off-street EV chargers is the MSOA containing Walton-On-The-Hill (labelled with a 1). This is an MSOA which is a focus area for several different low carbon solutions and could be considered for a more detailed case study.

The charging infrastructure is not seen as a major cost barrier compared to the price of a vehicle (home chargers are relatively easy to install and are generally in the £400-£700 range), particularly when accounting for the fuel savings seen by switching to electric. Twinning off-street EV chargers to rooftop solar power (opportunities for this are examined in 7.2.1) can help drive fuel costs down even further.

Not all households have off-street parking, to help support these properties, on street charging infrastructure should be installed in residential areas. Analysis based on national figures indicates this should be ~2000 charge points for the scenarios. The distribution of these charge points is presented in Figure 6—4, key to determining these hotspots is the availability of off-street parking. Areas with low levels of driveways or garages are thus focus areas for on-street charging infrastructure.

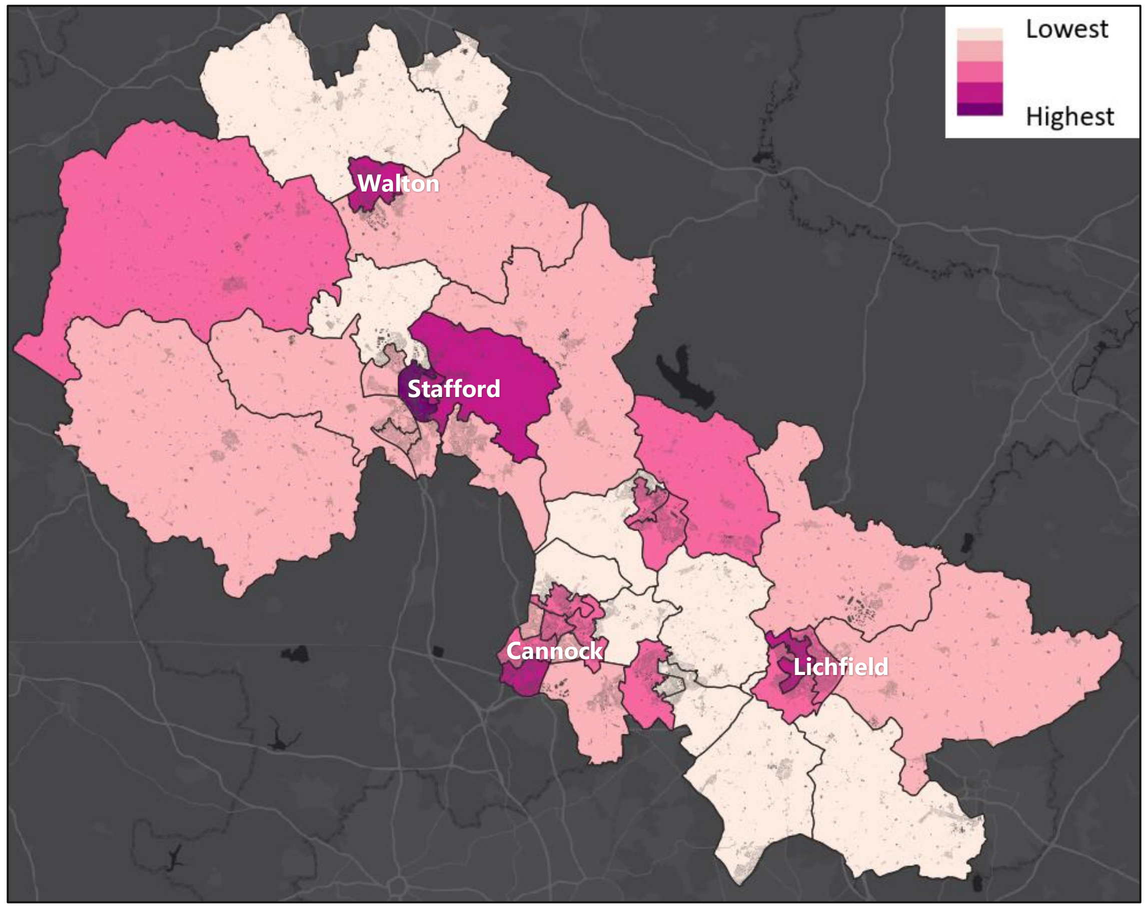


Figure 6—4 On street charge point hotspots. Basemap from ESRI.

Unsurprisingly central Stafford, Cannock and Lichfield were flagged as hotspots for the requirement of residential on-street charging infrastructure. This on street parking provision is more likely to fall within direct local government control and can be a useful earlier enable of EV adoption. Some local authorities have used innovative ways to support this transition, such as utilising existing street lighting infrastructure as hubs for electric vehicle charging. This is a solution which is likely to also be applicable in the areas flagged as having a high level of on-street EV charging within this LAEP area. Pursuing curb side solutions such as these in the highlighted areas are seen as a low regret near to medium term goal, as this on street charging infrastructure is a common requirement across all scenarios.

6.1.2 Workplace, Car Park and Destination Charging

As well as home and on street charging the transition to EVs will be supported by extensive workplace, public car park and destination charging (such as chargers in hotel car parks). The level of charging infrastructure modelled in the scenarios is relatively similar with a summary of the charging capacity assumed provided in Figure 6—5.

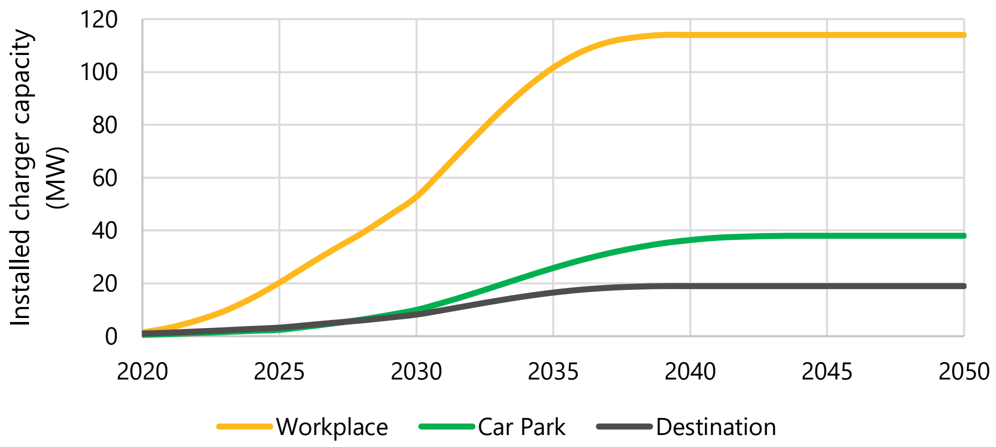


Figure 6—5 Installed EV charging by location type.

These deployment rates align broadly to national scenarios, matching the Future Energy Scenarios. However, with the ambitions for earlier decarbonisation in the area aligned and various target led scenarios this enabling infrastructure is assumed to be built out earlier. The main early opportunities identified for this are public car parks, the prevalence of car park charging is illustrated in Figure 6—6.

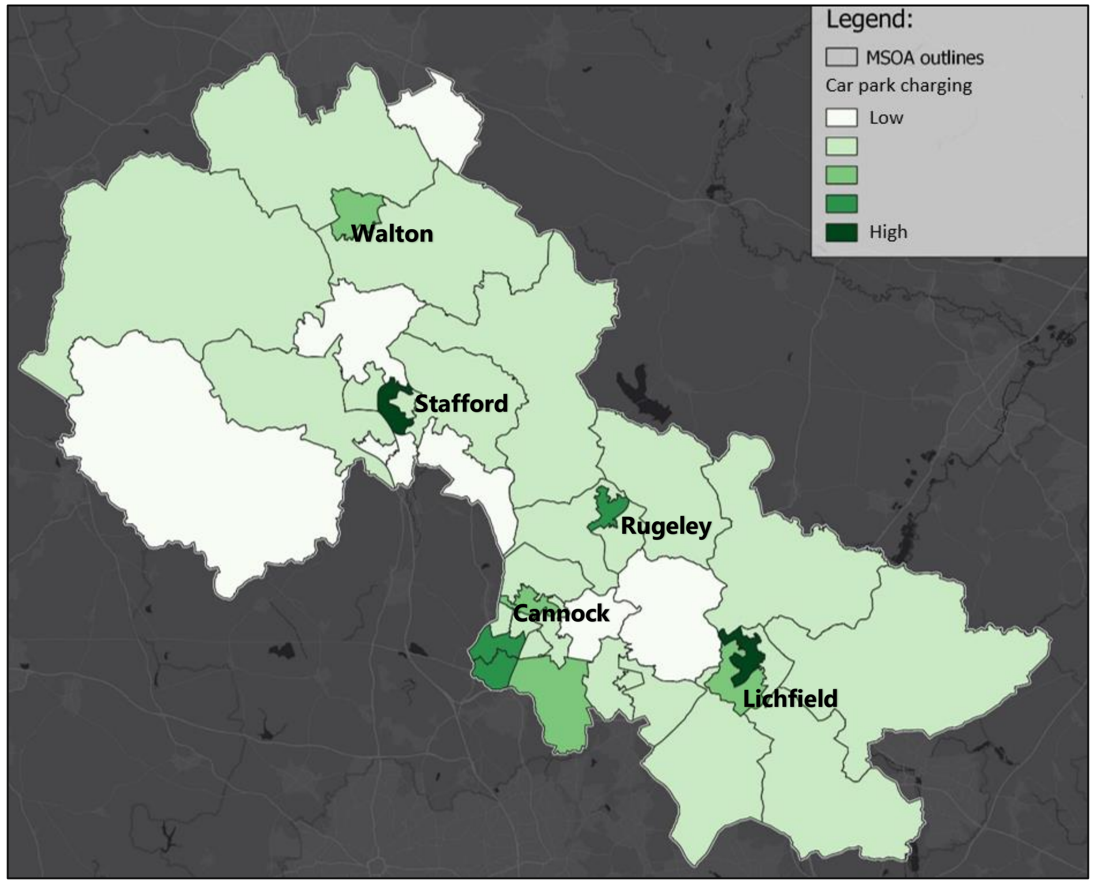


Figure 6—6 Prevalence of car park charging across the LAEP area. Basemap from ESRI.

Local authority owned car parks represent an excellent opportunity for early deployment of EV chargers and in certain situations can also be source of revenue. PV canopies can be integrated into these carparks, with electricity either being fed into the surrounding buildings, the grid or to charge the cars in the car park. In the case of the latter batteries are sometimes integrated, allowing for faster charging – whilst limiting the increased strain on the electricity network. Three potential car parks which were highlighted by the model as substantial opportunities, these were the Lombard car park in Lichfield, the Beecroft car park in Cannock and the Waterfront Car Park in Stafford.

6.2 Public Transport – Buses and Coaches

Public transport is key to the Consumer Led scenarios with wider use and adoption. The switch of road based public transport to low carbon technology is in some ways the easiest sector, particularly at the local level. This is because local transport provision does not need to rely on infrastructure changes at a national level to be adopted and the greater direct influence of government also makes policies easier to adopt at an early stage. Interestingly the transition to zero carbon buses was flagged in a recent survey by Stafford County Council as an important factor among non-bus users for encouraging bus use (24% of the surveyed non-bus uses said this). This finding was part of the Bus Service Improvement Plan put forward by Staffordshire County Council in 2021. The fact that there is a Bus Service Improvement Plan in the process of being signed off is promising, showing there is momentum in this sector.

The buses and coaches in the local area consume 54 GWh/yr of fuel. With the transition to low carbon buses (which is modelled to be the vast majority electric with ~10% hydrogen to include coaches which have longer journeys) this drops to under 13 GWh/yr. This reduction in energy demand includes a modelled increase in bus usage. This is due to the increased efficiency of EV technology over combustion engines. The infrastructure for this charging is assumed to be centralised at bus and coach stations.

6.3 Heavy Goods Vehicles (HGVs)

HGVs are more common in the LAEP area than in the country as a whole, this is based on vehicles registered in the area rather than energy consumption; these latter figures are highly elevated due to the substantial nationally significant transport links. Cannock Chase in particular has a high number of HGVs registered, 3300 compared to 1100 in Stafford and 1100 also in Lichfield. Some of the hotspots for HGVs are presented in Figure 6—7.

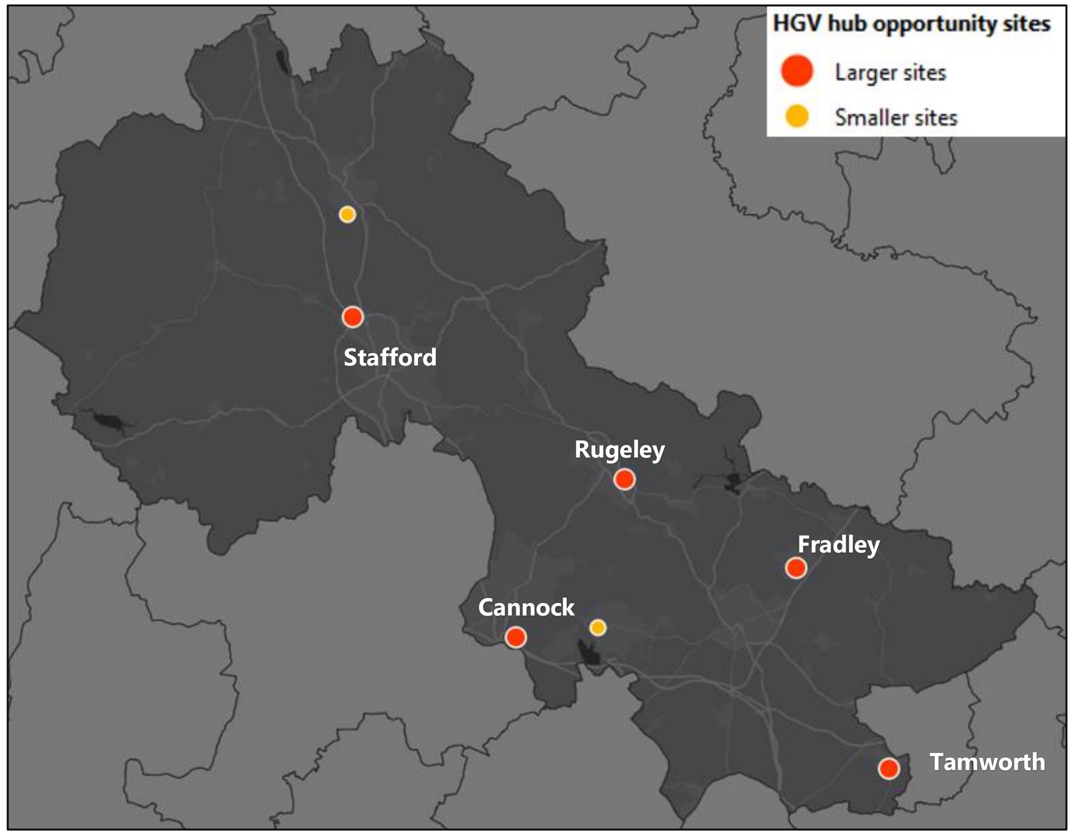


Figure 6—7 Location of priority HGV hubs. Basemap from ESRI.

The sites identified in Figure 6—7 are not all the sites which will require HGV charging infrastructure but some of the largest. It should be noted the dataset used to identify HGV hubs may have resulted in some being missed due to poor data quality. The site near Tamworth, for example, represents several opportunities in the general area – with a large cement works being a focus of HGVs as well as more standardised distribution centres.

The low carbon solution for HGVs is presumed to be a combination of hydrogen and electric solutions. This is based on national projects within the FES. Unlike buses it is important for HGVs to align to national and even international strategies, as given the distances they can travel the technology and strategy needs to be compatible with wider infrastructure transitions for the sector.

For hydrogen solutions it is assumed that the fuel is generated on site through electrolysis in most scenarios (those which follow the Consumer Led approach). Thus, regardless of the whether electric charging or hydrogen infrastructure is required there will be substantial electricity demands at these sites to achieve the LAEP. Local renewable generation, particularly solar, is an excellent means of helping to fulfil this demand requirement and helping to reduce the cost of the HGV charging (due to the levelized cost of solar power generated onsite generally being ~20% that of the current purchase price for electricity). Some opportunities for such schemes are explored further in section 7.2.2 in the context of private wire opportunities from ground mounted sites but the large roof spaces of distribution warehouses could also be an attractive option to explore in the areas highlighted in Figure 6—7. The use of onsite generation or private wire options is also the best practice for Net Zero Carbon Buildings laid out by the UK Green Building Council, due to increased additionality and accountability[39], and this holds true across the LAEP – not just at the building level.

In Cannock, the Orbital Retail Park and the large distribution warehouses to the east of it and in Lichfield, the Fradley Distribution Park are probably the two best immediate options for this highlighted in Figure 6—7. The LAEP modelling approach assumes where possible the renewable generation identified in section 7 is used locally through solutions like this, to maximise both its carbon and economic impact.

6.4 Transport costs and first steps

The transport costs do not consider vehicle change but rather the charging infrastructure itself. This infrastructure cost does not include factors like electricity network upgrades, which is instead captured in the general infrastructure cost (as it is hard to meaningfully apportion what costs are incurred by transport and what from wider system electrification). A summary of the costs for the transport infrastructure requirements Table 6—1.

Table 6—1 Cost breakdown for different transport system elements.

Transport sector	Cost (£ millions)
Off-street chargers	58
On-street chargers	1
Workplace and destination charging	8
Carpark charging	4
Bus charging infrastructure (mostly electric)	3
HGV charging (majority hydrogen but some electric)	30

For off-street charging relatively limited support is considered necessary, with wider national support schemes in place to reduce the costs of home-based charging infrastructure. However, on street parking is an area which the local authorities and Staffordshire County Council have a significant role in providing. The analysis presented in Figure 6—4 highlights areas this likely to be most significant. Carpark-based charging falls within a similar remit, with public sector owned car parks being the initial focus. The integration of PV canopies could help improve the business model and further reduce the carbon content in the transport sector (avoiding grid electricity).

[39] https://www.ukgbc.org/wp-content/uploads/2021/03/Renewable-Energy-Procurement-Carbon-Offsetting-Guidance-for-Net-Zero-Carbon-Buildings.pdf

The area is already progressing with a low carbon public transport strategy which can be integrated into the LAEP. A key insight from the work behind this strategy is that people were more likely to use public transport if it is low carbon, showing a dual carbon saving from decarbonising the sector.

The area has an extensive HGV fleet, and is a key strategic hub nationally, meaning it represents an excellent opportunity for helping to pioneer the decarbonisation of this sector. This is recognised at a UK government level as an important sector to consider, evidenced by a recent announcement of £200 million of funding[40]. Pursuing similar funding schemes to help support a pilot project at one of the HGV hubs is a key initial step and would help establish the area as a national innovator in this sector.

[40] https://www.gov.uk/government/news/200-million-boost-to-rollout-of-hundreds-more-zero-emission-hgvs

7 Low Carbon Generation

The electricity grid is decarbonising rapidly and this is set to continue, with large scale on and offshore wind developments being a key enabler nationally and increased interest in new nuclear. However, local generation of renewable electricity is important to all LAEP strategies; this ambition is also balanced against other needs. These include land for farming, woodland, environmentally protected areas and many other uses. Deployment of local renewables is informed by different targets of the FES, with the Consumer Led scenarios having higher levels of deployment than in the BaU and Hydrogen Heavy outputs. More ambitious timings for net zero will necessitate larger local renewable deployment due to higher grid carbon factors as the national energy system is still transitioning, with a high share of gas still on the system. This section examines the existing renewable capacity in the LAEP area followed by an overview of future renewable potential in the context of different deployment scenarios.

7.1 Existing Generation

The area has three large solar sites identified in the UK Renewable Energy Planning Database, all of which fall in Lichfield - see Figure 7—1 for the location.

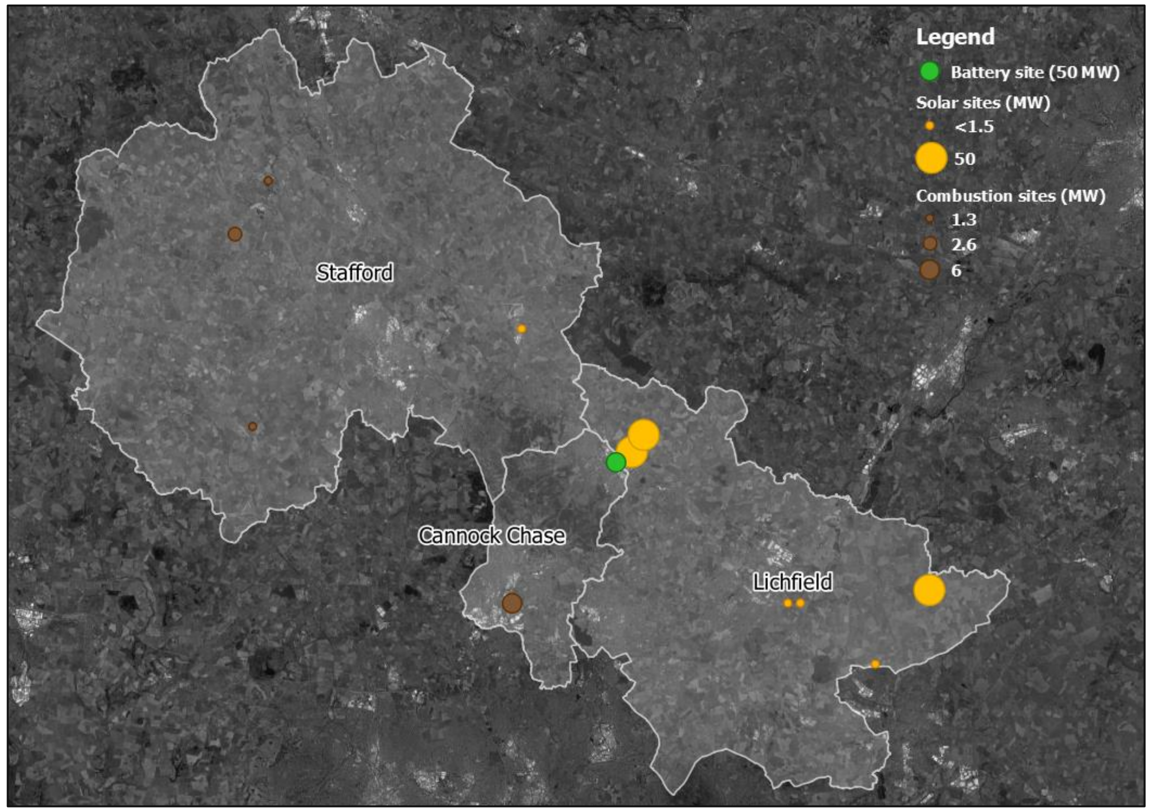


Figure 7—1 Existing or approved renewable sites in the LAEP boundary. Data is from the UK Renewable Planning database with background imagery from Google Satellite.

All of these large solar sites are not yet built with the largest renewable site currently in operation being the 6 MW anaerobic digestion based CHP plant in Cannock Chase.

The focus of two of the large solar sites and the battery site near the old Rugeley Power Station will benefit from the extensive electrical infrastructure already in the area. Utilisation of existing assets like this is key to a successful LAEP and a factor considered in the further solar analysis.

7.2 Solar PV Opportunities

Modelling identified solar PV as the dominant renewable opportunity in the LAEP, reflecting what is currently seen in the planning system. PV is examined in the context of both roof and ground mounted developments.

7.2.1 Roof Mounted PV

The potential for roof mounted is very large with the potential to generate well over 1000 GWh/yr, however, this level of deployment would be hugely challenging from a supply and implementation perspective.

For the three core scenarios directly based on the FES the rooftop PV deployment in 2050 is summarised in Table 7—1.

Table 7—1 Rooftop PV deployment for the three core LAEP scenarios (values are for 2050) and associated costs (in 2020 £s)

Scenario	Domestic rooftop PV (MW)	Domestic rooftop PV (GWh/yr)	Domestic rooftop PV cost (£ millions)	Non-domestic rooftop PV (MW)	Non-domestic rooftop PV (GWh/yr)	Non-domestic rooftop PV (£ millions)
BaU	65.7	57.6	92	11.7	10.2	12
Hydrogen Heavy	109.8	96.2	154	19.6	17.1	20
Consumer Led	171.8	150.5	241	30.5	26.8	31

The BaU scenario value equates to approximately double the currently installed rooftop capacity in the LAEP area, the Hydrogen Heavy three times the value and Consumer Led five times.

Different MSOAs have different levels of suitability for PV based on roof type, size and building numbers – the relative suitability is illustrated in Figure 7—2.

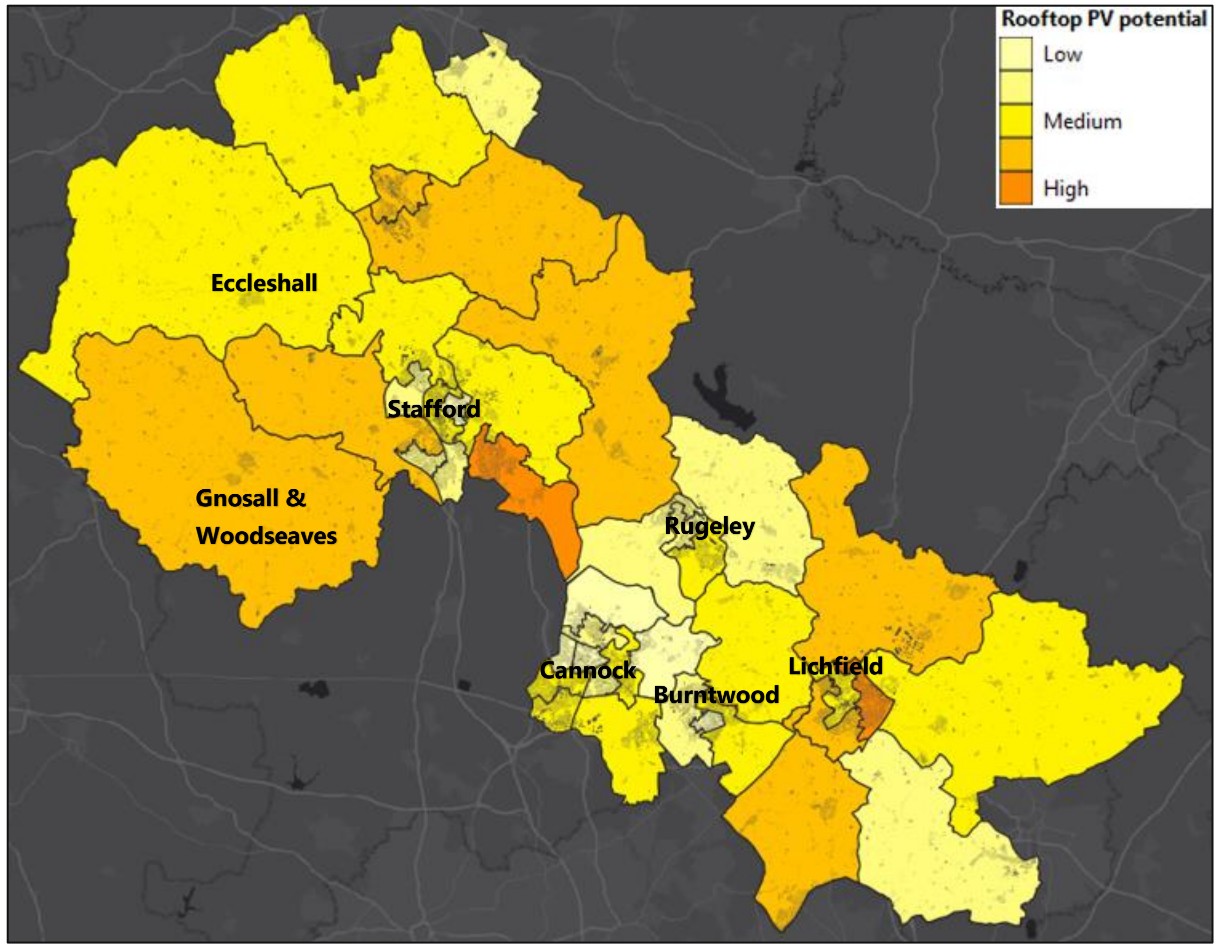


Figure 7—2 Rooftop PV potential for different strategic level zones. Image uses ESRI, Ordnance Survey (Crown Copyright) and OSM data.

In the Consumer Led scenario the lowest additional rooftop PV seen in any of the MSOAs is 2.1 MW with the highest being 8.6 MW. The two largest opportunities for rooftop solar identified in Figure 7—2 are also the two areas which see the highest adoption rates for off-street domestic EV charging, highlighting these two areas as an opportunity to develop the two technologies side by side.

7.2.2 Ground Mounted PV

Sites are screened for ground mounted PV initially based on a series of hard constraints. These include flood risk zones, high slope gradients, land use (such as urban areas and high agricultural grade land) and various with a protected status (e.g. SSSIs and the AONB[41] in Cannock Chase). After this analysis a series of soft factors are explored to help prioritise sites, including proximity to key electrical infrastructure (i.e. primary substations). An illustration of the potential sites identified after this soft factor analysis is provided in Figure 7—3.

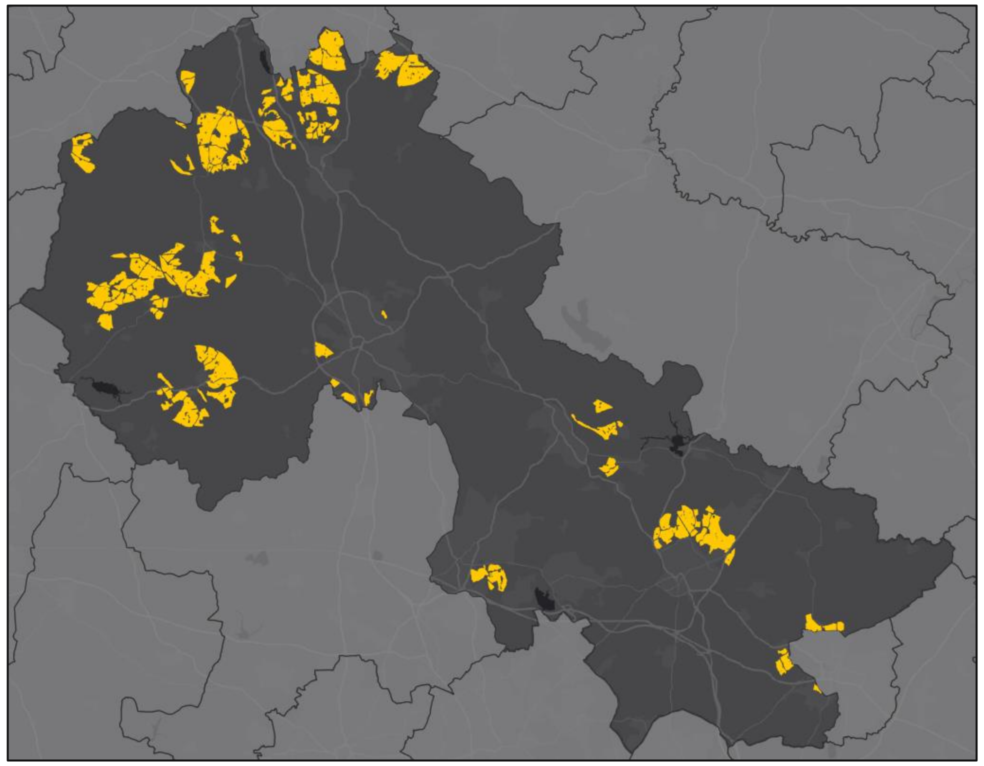


Figure 7—3 Ground mounted PV areas identified after soft factor screening. Image uses ESRI, Ordnance Survey (Crown Copyright) and OSM data.

Even after this screening the potential renewable capacity identified is more indicative of a technical potential than a likely deployment, with 3.4 GW of PV panels being able to fit on the land areas identified in Figure 7—3. The majority of these sites fall in Stafford (2727 MW) with Lichfield having the second highest capacity (608 MW) and Cannock Chase the lowest (99 MW). This makes Cannock Chase's 2030 ambitions for net zero even harder to reach as early additional renewable capacity is one of the more technically viable ways to help achieve this (as the grid still has a relatively high carbon factor in 2030).

Only a portion of the potential PV capacity is taken forward in each scenario (again based on a local breakdown of the FES), this is detailed in Table 7—2.

[41] In the case of the AONB this would normally be considered a hard constraint, however, the large quantity of other sites available it was screened out. If the work focused more on a pathway for Cannock Chase rather than the whole LAEP area this hard exclusion of AONB sites would not have been included.

Table 7—2 Additional ground mounted PV capacity at full build out for the three different scenarios based directly on the Future Energy Scenarios by local authority.

Local Authority	BaU scenario – ground mounted PV (MW)	Hydrogen Heavy scenario - ground mounted PV (MW)	Consumer Led scenario - ground mounted PV (MW)
Cannock Chase	10	17	26
Lichfield	46	76	119
Stafford	136	228	356
Total	192	321	501

For the BaU scenario these combine to produce 176 GWh/yr, 295 GWh/yr in the Hydrogen Heavy and 461 GWh/yr in the Consumer Led. The costs associated with this renewable capacity is provided in Table 7—3.

Table 7—3 Ground mounted PV costs.

	BaU scenario – ground mounted PV (£ millions)	Hydrogen Heavy scenario - ground mounted PV (£ millions)	Consumer Led scenario - ground mounted PV (£ millions)
Cannock Chase	8	13	20
Lichfield	35	58	90
Stafford	110	184	287
Total	153	255	397

When assessing the future renewable generation across the LAEP area the Western Power Distribution (WPD) electricity network was examined to examine ease of connection, with close proximity to primary/grid substations being ideal for large scale renewables. Information from WPD is also used to give an indication of where there is existing infrastructure headroom for renewable capacity (see Figure 7—4). This uses a red, amber, green high-level analysis – with red showing very limited capacity for more renewables and green a high level.

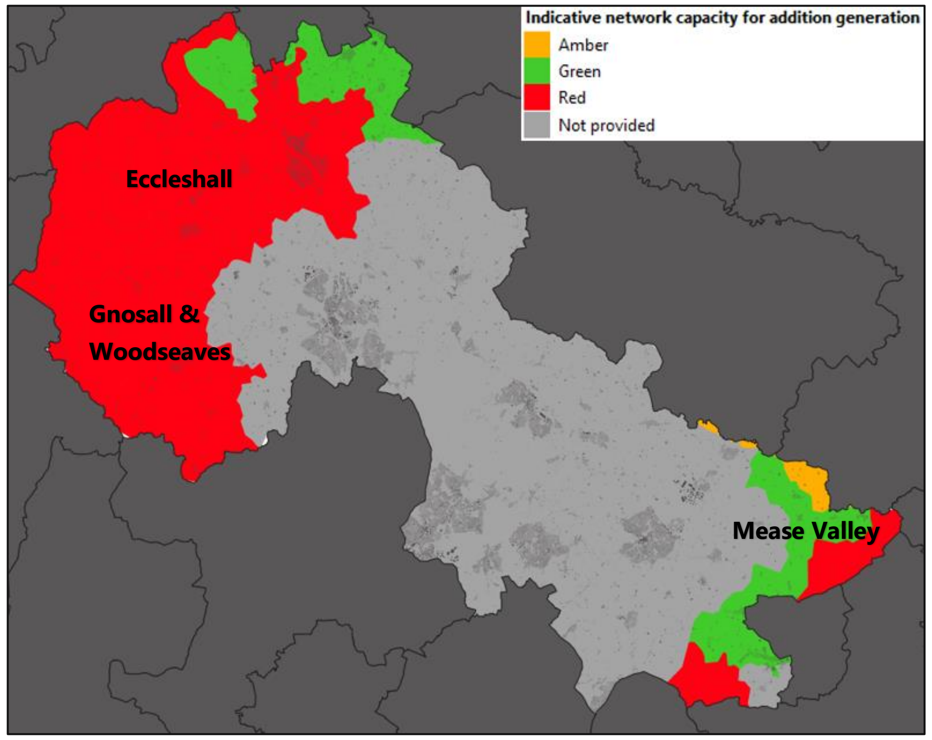


Figure 7—4 WPD Primary Substation catchments graded upon associated generation headroom. Image uses ESRI, Ordnance Survey (Crown Copyright) and OSM data.

Due to the nature of the local infrastructure, headroom figures were not available for large areas of the LAEP, however, alternative proxy datasets were examined in the areas where there was no information and these indicated that network capacity is available for additional renewable generation.

The most important finding from examining the current available network capacity is that the area in the west of Stafford, where most potential renewable capacity is identified, is in a currently constrained grid area. This issue is recognised by WPD and their long time plans indicate potential upgrades in the area (this is discussed further in section 8.1). Even accounting for these constrained areas there are extensive opportunities in currently unconstrained grid areas, so the large opportunities in the north-west of the LAEP area would be developed later.

Ideally where possible the power generated will be used onsite. This helps realise the maximum contribution to net zero[42] and can also result in substantial savings for the consumer as well as increased revenue for developer, potential location for three such private wire opportunities is provided in Figure 7—5.

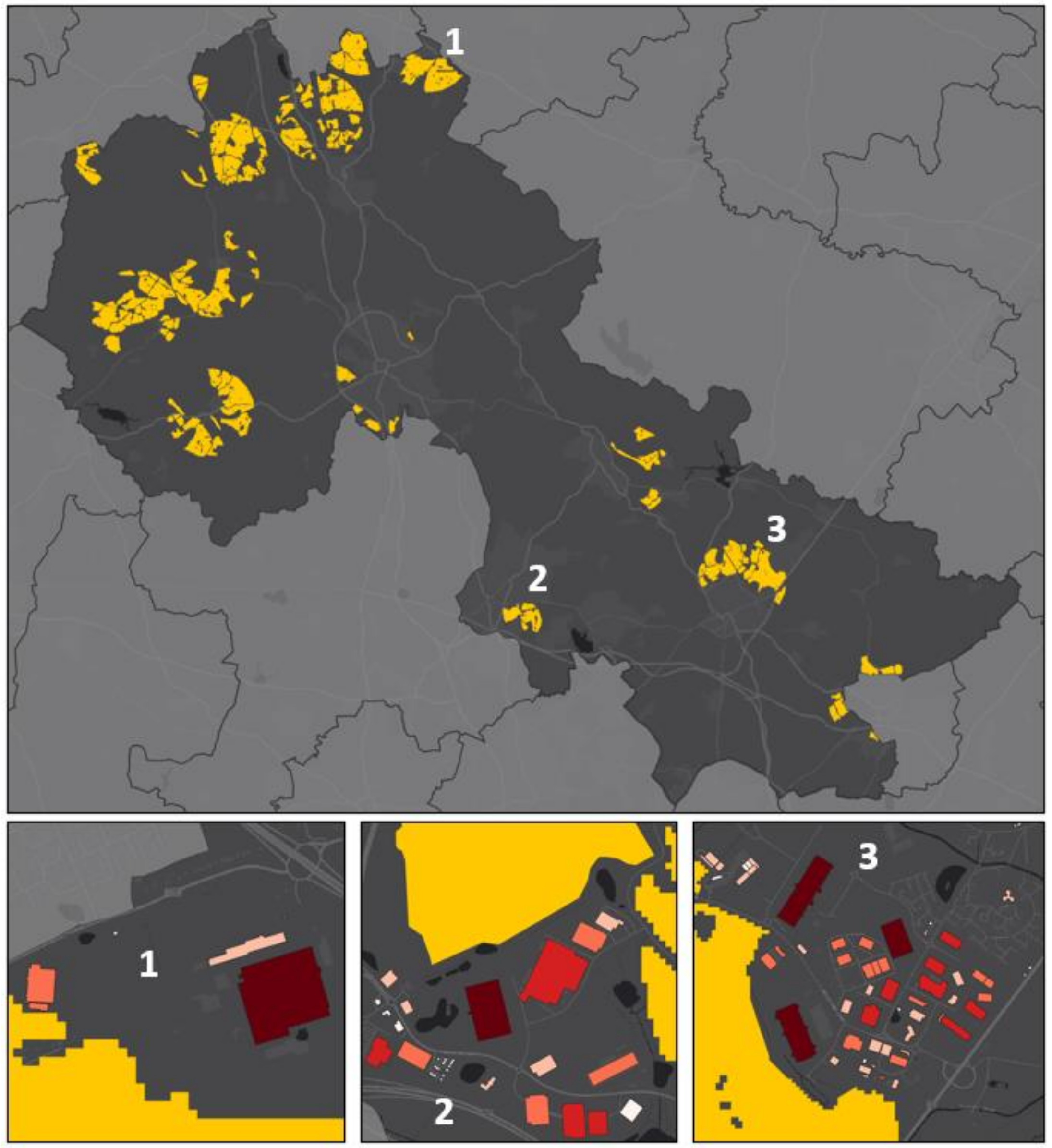


Figure 7—5 Potential PV sites with non-domestic private wire opportunities. The buildings are filled with different reds to illustrate the level of electricity demand – with the darker the red the higher demand. Image uses ESRI, Ordnance Survey (Crown Copyright) and OSM data.

Site 1 is associated with one very large consumer in the north of Stafford, this is illustrative of several similar opportunities in Stafford. The two examples in Cannock Chase (the Orbital Retail Park and the large distribution warehouses to the east of it) and Lichfield (the Fradley Distribution Park) are next to multiple large consumers. In both cases this includes distribution hubs, where local PV deployment could be a cost-effective way of providing power to charge the associated HGV fleets – either through direct electric charging or creation of hydrogen through electrolysis.

Development of these and similar opportunities with specific users in mind are key initial priorities. Alongside this local authority owned land should also be examined in the context of solar opportunities, as these can be taken forward more rapidly. GIS files of the analysis will be provided alongside this report to allow such analysis to be undertaken.

[42] https://www.ukgbc.org/wp-content/uploads/2021/03/Renewable-Energy-Procurement-Carbon-Offsetting-Guidance-for-Net-Zero-Carbon-Buildings.pdf

Given the benefits of developing on public land assets examining these opportunities should be considered after only hard constraints are screened. This identifies a far larger potential footprint for PV, see Figure 7—6.

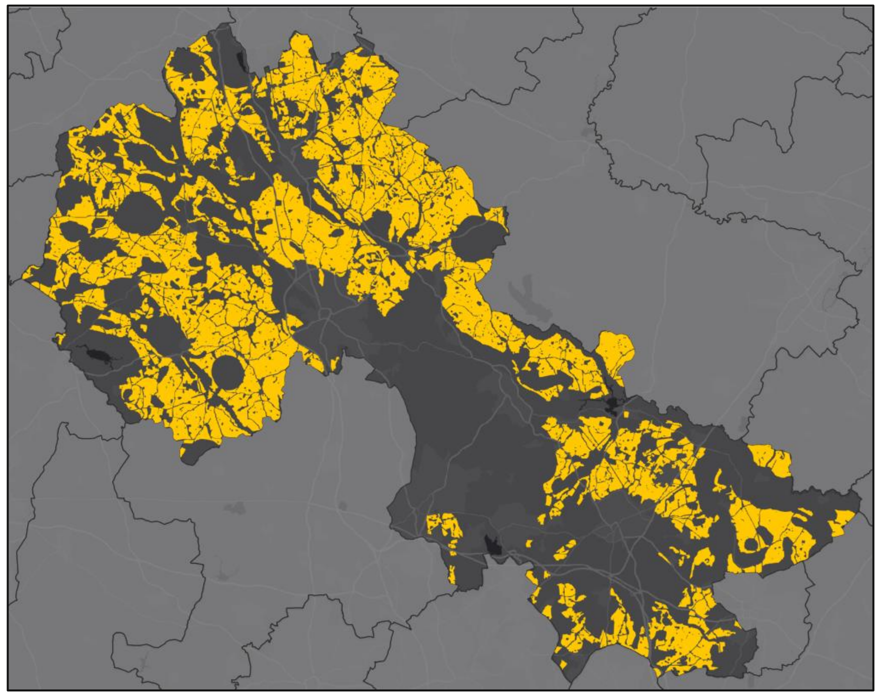


Figure 7—6 Potential ground mounted solar sites identified after only hard constraints screening. Image uses ESRI, Ordnance Survey (Crown Copyright) and OSM data.

7.3 Wind Power Opportunities

Wind power follows a similar two step screening process to solar but with higher levels of constraint placed upon it. As a result the capacity identified is lower, with potential sites after soft factors are considered presented in Figure 7—7.

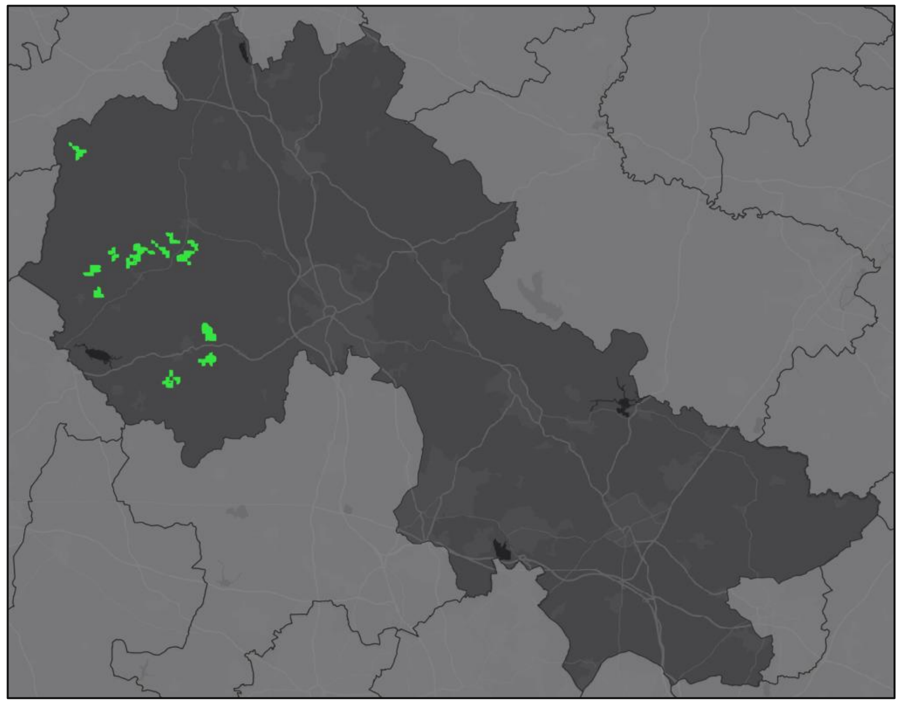


Figure 7—7 Potential wind sites in the LAEP area. Image uses ESRI, Ordnance Survey (Crown Copyright) and OSM data.

These sites total a potential of ~90 MW installed capacity. Again, as with solar, not all the potential capacity is assumed to be taken forward with 25 MW being modelled (generating ~50-65 GWh/yr depending on turbine size and site) – the cost associated with this is ~£28 million. Wind is only seen in the Consumer Led scenario (and the associated Target Led and Area Alignment scenarios), which has far greater focus on renewable generation. The modelling considers a range of turbines from ~800 kW to ~2.5MW. The latter generally being seen in large onshore wind farms. Given the historical challenges of wind deployment in the county (17% of planning applications have resulted in operational wind farms), a relatively low wind contribution is modelled compared to solar. However, with recent UK policy shift towards wider support of onshore wind[43] the policy landscape will be more favourable for deployment soon. With larger turbines being considered appropriate (which is more likely in a more politically supportive environment) and deployment potentially being closer to the 90 rather than 25 MW figure assumed.

The modelling is based on identifying areas most suitable to larger scale wind farm developments, so the results do not mean that individual turbines or even clusters of a few turbines will not be suitable outside of the areas identified in Figure 7—7. Rather, it is that the northwest of Stafford is most suitable to larger scale deployment.

7.4 Other Low Carbon Generation

Other renewables are not assumed to be seen in any significant volumes in the scenarios. 138 kW of hydro schemes (split across three sites) was identified in Stafford but the economics of these will likely be poor compared to wind or solar PV. Bioenergy and waste are not considered to exceed their current levels in the area but are expected to maintain similar levels of output across all three scenarios.

Larger and more novel technologies, such as small modular reactors or open cycle hydrogen turbines, that form some national scenarios are not considered in the LAEP. As these are contingent on national policy and strategy so not relevant at the LAEP level. Similarly large-scale seasonal storage is not considered within the LAEP scenarios.

[43] Onshore Wind Bill https://bills.parliament.uk/publications/41757/documents/353

7.5 Low carbon generation first steps

Renewable generation is a mature technology and of maximum benefit in early years, due to continued grid decarbonisation assumed in later years. This makes it an early priority for an LAEP being an easy win, to pursue both for large scale ground mounted sites and rooftop solutions.

For large scale renewable development, the north-west area of the LAEP is most suitable in the long term, however, in the short term it is a constrained network making it less suitable for development. Outside of the north-west area, there are many sites suitable for ground mounted solar. Public land information should be added to the identified sites to help prioritise potential locations. Private wire opportunities should also be considered, as they tend to realise the highest sale price and by being used within the LAEP area (rather than fed into the grid) they represent a more accountable carbon saving. As well as to building/process demands the transport sector can also be considered for these private wire opportunities, with PV powered electric vehicle charging or connection into the electrified rail network in the area being potential users. The recent electrification of the Chase railway line presents a potential opportunity for this.

Rooftop PV is also an extensive opportunity which could be explored early. Like the private wire approach it means grid electricity is directly displaced, representing maximum carbon saving. Without the feed-in-tariff, other support mechanisms need to be examined to help maximise rooftop PV deployment. The type of support which is currently most popular is bulk purchasing of equipment, to keep prices low, facilitated through local authorities or county councils. Also with increased grid electricity costs integrating batteries into rooftop PV systems to minimise purchasing power from the grid is becoming increasingly popular and can be supported through these same bulk purchase mechanisms.

8 Network Infrastructure

This section provides a brief overview of the current energy infrastructure in the LAEP area. This is important as it gives context for different energy solutions. The electricity network infrastructure is particularly important as it stresses on this infrastructure which is one of the highest cost elements in all scenarios.

8.1 Electricity Network

The electricity network is split into two main typologies in the LAEP area. The northwest portion is served by 33 kV infrastructure at the extra high voltage level, whilst the majority of the rest of the area is served by 132 kV, this is illustrated in Figure 8—1.

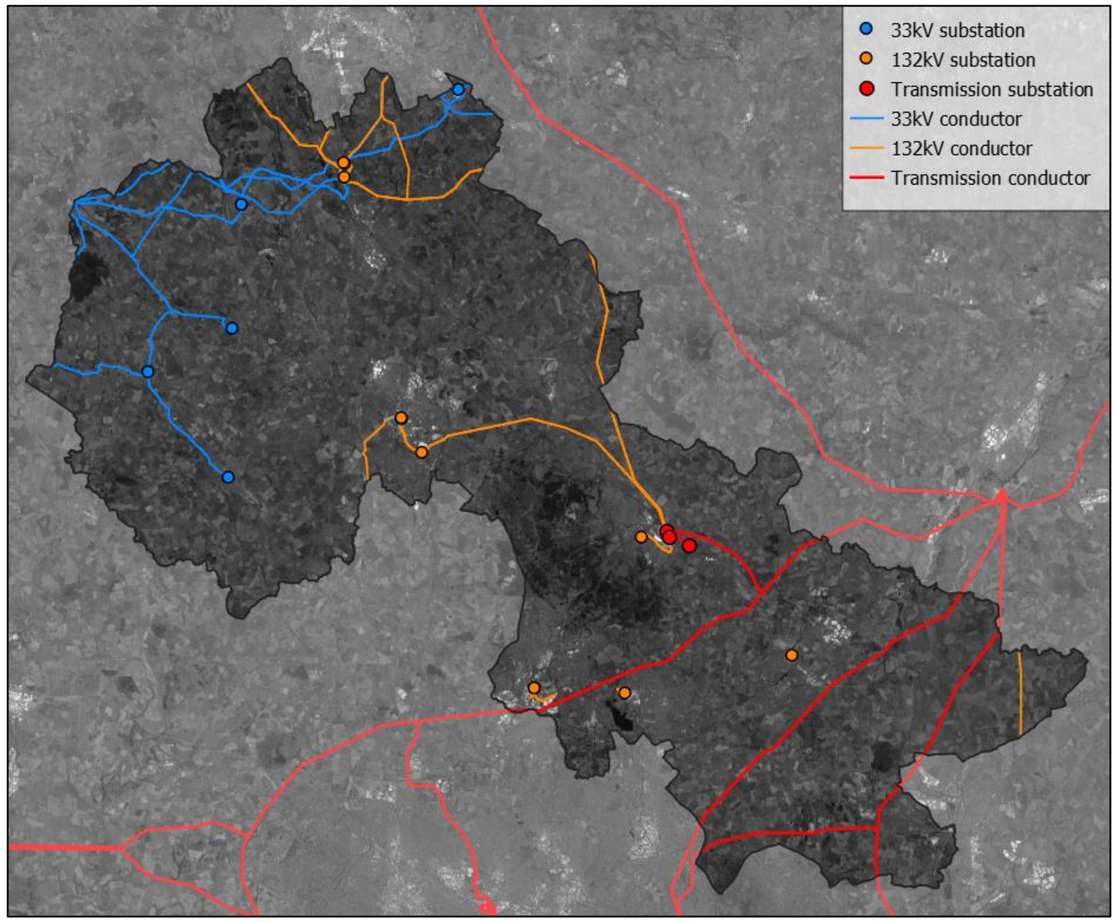


Figure 8—1 Extra high voltage and transmission electricity infrastructure. The background map is from Google Satellite with the electricity infrastructure data from WPD and National Grid.

The areas served by the higher voltages are generally less constrained, whilst in the northwest area there is already substantial stress on the network. This has implications for realising any decarbonisation opportunities early in this area as for any scale of electrified solutions substantial network reinforcements are likely to be required.

Figure 8—2 provides a RAG analysis (red substations have very limited capacity whilst green substations can have significant levels available, with amber somewhere in the middle) of the different substations in the area based on WPD data.

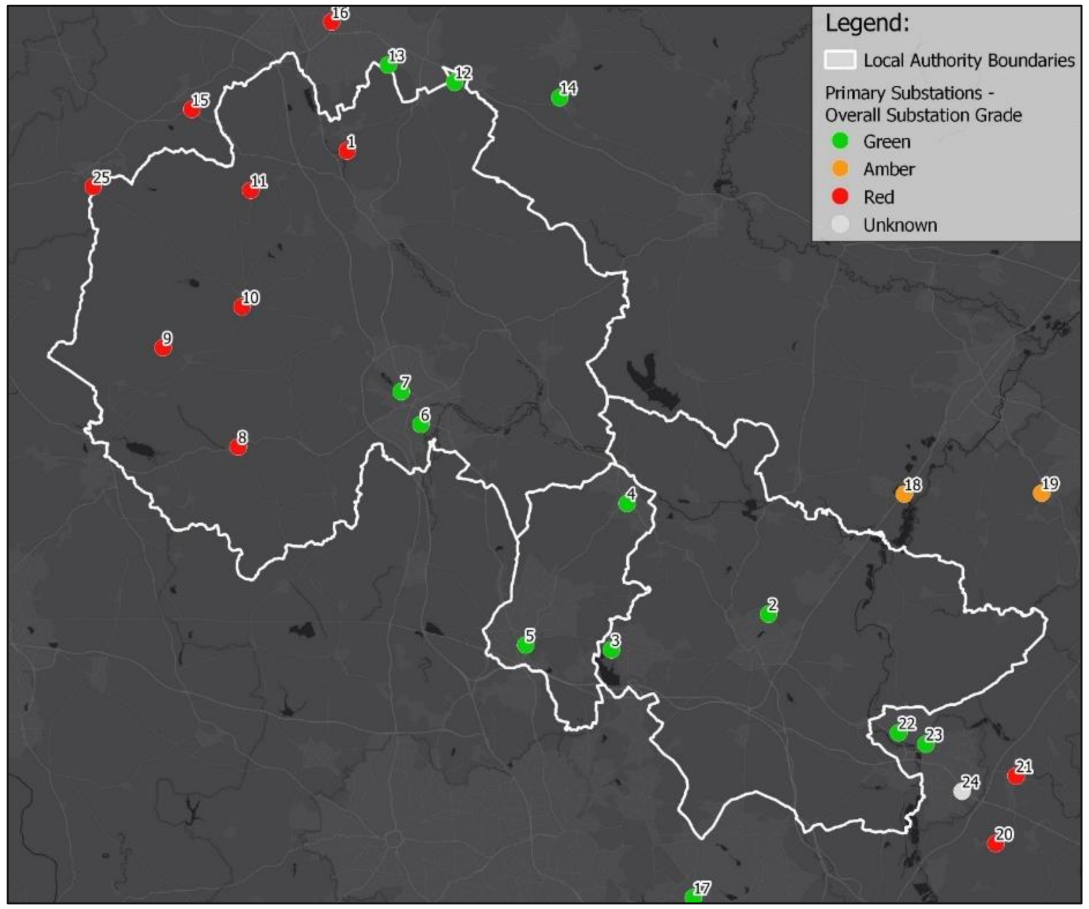


Figure 8—2 RAG analysis to provide an indication of available capacity at the primary substations in the LAEP area. Basemap from ESRI with substation data provided by WPD.

The information in Figure 8—2 is an aggregated RAG analysis for both demand and generation for substations. Whilst these are two different factors, in the data available the areas which are constrained from a demand perspective are also constrained from a generation perspective and vice versa. A large number of substations in Figure 8—2 fall outside the LAEP area, this is because although being outside the area their feeders supply the LAEP area. This widely interconnected nature of the electricity network is important to consider in the wider context beyond the LAEP, as net zero decisions made in adjacent local authorities can have a substantial impact on the costs and capacity availability for the LAEP.

The northwest region is the only area to have obvious issues with grid constraint based on the WPD data, with all substations being shown as red in the RAG analysis. The area is (as of 09/06/2022) an active network management zone[44]. This highlights the challenge of connecting new demand or generation in the area, with active network management zones generally being used to assist with these new connections, whilst avoiding reinforcement. Such zones are generally a relatively short-term solution with a limited capacity to absorb additional strain. It does, however, open opportunities for storage and flexibility services in the area for any new generators.

This constraint impacts both the demand and generation elements of the LAEP in the near term, the latter is particularly important as it was identified as the area with the largest renewable potential in section 7. There is currently one reinforcement in the area listed within the WPD Green Recovery Scheme[45] but more notably within the WPD Network Development Plan the issue is noted[46]. A reinforcement solution is proposed (based at the Mearford Bulk Supply Point – which supplies the constrained areas in the north west of the LAEP area), with the note that any final solution being

[44] https://www.westernpower.co.uk/our-network/network-capacity-map-application
[45] https://www.westernpower.co.uk/green-recovery-map-application
[46] See Network Development Reports at https://www.westernpower.co.uk/network-strategy/network-development-plan

subject to a cost benefit analysis. The LAEP could help evidence the cost benefit analysis, particularly if it was adopted into local strategy.

Despite the rest of the LAEP area generally having good network capacity substantial upgrades are required across all scenarios and all areas, the vast majority of these costs are seen at the lower voltage levels. However, having capacity available does enable early action, with the opportunity to start deploying low carbon solutions across much of the LAEP before substantial network upgrade costs will be required.

8.2 Gas Network

The gas network is a significant asset in the Hydrogen Heavy scenario. The vast majority of the network at medium and lower pressures is already plastic and suitable for hydrogen. There are, however, costs associated with switching to hydrogen, there are still areas of pipework which are iron, higher pressure pipes are mostly steel (which is unsuitable for hydrogen), pressure reductions stations (these act in a similar way to substations for the electricity network) are likely to need refurbishing and there is all cost in switching the building connections. The cost model, which due to the uncertainty of the switch is relatively conservative, gives a £241 million associated infrastructure upgrade for the Hydrogen Heavy scenario[47]. Whilst this is a substantial cost it is markedly lower than the additional £473 million electricity network upgrade cost in the Consumer Led scenario[48].

The transition of the gas network would be dependent on a national drive and the actions of the gas network operator (Cadent). The lack of heavy industry in the LAEP area means it is not a priority for hydrogen. For the Hydrogen Heavy scenario hydrogen for use in the network is assumed to be generated in a national centralised network, using large scale renewable generation – such as offshore wind to drive costs down. Due to the net zero ambition the hydrogen is assumed to be green (i.e. generated directly from renewables and using process like steam methane reformation).

Some hydrogen is also seen in the Consumer Led scenario not only in transport (where it is supplied by local electrolysis) but also in the non-domestic building stock. This is also assumed to be green and either generated locally or using a road-based tanker delivery (enabled by the excellent transport networks in the area) or a similar solution, consequently the hydrogen used in this scenario carries a substantially higher tariff than in the Hydrogen Heavy scenario. Hydrogen is only used in the Consumer Led scenario to in the most challenging instances for heat – generally for process heat rather than space or water heating.

[47] It should be noted that these costs do not include development of a hydrogen supply chain – it is assumed in this scenario costs are captured nationally, with significant transferable skills from the natural gas industry.

[48] If similar smart EV charging and demand side management were deployed in the Hydrogen Heavy scenario as in the Consumer Led scenario it would decrease the peak demand on the grid. In this situation the relatively low cost of hydrogen infrastructure compared to the electricity network will be further emphasised.

9 Next Steps

This section provides a summary of the hotspots and opportunities highlighted in sections 3 to 7 (section 8 focuses on the enabling infrastructure) for different low carbon energy solutions. The focus of this is opportunities that relate to the Consumer Led/Target Led/Area Aligned scenarios, although apart from domestic heating technology choice there are several similarities with the Hydrogen Heavy scenario as well. This is the first part of the section, the second uses the context of the priority areas to provide low regrets next steps on the net zero transition pathway.

9.1 Early Opportunities

Domestic heating solutions are the single largest capital expenditure modelled in the Consumer Led scenario with the shift to heat pumps and their higher cost compared to tradition boilers. The housing stock in the LAEP area is generally well suited to heat pumps, with many properties being suitable for heat pump installation without the need for fabric upgrades, focus areas for immediate heat pump installation are provided in Figure 9—1.

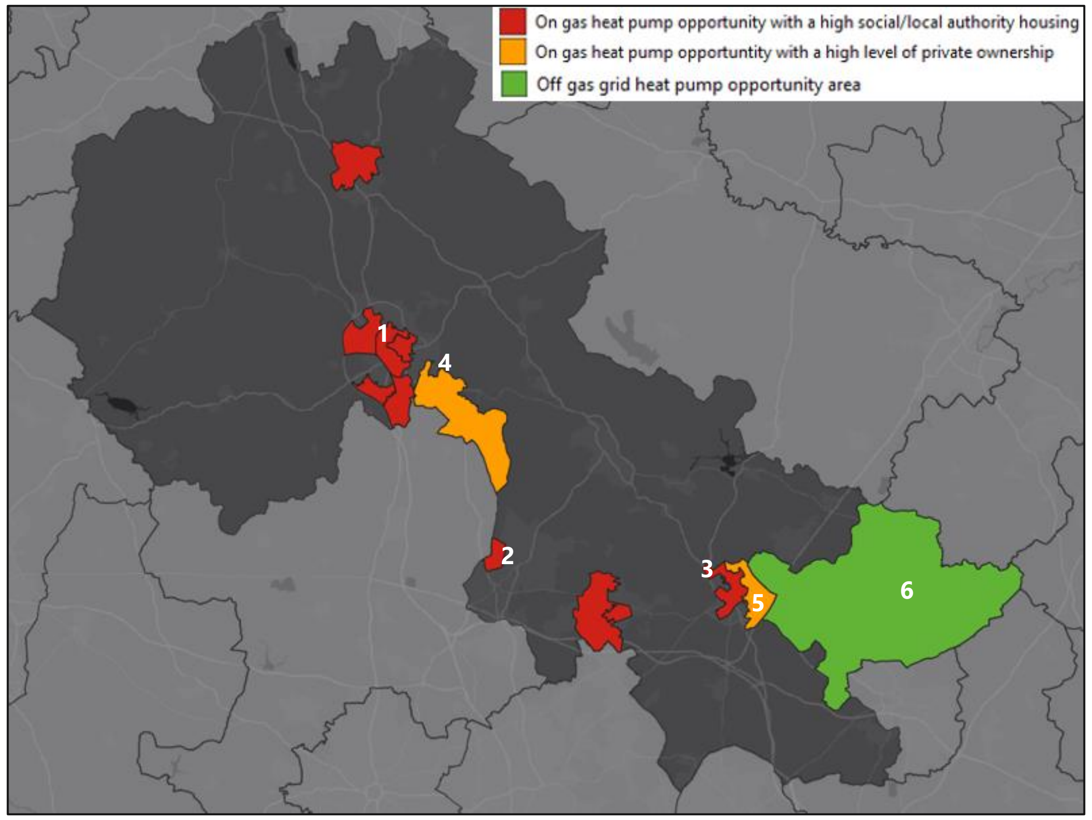


Figure 9—1 Domestic heat pump priority areas. Basemap from ESRI.

As well as technical suitability (i.e. high fabric efficiency, a wet system and capacity on the electricity network in the area) social/local authority tenure is a focus for deployment in the early stages of the LAEP due to easier policy implementation. Nine MSOAs are highlighted with a high density of properties already suitable for heat pumps with these tenure types. These are all in on gas grid areas, two priority areas are highlighted for heat pumps in on gas grid areas based purely on the high number of suitable properties. Only one-off gas grid MSOA is highlighted as a priority area for heat pumps, this is because most of the buildings which are off the gas grid and already suitable for heat pumps are in the northwest area of the LAEP – which has a high grid constraint.

Areas 1-6 highlighted in Figure 9—1 are examined in more detail on a 100 m grid in Figure 9—2, providing greater detail of specific target areas.

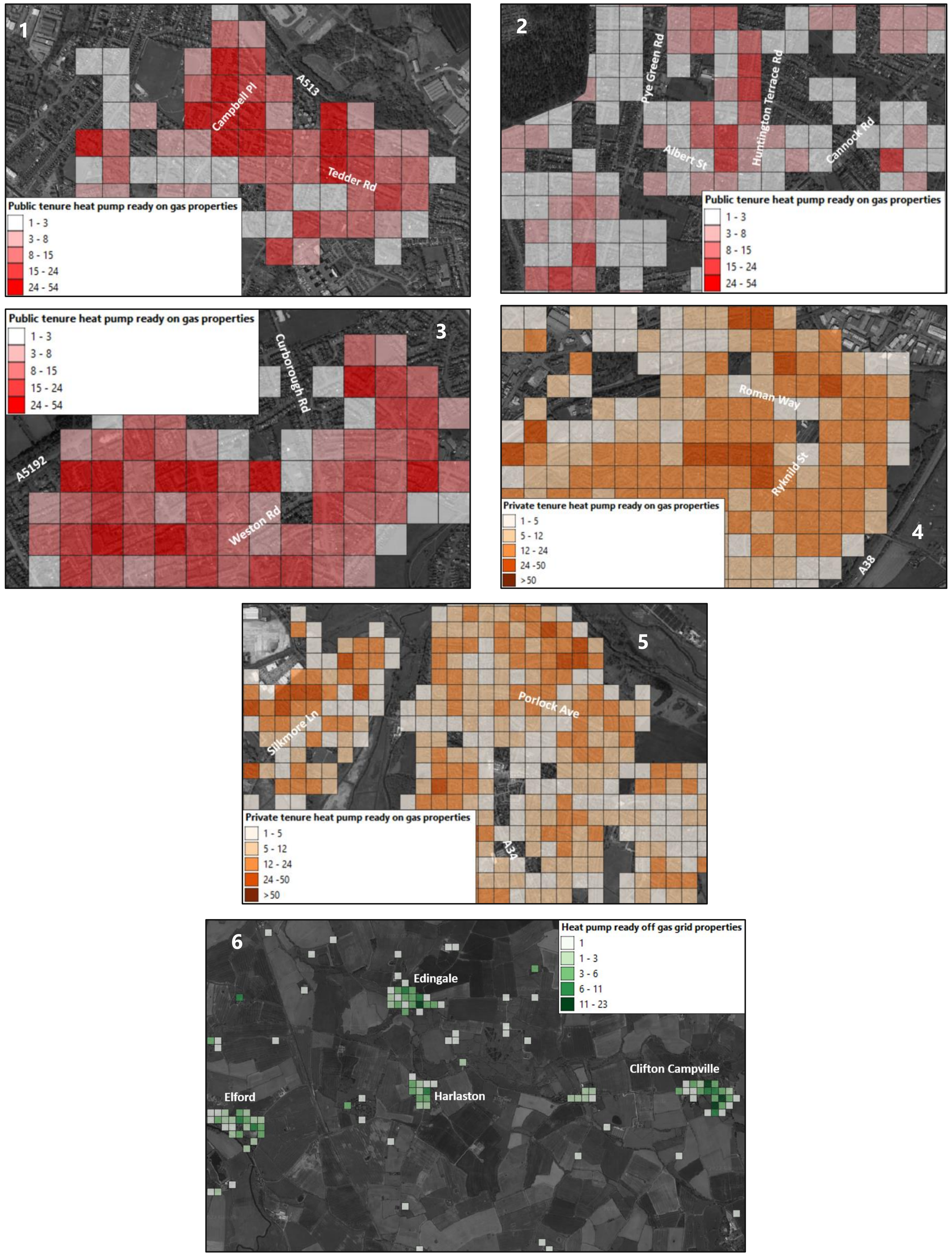


Figure 9—2 Counts of properties fulfilling different criteria for areas 1-6 identified in Figure 9-1. Basemaps from Google Satellite.

Related to the heat system transition is energy efficiency improvement, this is important in both the Consumer Led and Hydrogen Heavy scenarios. In the case of the latter improving energy efficiency is important as it allows decarbonisation to start before the switch in the gas system to hydrogen. Priority areas for domestic energy efficiency improvements are highlighted in Figure 9—3.

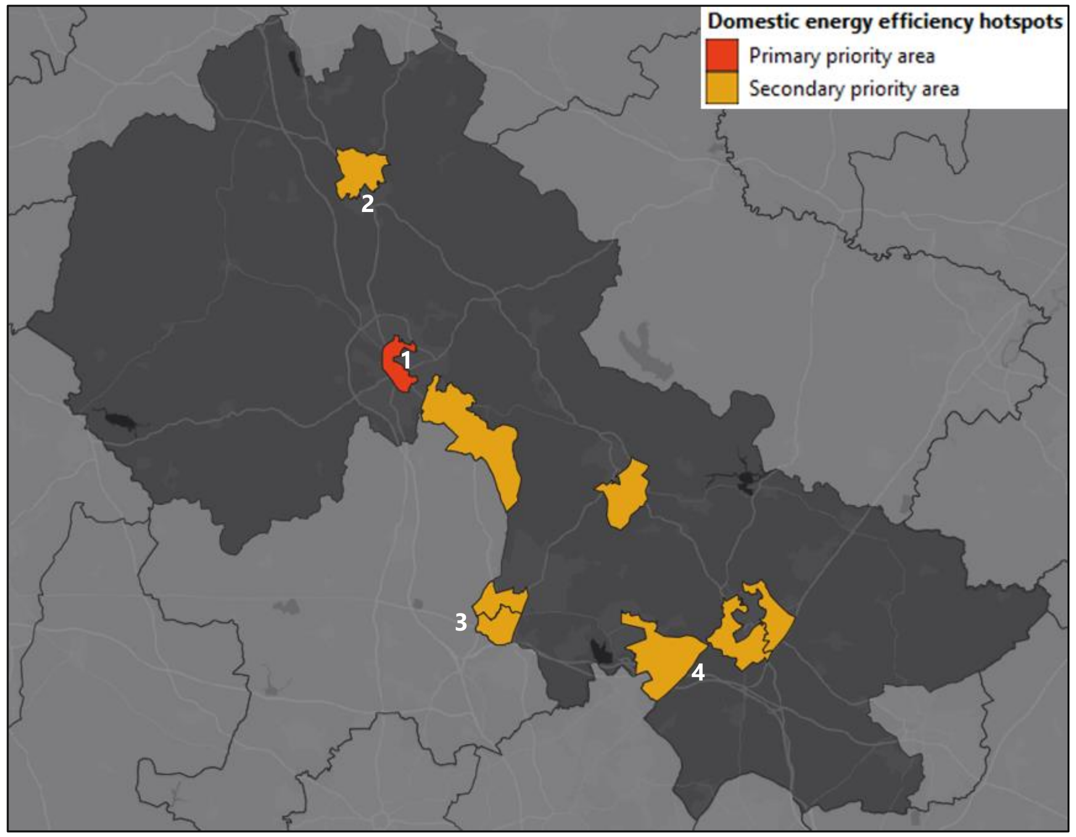


Figure 9—3 Domestic energy efficiency priority areas. Basemap from ESRI.

The priority area highlighted in red in the centre of Stafford is considered the most significant MSOA to target, this is due to it being highlighted as having the highest number of energy efficiency improvements required, having a high level of social/local authority owned housing and being one of the most fuel poor areas in the LAEP. It thus appears to have tenures which are easy to reach, a population vulnerable to rising fuel prices as well as the greatest density of required improvements. The properties in this tend to be older with the housing association and local authority housing having a large share of flats. This means by treating relatively few buildings a large number of homes could be improved. Whilst carrying out the fabric improvement in these buildings installing low carbon heating should be considered at the same time, as this is also a priority area for heat pump installation.

The other areas highlighted are the next highest in terms of energy efficiency measures required and the two MSOAs highlighted in Cannock are two more which have a higher level of fuel poverty. Alongside this report a PowerBI database is provided (for further details see Appendix E), this can be used to analyse the data further – potentially focusing on individual energy efficiency measures (such as cavity wall insulation) to help target energy efficiency programmes most effectively. A detailed 100 m meter gridded analysis for the four numbered areas in Figure 9—3 is provided in Figure 9—4.

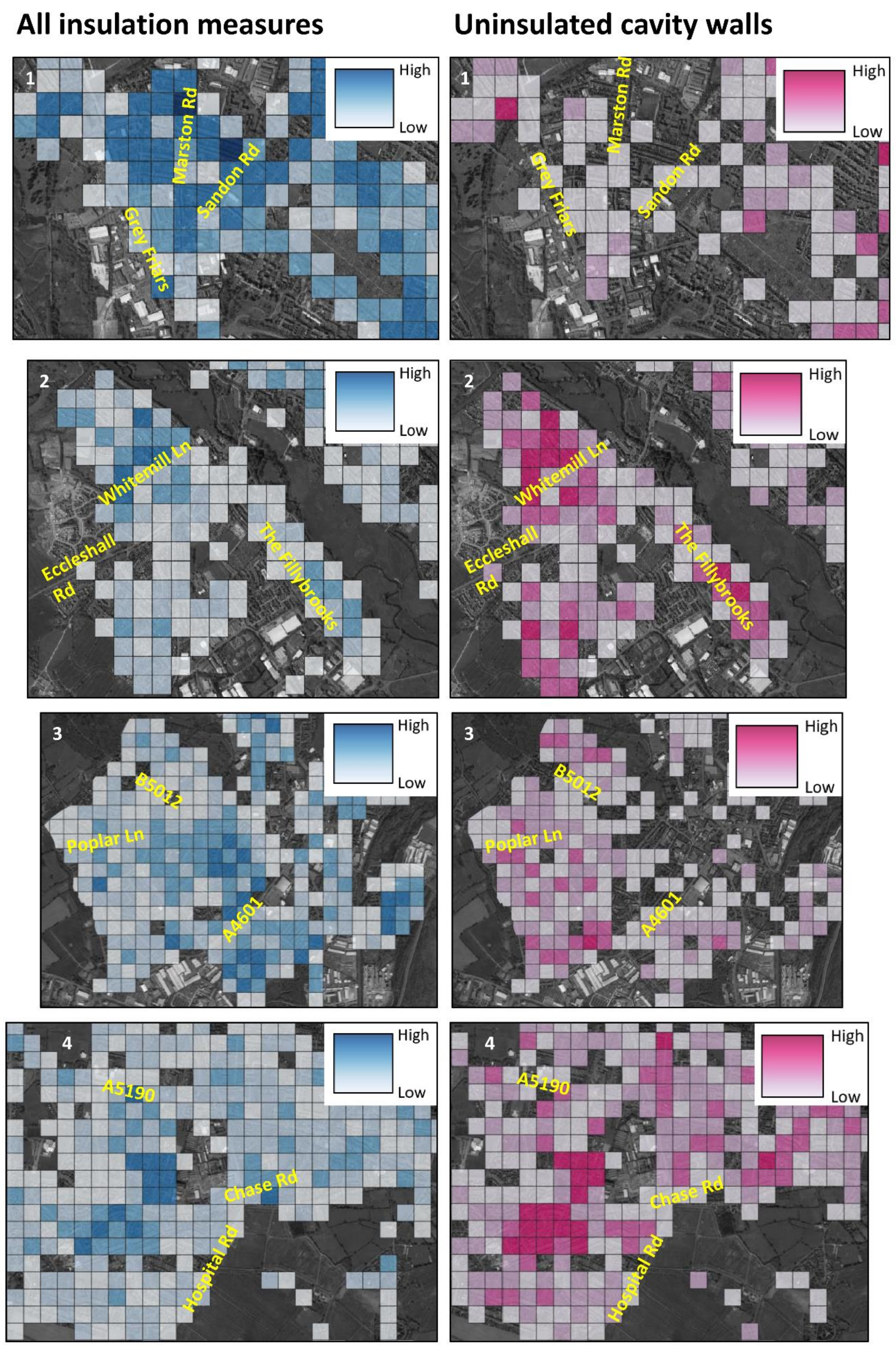


Figure 9—4 Gridded information for the number of insulation measures required in the four areas highlighted in Figure 10-3. Background imagery from Google Satellite.

Priority areas for non-domestic fabric energy efficiency are highlighted in Figure 9—5, these areas are also focus areas for low carbon heating system solution at an individual building level.

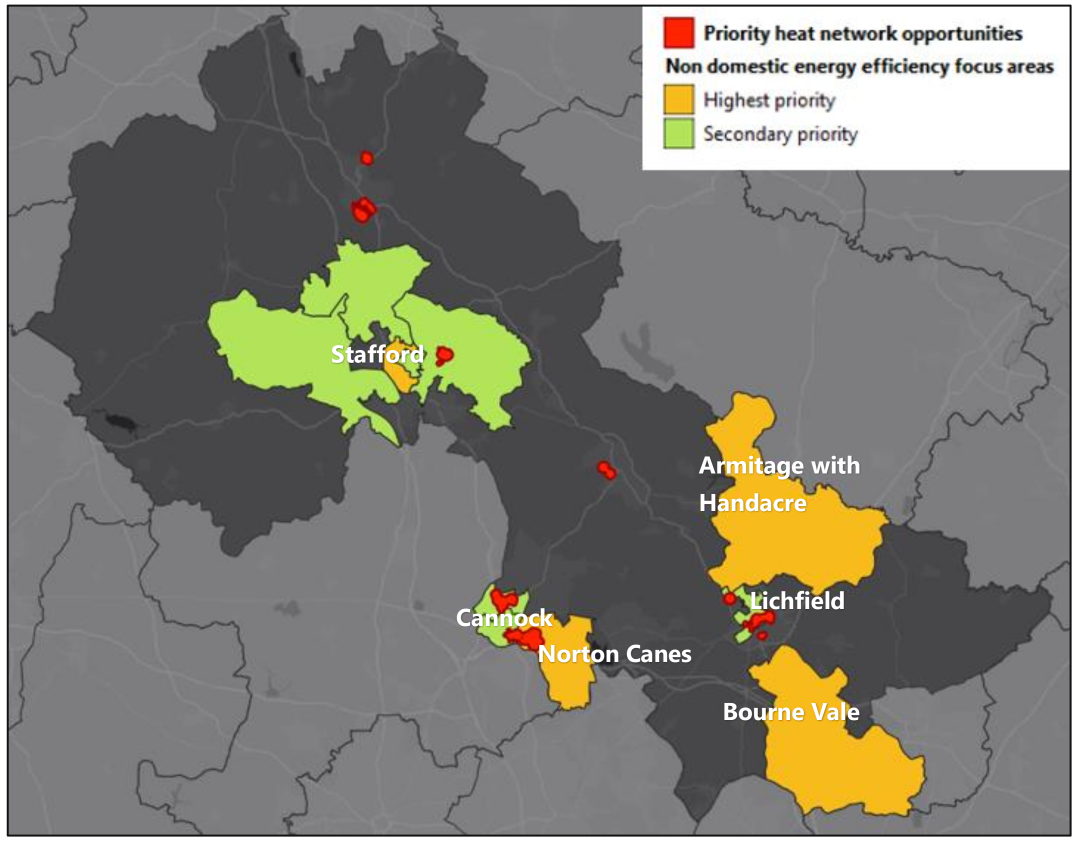


Figure 9—5 Non-domestic energy efficiency priority areas and primary heat network opportunities. Basemap from ESRI.

The hotspots identified are based primarily on heating demand and thus consider the non-domestic building stock as a whole. It is anticipated that public owned assets will be the first to improve energy efficiency and switch to low carbon heating solutions, particularly given the various local targets.

Figure 9—5 also highlights some of the best immediate opportunities for heat networks in the LAEP area (for more details see Section 5.3). These heat network opportunities represent a lows regrets heat decarbonisation option, being considered in both the Consumer Led and Hydrogen Heavy scenarios.

Like heat networks, transport solutions align well across all scenarios examined, even within the BaU scenario. Domestic charging infrastructure represent the highest infrastructure deployment for transport in terms of both quantity and cost. Hotspots for on and off-street parking are highlighted in Figure 9—6.

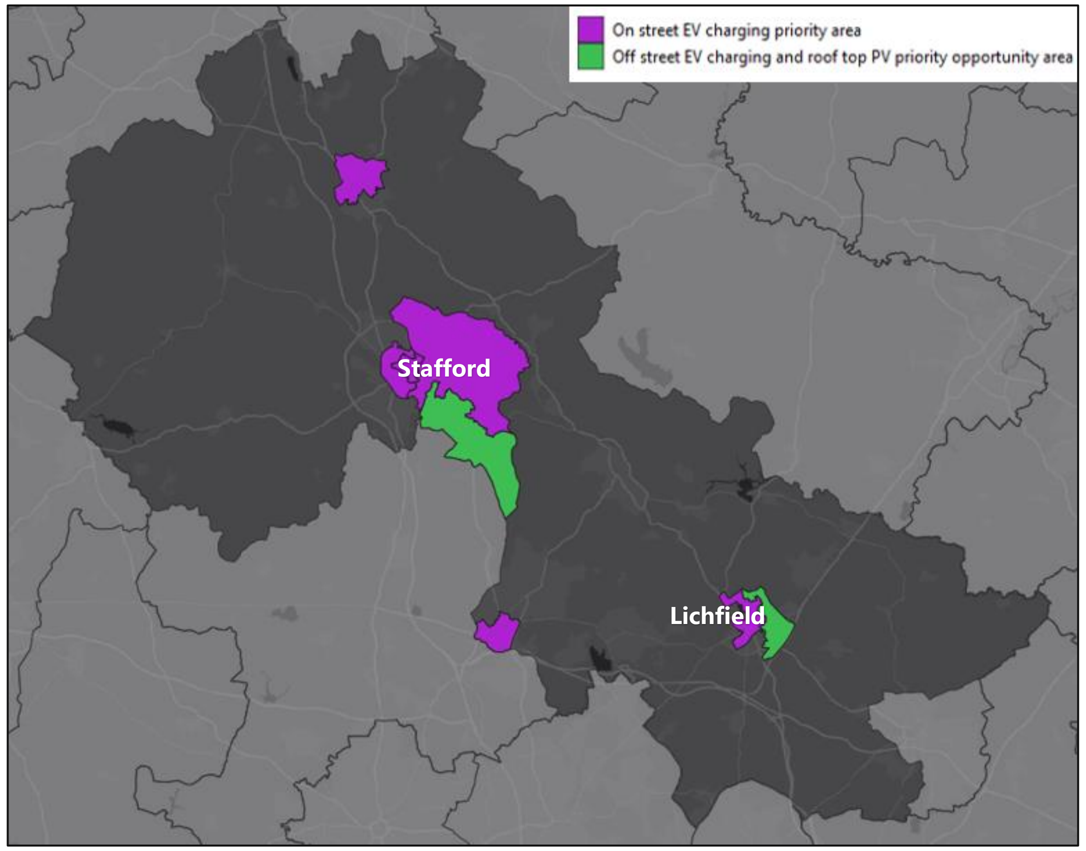


Figure 9—6 On and off-street charging priority areas. Basemap from ESRI.

Home based charging represents the vast majority of charge points, these are relatively well spread across the whole LAEP area with the majority dwellings having access to off street parking. The two areas with the highest numbers of off-street parking are also identified as those with the highest rooftop PV potential. Combining off-street home-based charging with domestic PV can increase the value of the electricity generated from the PV panels (as it displaces purchasing grid power), reducing the running costs of the electric vehicles. The greater use of electricity onsite could potentially reduce the need for electricity network reinforcement.

The majority of the LAEP has substantial off-street parking (so individuals can be more responsible for charging infrastructure) but it is the areas which rely on street parking, and thus on street charging infrastructure, that are more important to focus on. It is these areas highlighted in Figure 9—6 that are likely to require public sector intervention to ensure the necessary charging infrastructure is available.

Car parks are also modelled to become increasingly relied upon to provide charging capacity, five priority MSOAs for car park charging infrastructure are highlighted in Figure 9—7.

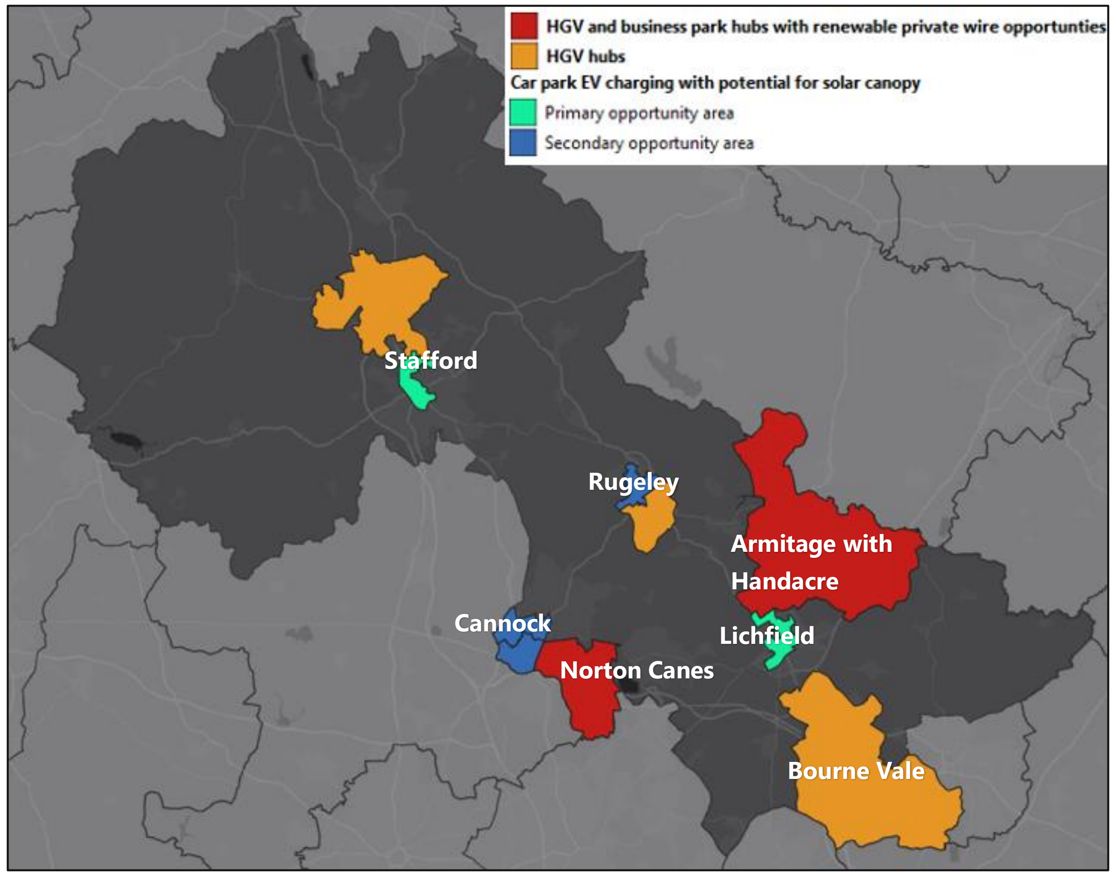


Figure 9—7 HGV hubs and solar car parks with EV chargers opportunity areas. Basemap from ESRI.

The primary and secondary opportunity areas highlighted for car park EV charging are also considered as opportunities to integrate PV canopies. These PV canopies can provide power to the charging infrastructure, realising a substantially higher value for the electricity than would be achieved through selling to the grid. In local authority owned car parks this can be a useful stream of revenue. This coupling of PV and EV chargers can be even more effective for car parks than home based charging due to the timing of car park use.

The HGV hubs highlighted in Figure 9—7 are also anticipated to benefit from onsite solar generation to provide a cheap source of electricity for electrolysis or battery charging. This can be sourced from PV panels on the extensive roof spaces of these HGV hubs, or alternatively ground mounted renewables. Two sites next to substantial ground mounted PV opportunities are highlighted in Figure 9—7, the scale of the renewable potential in these areas could provide power not just for vehicle charging but wider electricity demands on these sites.

9.2 Sub-scenario appraisal

The focus of the report has been on examining the three main scenarios; however, it is important to consider the viability of the Target Led and Area Alignment scenarios. They require the same level of deployment as the Consumer Led scenario but in a constrained timeframe. A summary of the technology deployment required in the Consumer Led scenario is provided in xxx, with the Hydrogen Heavy and BaU for context.

Table 9—1 Summary of low carbon technologies installed for the three core scenarios.

	Business as Usual	Hydrogen Heavy	Consumer Led
Domestic Heating system	45000 heat pumps (includes hybrid)	58000 heat pumps (includes hybrid) and 10900 hydrogen boilers.	140000 heat pumps
Domestic fabric efficiency	18000 fabric retrofit measures	132000 fabric retrofit measures	121000 fabric retrofit measures
Non-domestic Heating system	34 MW heat pumps and 55 MW hybrid heat pumps	78 MW heat pumps, 92 MW hybrid heat pumps and 19 MW hydrogen boilers	123 MW heat pumps, 13 MW hybrid heat pumps and 2 MW hydrogen boilers
Non-domestic fabric efficiency	Save 17 GWh/yr	Save 93 GWh/yr	Save 86 GWh/yr
Heat networks	Provide 24 GWh/yr	Provide 83 GWh/yr	Provide 92 GWh/yr
Transport	113000 home EV chargers, 2000 on street chargers, 114 MW work/destination charging, 57 MW car park charging, 170 HGV electric chargers, 40 MW of HGV electrolysis units and 20 electric bus chargers	113000 home EV chargers, 2000 on street chargers, 114 MW work/destination charging, 57 MW car park charging, 170 HGV electric chargers, 40 MW of HGV electrolysis units and 20 electric bus chargers	113000 home EV chargers, 2000 on street chargers, 114 MW work/destination charging, 57 MW car park charging, 170 HGV electric chargers, 40 MW of HGV electrolysis units and 20 electric bus chargers
Renewable generation	66 MW domestic rooftop PV, 12 MW non-domestic rooftop PV and 192 MW ground mounted PV	110 MW domestic rooftop PV, 20 MW non-domestic rooftop PV and 321 MW ground mounted PV	172 MW domestic rooftop PV, 31 MW non-domestic rooftop PV, 501 MW ground mounted PV and 25 MW of wind

In Cannock Chase the Target Led scenario does not seem tenable, with all the measures of the Consumer Led scenario needing to be in place by 2030. This includes 38,000 fabric energy efficiency improvements in the domestic sector, 48,000 low carbon heating systems to be installed (the majority being heat pumps but also some connection to heat networks and hydrogen if required), transition of nearly the entire vehicle fleet to low carbon solutions and the supporting infrastructure (which would include 33,000 home chargers), extensive renewable roll-out (including at least 50 MW of additional rooftop PV)[49]. This target would require retiring energy system elements before the end of life, for example, recent car purchases will last beyond 2030 and replacing early would cause increased emissions due to the embodied carbon. A similar argument is also seen for heating systems which would need the swapping out of what will still be efficient combi boilers.

If mass transition of the energy system were to start in 2023, until the end of 2030 over 16 heating systems a day would need to be switched over to zero carbon solutions in Cannock Chase and a similar number of fabric efficiency measures installed. This is all within a period when Stafford and Lichfield are also looking to decarbonise their own energy systems, putting more pressure on the supply chain. For context this is similar to the rate of deployment required across the LAEP area within the Consumer Led scenario, highlighting the scale of the challenge presented by focusing on a Target Led approach.

The Area Alignment scenario requires ~26 heating system changes a day and ~13 different fabric improvements a day, out until 2040 to reach the required rate of transition. Heat decarbonisation is the most challenging sector in terms of required deployment, particularly at the domestic level due to the number of actors and buildings. This is a highly ambitious deployment rate but more tenable than hitting all the Target Led targets as it would allow better targeting of resource and skills based on the technical and stakeholder characteristics of the LAEP area, rather than a more arbitrary location-based approach.

[49] The renewable deployment will need to exceed that presented in section 7 due to the relative grid carbon content. External power purchase arrangements could help achieve the additional required generation.

9.3 Next Steps

In the context of next steps it is useful to establish broader understanding of what an LAEP can do (and in what time frames) and what it needs further support for, this is outlined in Figure 9—8.

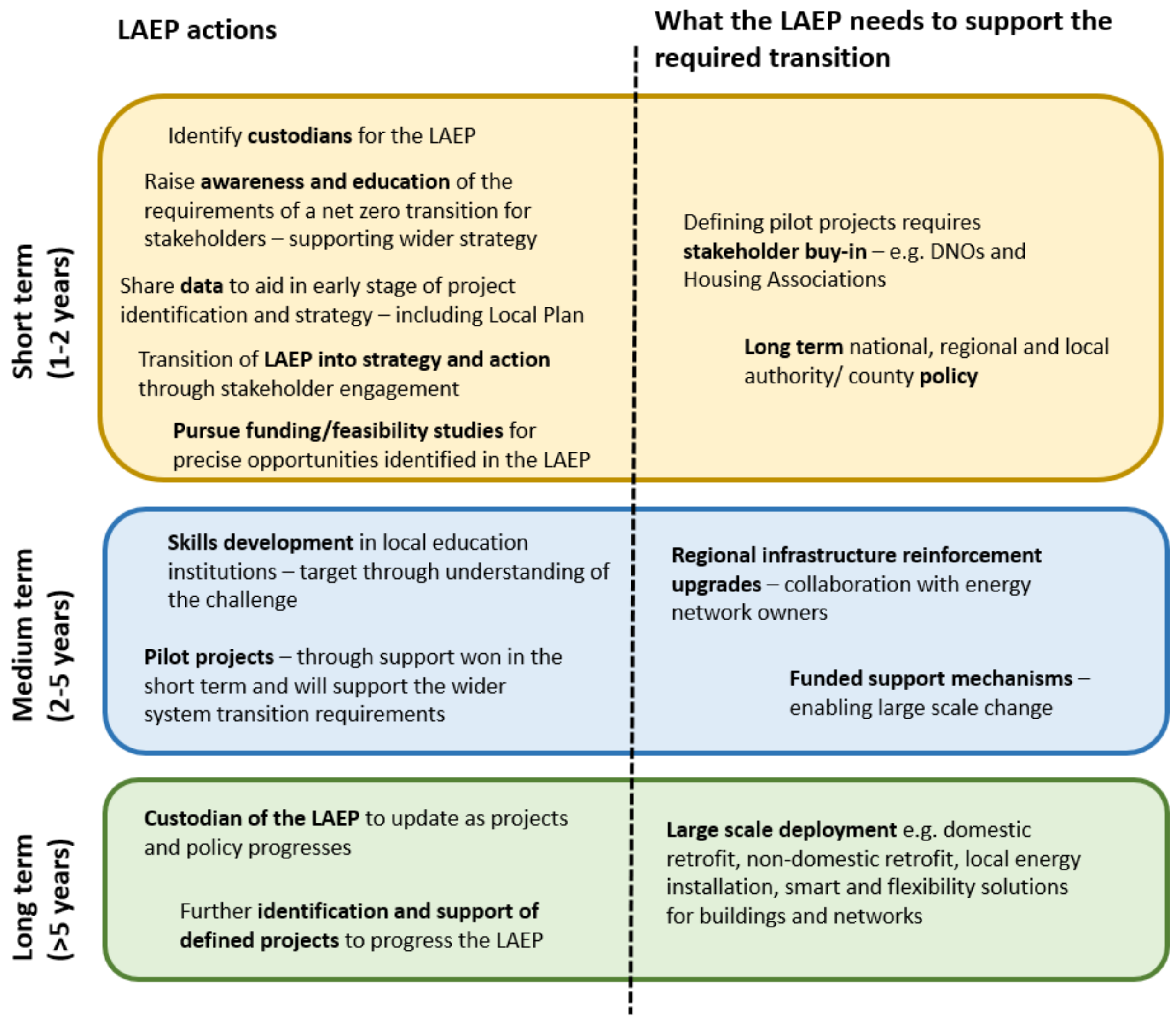


Figure 9—8 Making it happen, what the LAEP can help deliver and what requires wider action.

The LAEP details the scale of the challenge, the solutions needed for net zero and identifies some initial areas to focus on to be the first steps on the pathway to net zero. The LAEP shows the scale of the challenge is far beyond what can be achieved by individual local authorities or counties, with extensive national support and DNO engagement required to achieve the LAEP. However, there opportunities which the local authorities or Staffordshire County Council could take a lead in progressing, for example:

- public housing
- their own non-domestic buildings
- certain aspects of transport (such as street level EV charging, EV chargers in their own car parks and buses)
- utilisation of their own land assets
- pursuing funding to realise pilot projects highlighted throughout the LAEP and in 9.1

[50] https://solartogether.co.uk/info/interested-council

Feedback from the stakeholder engagement process highlighted a high level of will and engagement but issues surrounding funding and dedicated local authority resource for pursuing projects. This is a particular issue as a trigger point for successful LAEPs is building sufficient momentum which is likely to be contingent on accessing central funding to help achieve the opportunities identified in 9.1 is a vital first step. There are multiple grant and support schemes to consider – some key opportunities are highlighted in Appendix B.

These schemes can support a variety of actions from feasibility to deployment, helping to shift the LAEP from a strategy into realisation. However, there are many strategic elements which should also be considered. Key is engaging the DNOs, particularly WPD. If the LAEP strategy is agreed upon, even if it initially focuses on social housing and local authority owned stock this is still key. Having a short to medium term indication of the scale of appetite for heat pump deployment can help inform the DNO and also shape the deployment strategy more precisely, highlighting areas with capacity for deployment. Both the Heat Pump Ready Programme and Social Housing Decarbonisation Fund could be of significant assistance for delivering this strategy in the near term. These schemes, particularly the latter, could also assist with the early energy efficiency ambitions of the LAEP and given the nature of social housing the local authorities and county council will be well placed to help deliver schemes under the Social Housing Decarbonisation Fund.

High domestic PV potential is identified across all scenarios. To help reduce the costs of accessing this potential a bulk purchasing scheme, such as iChoosr/Solar Together[50], could be established by the local authorities.

There is also a substantial educational element to the LAEP strategy, understanding new technologies and engaging with consumer flexibility are core to the LAEP. Improving the understanding of individuals about their role in this decarbonisation and the benefits to them (beyond carbon saving) will be key to its success.

Heat networks are one of the areas with good funding support through the various stages of development. Consideration should be given of progressing the potential zones identified to the feasibility study stage, particularly for the nine zones highlighted in Figure 9—5.

The scale of change needed for the LAEP means the current supply chain is not well equipped to deliver the transition. Having an agreed programme for deployment in place (based initially on social housing and local authority owned buildings) will help increase confidence in the stream of work and can help build the supply chain. However, there is still a shortage in the specialist skills to deliver the scale of deployment required. Apprenticeship schemes could help create the skills required. Engaging with local universities, academies, schools and colleges is another way to try and grow the required skill set locally. Doing this rather than relying on labour from outside the area will help retain much of the expenditure required for the net zero energy transition within the local area.

Understanding public owned assets in the LAEP outputs will help identify focus areas, this can be land for renewables or car parks to deploy EV chargers and solar panels to buildings that can act as anchor loads for heat networks. There are already significant ambitions for use of council land for solar PV, this could allow the substantial targets in this LAEP for ground mounted PV to be met or even exceeded in the first half of the plan life cycle. This is when such developments will have the maximum impact on carbon targets, due to the relatively high carbon content of the grid.

Encourage new developments locally to already be zero carbon, this is emphasised through the LAEP modelling and also recognised as a key early action/policy by stakeholders to try and integrate into Local Plans. This could follow a similar model to that seen at the Rugeley Power Station site or is being considered at the Meece Brook development[51], with zero carbon heating solution and a high level of fabric efficiency. Even if a zero-carbon heating solution is not installed having highly efficient buildings that could easily and effectively integrate such solutions is a minimum.

In the stakeholder engagement sessions, it was highlighted that the LAEP should play a role in creating a readymade portfolio of projects. This will help support local authorities as funding calls tend to be short windows, which local authorities and county councils have limited resource to respond to. Having potential projects ready to go is a useful early

[51] Which aims to be carbon neutral.

application of the analysis carried out within the LAEP, which the associated GIS and PowerBI datasets provided alongside this report to help support.

Finally, and most importantly is getting agreement and buy-in to the LAEP strategy. Initially this will need to be at the local authority and county level. This will better determine how the strategy sits in ongoing strategies in the LAEP area. After this, wider stakeholder engagement such as the DNO's, government, the Energy Hub, large energy consumers, community energy groups and most importantly the inhabitants of the area as they represent the largest element of the energy sector. From this point policy to achieve the LAEP strategy can be established.

Appendix A Fuel Costs and Carbon Factors

A.1 Carbon factors

An emissions factor is a coefficient which allows one to convert data related to a certain activity into GHG emissions. They facilitate the comparison of different emissions by offer a common unit such as CO_2e. Emissions are calculated using the calculation methodology and conversion factors from the Department for Business, Energy and Industrial Strategy (BEIS).

Figure 9—9 shows the natural gas and electricity carbon factors to be used in this LAEP, which are based on the BEIS published values. Industrial factors align similarly with domestic factors, which have been applied for non-domestic building composed of commercial and industrial builds.

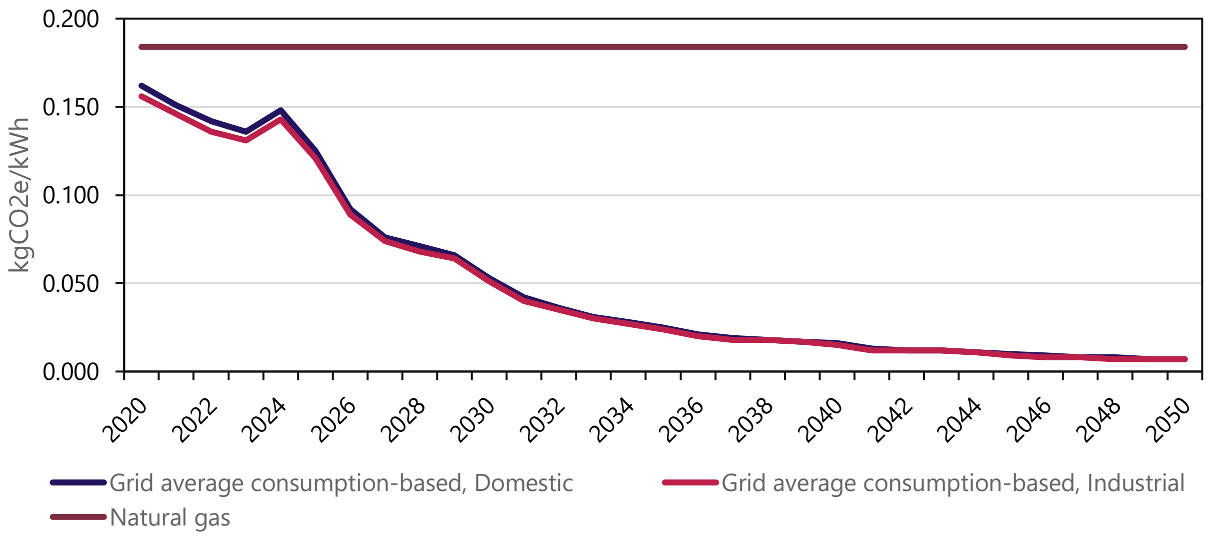


Figure 9—9 BEIS grid carbon factors projections to 2050

A.2 Offsetting carbon costs

Carbon price projections predict sharp rises in offsetting costs over time, as shown in Figure 9—10, incentivising the need to drive direct measures where possible and also act sooner to lock in long term offsetting costs. All scenarios agree that the increasing difficulty of carbon reduction will mean that carbon prices will increase gradually from now. For the purpose of this study, the central sensitivity carbon costs have been used. Which demonstrate a carbon cost rise from 241 to 378 (56% increase).

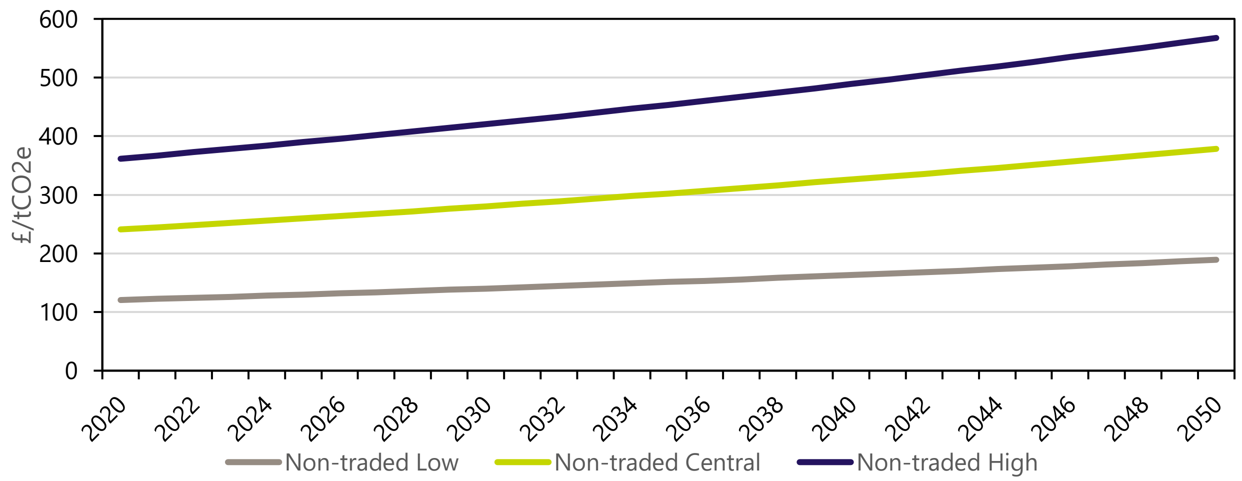


Figure 9—10 Carbon price projections (BEIS)

A.3 Energy costs

Energy costs are BASED on the BEIS forecasted Central Sensitivity scenario, these costs are presented in Figure 9—11 to Figure 9—13.

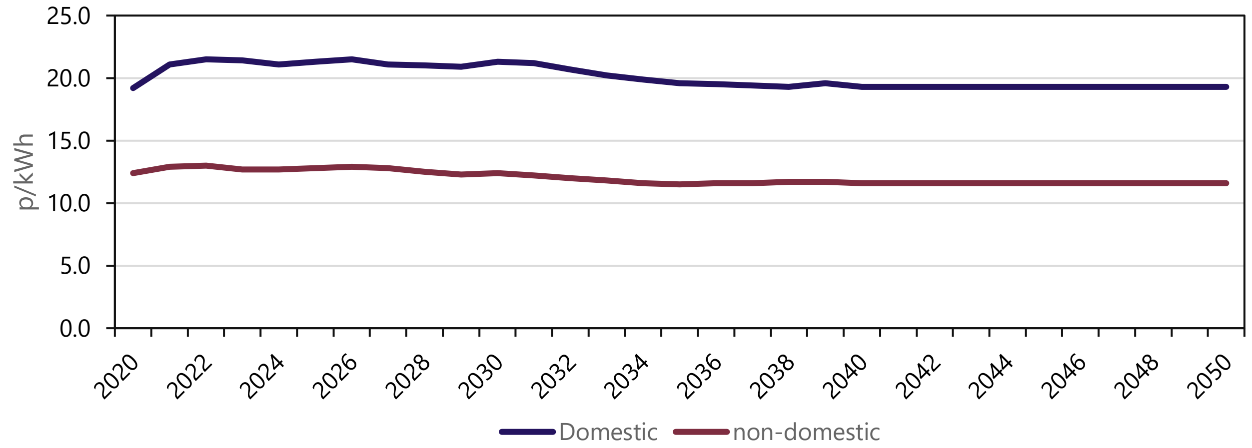


Figure 9—11 BEIS forecasted electricity retail prices (updated 2021 – central sensitivity)

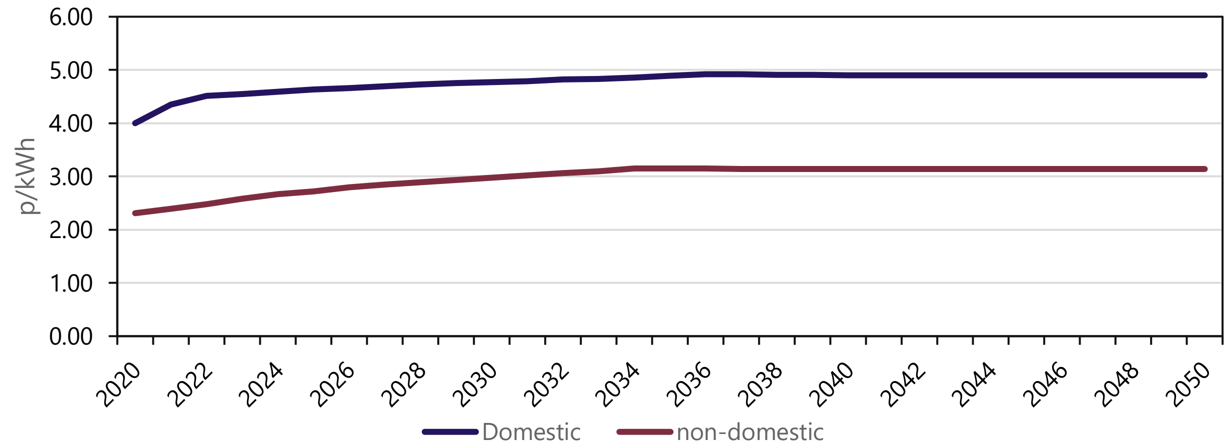


Figure 9—12 BEIS forecasted gas retail prices (updated 2021 – central sensitivity)

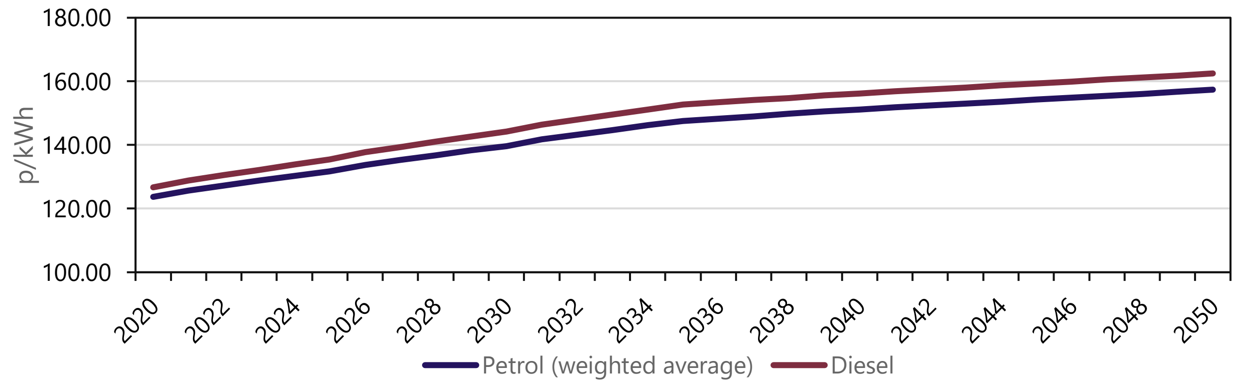


Figure 9—13 BEIS forecasted transport costs (updated 2021 – central sensitivity)

Appendix B Funding Streams

B.1 Green Heat Network Funding

The GHNF is a £270m government grant fund with the aim to support the development of low and zero carbon (LZC) heat networks. The fund will replace the Heat Networks Investment Project (HNIP) from April 2022 and will run for three years. A list of the main eligibility criteria and exclusions are listed below:

Inclusions

- ✓ New and existing heat networks that deliver low carbon heat – up to and including HIUs
- ✓ Project costs are attributed directly to delivering network operation as per the low carbon design intent
- ✓ At least one private commercial /multi-residential/public sector building is connected to the network
- ✓ Non-heat/cooling included for projects with wider energy infrastructure in their application

Exclusions

- X Any construction costs that have already been incurred prior to a GHNF award The Lead LA submits their own stock as part of a consortia bid
- X Costs associated with constructing heat/cooling sources whose primary function is not the generation of heat/cooling
- X Costs associated with connecting existing heat/cooling sources where there is a legal requirement for those sources to connect to a network
- X The cost of buying and installing tertiary heat distribution systems or plant that uses biogas or syngas (with some exceptions)
- X The cost of changes to existing building fabric such as glazing, ventilation and insulation upgrades
- X The cost of first of a kind technology (FOAK)

An indicative timeline for the GHNF and application rounds are shown below in Figure 9—14

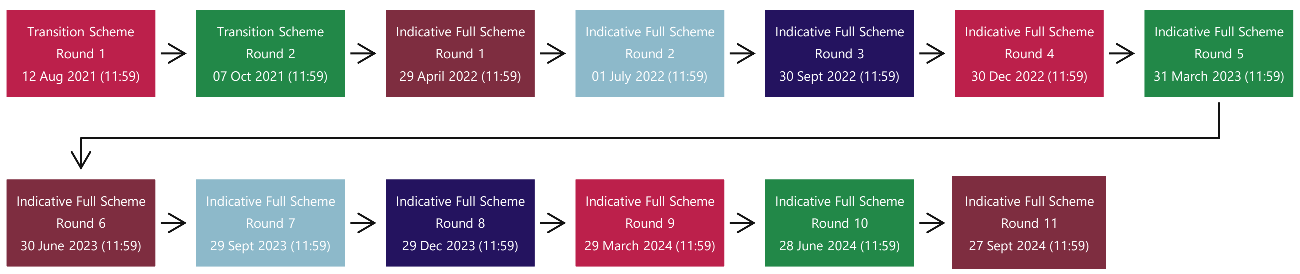


Figure 9—14 GHNF timeline

The eligible grant funding is based on the total heat delivered over the first 15 years of the scheme life. For each kWh of heat delivered, 4.5p is available through the GHNF up to 50% of the capital costs for the scheme.

B.2 Social Housing Decarbonisation Funding

The SHDF has been allocated to improve the energy performance of social rented home on the pathway to Net Zero 2050. Over a 10-year period, £3.8bn funding will be allocated in several waves. Wave 1 (£160m) follows the SHDF Demonstrator, which was an initial investment to test innovative approaches to retrofitting at scale.

Inclusions

- ✓ Within the competition scope and located within England
- ✓ Works must adopt a fabric first, lowest regrets approach
- ✓ Available to Registered Providers (RPs) of Social Housing, including Private and Local Authority (LA) providers. Private RPs, including Housing Associations, must apply within a consortium with a lead LA.
- ✓ Private domestic homes, such as those owned by leaseholders, and shared ownership homes may be eligible for funding under the Wave 1 Mixed Tenure policy. The Mixed Tenure policy offers support to the retrofit of social homes in the presence of other tenure types. Where over 70% of an application consists of Social Housing, RPs can apply for infill funding for leaseholder properties.
- ✓ Focus is on social housing (all property types) with an EPC rating of Band D, E, F or G
- ✓ Multiple funding sources can be used as long as they are not on the same measure
- ✓ Installation of energy efficiency and heating measures compatible with the Standard Assessment Procedure (SAP)
- ✓ Homes both on and off the gas grid

Exclusions

- X The grant requested includes recoverable VAT – this grant funding to the LA falls out of scope of VAT, because the provision of the grant is not a consideration of supply for VAT purposes.
- X The Lead LA submits their own stock as part of a consortia bid
- X Income related eligibility for social housing tenants
- X The installation of fossil fuel heating systems as energy efficiency and heating measures

An indicative timeline for the SHDF Wave 1 application process is shown below in Figure 9—15

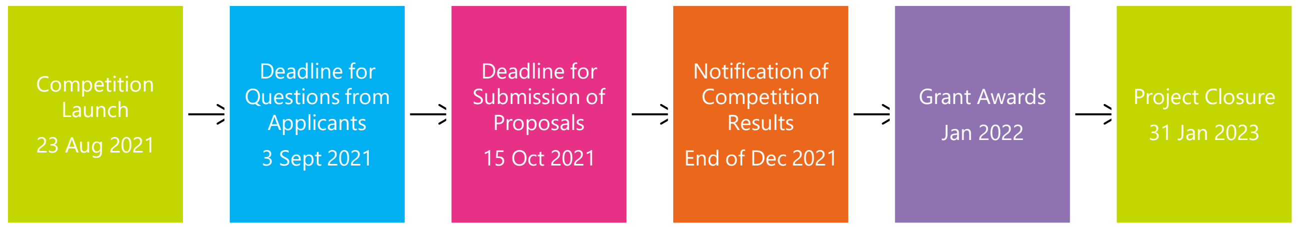


Figure 9—15 SHDF wave 1 application timeline

During the 2021 Spending Review, BEIS committed a further £800 million across 3 years for the SHDF (Wave 2). The SHDF Wave 2 competition will launch in the next financial year. To understand accessibility to funding from Wave 1 of the SHDF at any stage, the Social Housing Retrofit Accelerator (SHRA) has been established to provide technical support for all social housing landlords interested in applying.

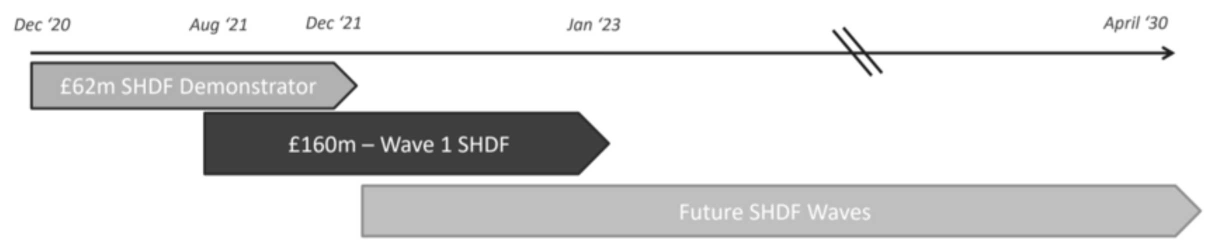


Figure 9—16 SHNF timeline

B.3 Heat Network Efficiency Scheme

The Heat Network Efficiency Scheme (HNES) Demonstrator is a £4.175 million grant scheme for the 2021 to 2022 financial year but expected to continue for future phases. It will support performance uplifts to existing heat network or communal heating projects where outcomes for customers and operators are sub-optimal. Projects can apply for either capital grant funding (£3.8m) or revenue grant funding (£0.375m).

Inclusions

- ✓ England and Wales applicants responsible for operating or managing existing district heat networks or communal heating systems, under either public, private or third sector operation
- ✓ Legal entities, with authority to sign-off investment decisions for their heat network
- ✓ Applicant projects made-up of different customer types, e.g. residential, commercial, mixed

Exclusions for Capital grant funding

- X Capital costs that have already been incurred prior to an HNES Demonstrator award having been made
- X Capital costs unrelated to heat network infrastructure
- X Any costs relating to engagement activities
- X Any costs relating to engagement activities
- X Any costs relating to engagement activities
- X Any costs relating to engagement activities

Exclusions for Revenue grant funding

- X Work already commissioned or incurred before this application
- X Internal applicant staffing or secondment staff or charged agencies within applicant organisations, including for project management of the external support / Optimisation Studies.
- X Construction, operation and maintenance of a heat network

Links. **Government guidance:**

https://www.gov.uk/government/publications/heat-network-efficiency-scheme-demonstrator

Guidance for applicants

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1018834/hnes-demonstrator-guidance.pdf

B.4 Electric vehicle grants

B.4.1 Electric charge point grant

Applicable to domestic properties, the government offers grants to support the wider use of electric and hybrid vehicles via the Office of Zero Emission Vehicles (OZEV). The EV ChargePoint grant provides funding of up to 75% towards the cost of installing electric vehicle smart chargepoints at domestic properties across the UK. It replaces the Electric Vehicle Homecharge Scheme (EVHS) from 1 April 2022.

B.4.2 Workplace Charging Scheme

The Workplace Charging Scheme (WCS) is a voucher-based scheme that provides support towards the up-front costs of the purchase and installation of electric vehicle charge-points, for eligible businesses, charities and public sector organisations. The scheme is run by the Office for Zero Emission Vehicles (OZEV) and administered by the Driver and Vehicle Licensing Agency (DVLA).

Similar to the electric charge point grant, the grant covers up to 75% of the total costs of the purchase and installation of EV chargepoints (inclusive of VAT), capped at a maximum of:

- £350 per socket
- 40 sockets across all sites per applicant – for instance, if you would like to install them in 40 sites, you will have 1 socket available per site

Once the chargepoint(s) have been installed, the authorised installer can claim the grant from OZEV on the applicant's behalf. The chargepoint installation must be completed and the voucher claimed within 6 months of the voucher's issue date. Claims against expired vouchers will not be paid

B.5 Heat Pump Ready Programme

The Heat Pump Ready programme supports the development and demonstration of heat pump technologies and tools, and solutions for optimised deployment of heat pumps. The programme is part of BEIS £1bn Net Zero Innovation Programme (NZIP), where the main aim is to accelerate the commercialisation of innovative clean energy technologies and processes.

The programme is split into three separate delivery streams shown in Figure 9—17:

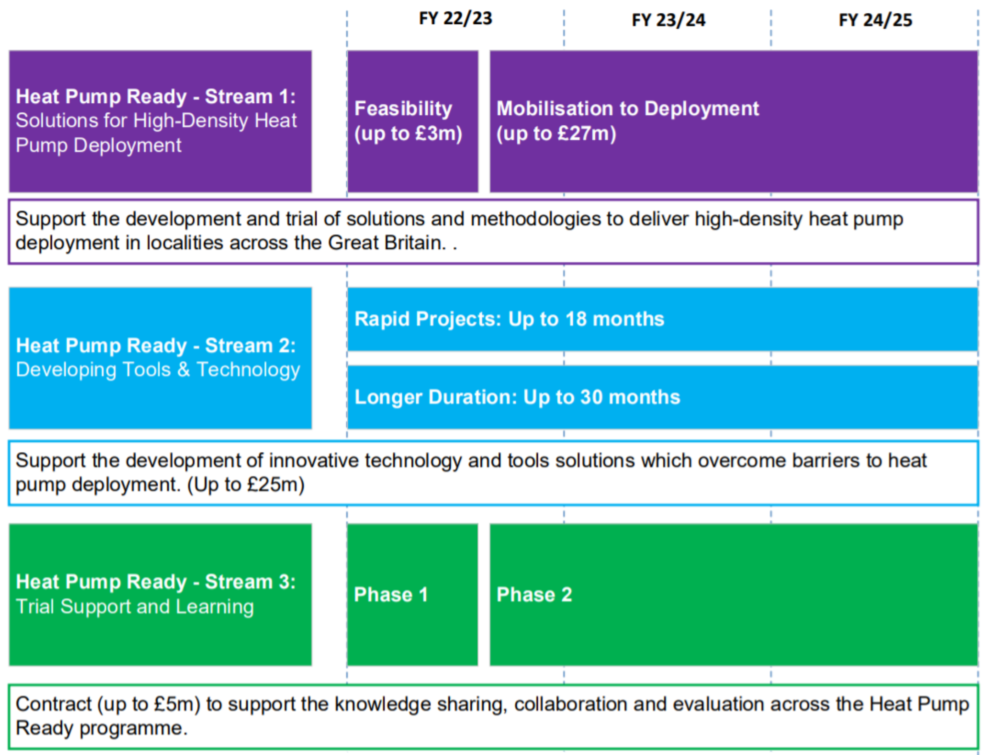


Figure 9—17 Heat pump ready programme overview

Stream 1 (solutions for high-density heat pump deployment) will support the development and trial of solutions and methodologies for the optimised deployment of high-density domestic heat pumps. To be delivered by phase 1 (£3m) and phase 2 (£27m).

Link for further information: www.gov.uk/government/publications/heat-pump-ready-programme

Inclusions

- ✓ An area within a single, named Local Administrative Unit (LAU) Level 1 area within Great Britain
- ✓ An urban or rural population, determined by the dwelling density in the area

- ✓ SBRI is aimed at organisations working on research, development and demonstration (RD&D) of an innovative process, material, device, product, or service prior to commercialisation. Funding is available for RD&D activities only, including related dissemination activity.
- ✓ Building type: social housing, new build (pre-occupancy), non-domestic, off-gas grid homes
- ✓ Heat pump/source types: Low temperature hydronic ASHP and GSHP, non low temperature heat pumps (with limit), shared ambient temperature ground loop
- ✓ Evidence can be provided that innovation would not be taken forwards (or would be taken forwards at a much slower rate) without public sector funding. Stream 1 projects are now able to claim a portion of heat pump capital and installation costs as an eligible cost.
- ✓ Stream 1 projects are now able to claim a portion of heat pump capital and installation costs as an eligible cost

Exclusions

- X Heat pump/source types: shared high temperature ground loop and heat networks
- X Any retrospective work on a Stream 1 project (i.e. work completed before the formal project start)
- X Innovative methodologies tested in the market or commercialised
- X Projects requesting funding for commercialisation activities (for example, advertising and marketing of their developed solution as a commercial product to other heat pump coordinating organisations)

Stream 2 (developing tools and technology) will support the development of tools, technology and processes to overcome specific barriers to domestic heat pump deployment. Stream 3 (trial support and learning) will provide support to ensure knowledge transfer and shared learning across the Heat Pump Ready Programme.

B.6 Innovation Funding

UK-based business or research organisations are able to compete for government-backed funding to test innovation ideas, of which applies to decarbonisation. A series of competitions are run to fund innovation programmes, some of which applies to decarbonisation projects.

B.6.1 Net Zero hydrogen funding

The aim of the Net Zero Hydrogen Fund (NZHF) is to provide capital expenditure (CAPEX) and development expenditure (DEVEX). This will support the commercial deployment of new low carbon hydrogen production projects during the 2020s. This innovation funding stream was set up to ensure the UK has a diverse and secure decarbonised energy system fit for meeting our ambition of up to 10GW low carbon hydrogen production by 2030, and commitment to reach net zero by 2050.

The NZHF will deliver up to £240 million via four strands as follows:

- **Strand 1**: Development Expenditure (DEVEX) support for front end engineering design (FEED) and post-FEED studies, to grow the future pipeline of hydrogen projects in the UK. (This strand)
- **Strand 2**: Capital expenditure (CAPEX) for projects that do not require a hydrogen specific business model. These are low carbon hydrogen projects that can deploy on the basis of capital expenditure support and are able to start construction rapidly.
- **Strand 3**: CAPEX for projects that require a hydrogen business model (HBM) and sit outside of the Phase 2 cluster sequencing process.
- **Strand 4**: CAPEX for carbon capture usage and storage (CCUS) enabled projects that require a hydrogen specific business model and are part of the Phase 2 cluster sequencing process.

To lead a project or work alone your organisation must be a UK registered business of any size. Academic institutions, research and technology organisations (RTOs), public sector organisations or charities cannot lead or work alone, but instead can collaborate with the lead.

Link for further information: apply-for-innovation-funding.service.gov.uk

B.7 Salix funding

Salix Finance is a non-departmental public body, owned wholly by Government and is funded by the Department for Business, Energy and Industrial Strategy, the Department for Education, the Welsh Government and the Scottish Government. Salix Finance Ltd. provides Government funding to the public sector including Staffordshire to allow public sector organisations to apply energy saving measures, without the need for up-front capital cost by providing interest free loans. Energy saving measures could include introducing low carbon and efficient heating systems or installing energy saving building systems such as lighting/heating controls, BMS or insulation upgrades to name a few. Salix Finance is currently delivering funding for Phases 1 and 2 of the Public Sector Decarbonisation Scheme (PSDS) and funding is now all allocated for these two schemes.

Who is eligible?

Any Public Sector Body who receives most of their income from the public sector can apply to the scheme, such as hospital, higher education schools or colleges etc. However, Salix can only fund projects where the resultant energy savings go directly back to the Public sector body of whom would gain a direct financial benefit.

The compliance criteria for the scheme is:

- The cost to save a tonne of CO_2e over the lifetime of the project must be no more than £191
- The loan must be repaid to Salix in 5 years following completion of the project in 10 equal half-yearly instalments
- Salix can part fund projects which do not fully meet these criteria

Link for further information: https://www.salixfinance.co.uk/

B.7.1 Network Innovation Allowance (NIA)

The NIA funding mechanism is part of the RIIO price controls introduced by Ofgem .The NIA is a set allowance each RIIO network licensee receives as part of their price control allowance. The aim of the allowance is to provide capital for smaller innovation (typically <£1m) projection as the UK moves towards a low carbon economy.

In the RIIO price control, NIA provides limited funding to RIIO network licensees to enable them to develop innovation projects that have the potential to deliver financial and environmental benefits for consumers. For projects to be eligible for NIA funding, the projects must comply with the requirements in the RIIO-2 NIA Governance Document.

Link for further information: Network Innovation Allowance (RIIO-2) | Ofgem

B.7.2 Strategic Innovation Fund (SIF)

As part of the IOO-ED2 price control, the Strategic Innovation Fund (SIF) was introduced by Ofgem as a funding mechanism for the Electricity System Operator, Electricity Transmission, Gas Transmission and Gas Distribution sectors. The SIF aims to find and fund ambitious, innovative projects with the potential to accelerate the transition to Net zero. These projects should help shape the future of the gas and electricity networks and succeed commercially where possible.

The fund is expected to invest £450 million in energy network innovation from 2021-2026, with the option to extend and increase as necessary. The SIF is delivered in partnership with Innovate UK, part of UK Research and Innovation (UKRI) with the objective for the SIF is to help transform UK energy systems networks.

Using Innovate UK's expertise and extensive business and academic networks, the SIF programme will tap into the best of UK and international innovation whilst also aligning with other public innovation funding, delivering measurable benefits to network users and consumers.

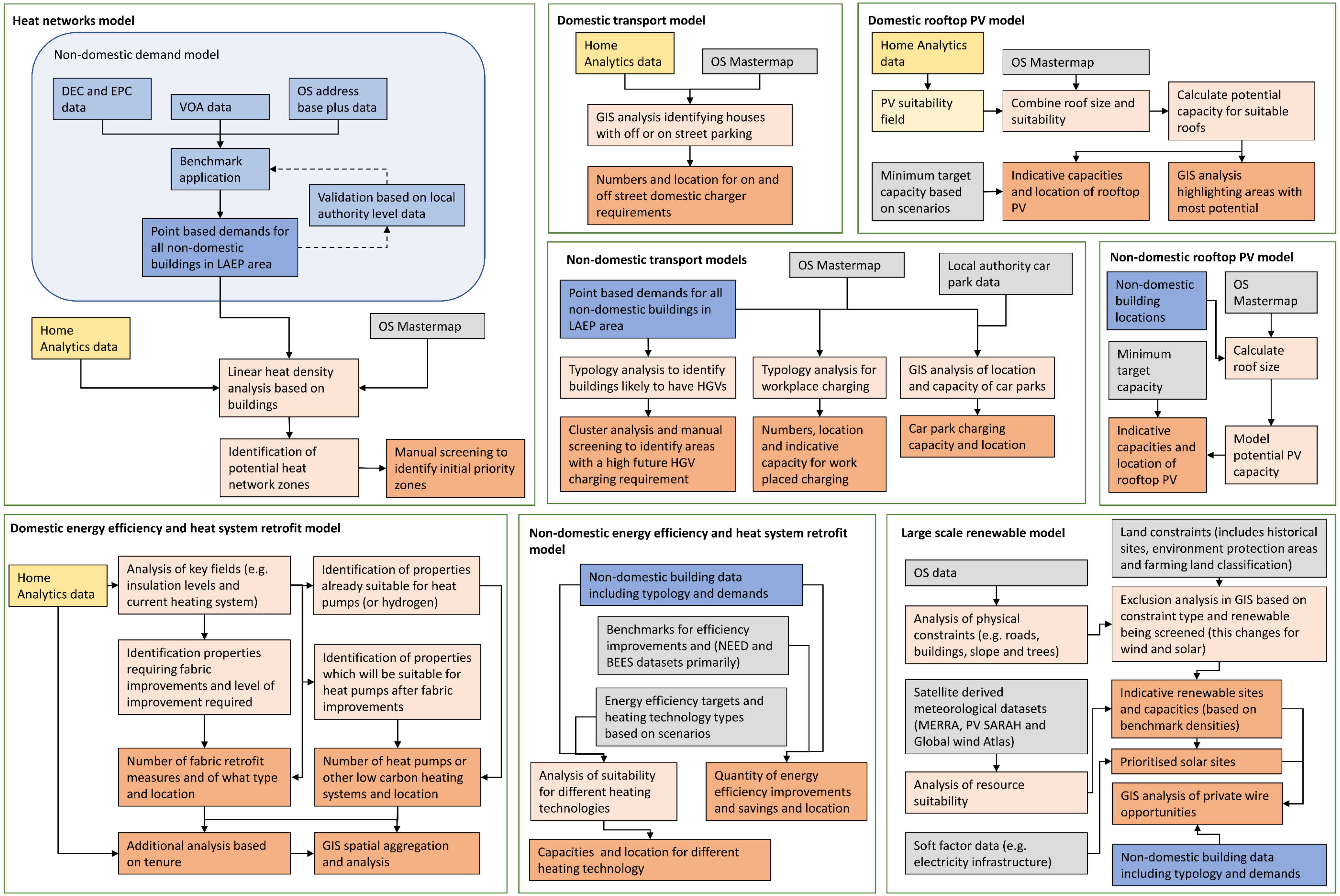
Funding opportunities have been identified to tackle four current challenges:

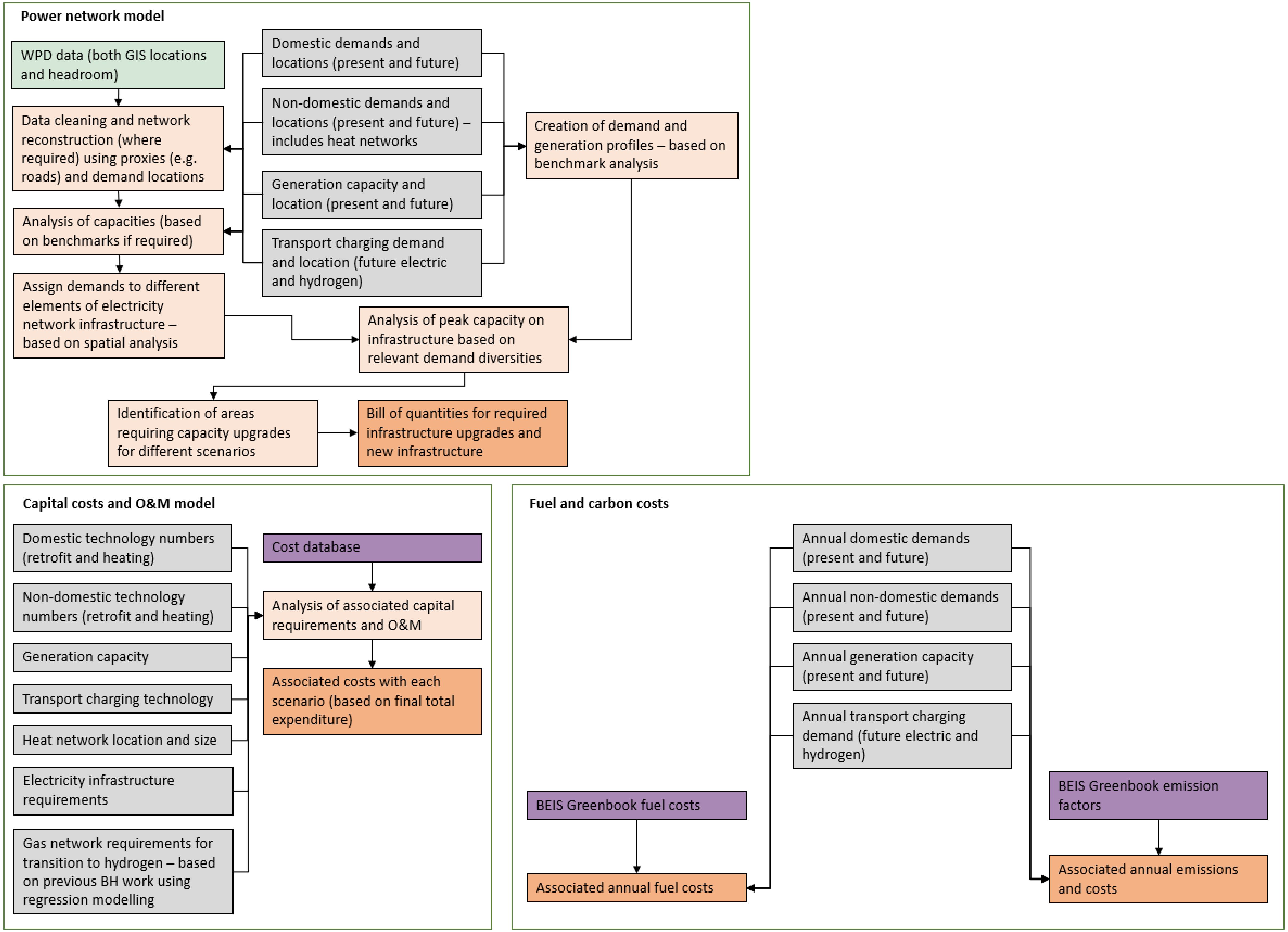
- Whole system integration
- Data and digitalisation
- Heat
- Zero emission transport.

In future this mechanism will launch more challenges regularly, when there are opportunities to address additional innovation needs.

Appendix C Modelling Approach

This appendix provides a summary of the modelling approach – with the core sector models provided on this page and the network and costs models which tie these different elements together provided overleaf.




Power network model
WPD data (both GIS locations and headroom)
Data cleaning and network reconstruction (where required) using proxies (e.g. roads) and demand locations
Analysis of capacities (based on benchmarks if required)
Assign demands to different elements of electricity network infrastructure – based on spatial analysis
Domestic demands and locations (present and future)
Non-domestic demands and locations (present and future) – includes heat networks
Generation capacity and location (present and future)
Transport charging demand and location (future electric and hydrogen)
Creation of demand and generation profiles – based on benchmark analysis
Analysis of peak capacity on infrastructure based on relevant demand diversities
Identification of areas requiring capacity upgrades for different scenarios
Bill of quantities for required infrastructure upgrades and new infrastructure
Capital costs and O&M model
Domestic technology numbers (retrofit and heating)
Non-domestic technology numbers (retrofit and heating)
Generation capacity
Transport charging technology
Heat network location and size
Electricity infrastructure requirements
Gas network requirements for transition to hydrogen – based on previous BH work using regression modelling
Cost database
Analysis of associated capital requirements and O&M
Associated costs with each scenario (based on final total expenditure)
Fuel and carbon costs
Annual domestic demands (present and future)
Annual non-domestic demands (present and future)
Annual generation capacity (present and future)
Annual transport charging demand (future electric and hydrogen)
BEIS Greenbook fuel costs
Associated annual fuel costs
BEIS Greenbook emission factors
Associated annual emissions and costs

Appendix D Input data and core modelling assumptions

A summary of the core input data is provided in Table 9—2.

Table 9—2 Core datasets used in the modelling

Dataset	Data owner	Link	Use
OS Mastermap	Ordnance Survey	https://www.ordnancesurvey.co.uk/business-government/products/mastermap-topography	Multiple, from building locations and boundaries to match to demand data, to constraint modelling for renewable sites and identification of off street parking locations.
OS Address Base Plus	Ordnance Survey	https://www.ordnancesurvey.co.uk/business-government/products/addressbase-plus	Matching UPRNs and addresses to precise locations. Also contains information used to inform non-domestic model and transport site identification.
Home Analytics	Energy Savings Trust	https://energysavingtrust.org.uk/service/home-analytics/	Cleaned base dataset used for the domestic modelling.
CIBSE TM46	CIBSE	https://www.cibse.org/knowledge-research/knowledge-portal/tm46-energy-benchmarks	Non-domestic demand benchmarking.
Building Energy Efficiency Survey	BEIS	https://www.gov.uk/government/publications/building-energy-efficiency-survey-bees	Non-domestic demand benchmarking.
Nondomestic EPCs	Department for Levelling Up, Housing & Communities	https://epc.opendatacommunities.org/	Base dataset for non-domestic buildings.
Display Energy Certificates	Department for Levelling Up, Housing & Communities	https://epc.opendatacommunities.org/	Base dataset for non-domestic buildings.
VOA data	UK Government	https://voaratinglists.blob.core.windows.net/html/rlidata.htm	Base dataset for non-domestic buildings.
PVGIS	European Commission	https://joint-research-centre.ec.europa.eu/pvgis-photovoltaic-geographical-information-system_en	Source of satellite derived weather data for renewable modelling and a cross check of solar yield calculations.
UK Renewable Planning data	BEIS	https://www.gov.uk/government/publications/renewable-energy-planning-database-monthly-extract	Existing and planned renewable developments in the area.
Magic Map	DEFRA	https://magic.defra.gov.uk/magicmap.aspx	Source of various environmental constraints particularly in renewable modelling.
CORINE DSM	Copernicus Services	https://land.copernicus.eu/imagery-in-situ/eu-dem/eu-dem-v1.1	Background elevation for solar yield analysis.
Provision Agricultural Land Classification	Natural England	https://www.data.gov.uk/dataset/952421ec-da63-4569-817d-4d6399df40a1/provisional-agricultural-land-classification-alc	Constraints mapping for renewable sites.
Indicative Flood Risk Areas	Environment Agency	https://www.data.gov.uk/dataset/7792054a-068d-471b-8969-f53a22b0c9b2/indicative-flood-risk-areas-shapefiles	Constraints mapping for renewable opportunities.
Landfill sites	Environment Agency	https://www.data.gov.uk/dataset/17edf94f-6de3-4034-b66b-004ebd0dd010/historic-landfill-sites	Renewable opportunity identification.
Emissions dataset	Nation Atmospheric Emissions Inventory	https://naei.beis.gov.uk/data/map-uk-das	Identification of large non-domestic energy users and base emissions – which are used to infer energy demands to validate modelling.
Gas infrastructure at MSOA/LA level	Buro Happold	Internal dataset created by Buro Happold using a peer reviewed model, generating gas infrastructure for each MSOA or LA (depending on infrastructure type) based on regression modelling.	Cost analysis of hydrogen transition.
Electricity Infrastructure	WPD	https://dataportal2.westernpower.co.uk/Auth/Register	Geographic dataset for electricity infrastructure used across many modelling streams.
Electricity network capacity map	WPD	https://www.westernpower.co.uk/our-network/network-capacity-map/	Used to apportion current headroom.
Cost database	Buro Happold	Internal cost database generated through project experience key being creation of the Infrastructure Cost Calculator for the Energy Technologies Institute - https://ukerc.rl.ac.uk/cgi-bin/eti_query.pl?GoButton=DisplayLanding&etiID=505&GoButton=Year&YWant=2016	Costing scenario transitions.
Fuel Poverty	BEIS	https://www.gov.uk/government/collections/fuel-poverty-sub-regional-statistics	Informing fuel poverty for background mapping and focus areas for modelling.
Global Wind Atlas	DTU	https://globalwindatlas.info/	Wind resource modelling.
Local authority level gas consumption	BEIS	https://www.gov.uk/government/statistical-data-sets/gas-sales-and-numbers-of-customers-by-region-and-local-authority	Demand modelling validation.
Local authority level electricity consumption	BEIS	https://www.gov.uk/government/statistical-data-sets/regional-and-local-authority-electricity-consumption-statistics	Demand modelling validation.
Future Energy Scenarios	National Grid	https://www.nationalgrideso.com/future-energy/future-energy-scenarios/fes-2021	Used to inform base modelling assumptions and targets for different scenarios.
Indices of Multiple Deprivation	Ministry of Housing Communities and Local Government	https://www.gov.uk/government/statistics/english-indices-of-deprivation-2019	Index of Multiple Deprivation for background mapping and focus areas for modelling.
LSOA boundaries	Office for National Statistics	https://www.data.gov.uk/dataset/fa883558-22fb-4a1a-8529-cffdee47d500/lower-layer-super-output-area-lsoa-boundaries	Data aggregation and mapping.
MSOA boundaries	Office for National Statistics	https://www.data.gov.uk/dataset/2cf1f346-2f74-4c06-bd4b-30d7e4df5ae7/middle-layer-super-output-area-msoa-boundaries	Data aggregation and mapping.
Ward boundaries	Office for National Statistics	https://geoportal.statistics.gov.uk/search?collection=Dataset&sort=name&tags=all(BDY_WD)	Data aggregation and mapping.
Local authority level energy demand from road	BEIS	https://www.gov.uk/government/statistics/road-transport-energy-consumption-at-regional-and-local-authority-level-2005-2019	Transport modelling.
Local authority vehicle ownership	BEIS	https://www.gov.uk/government/statistical-data-sets/all-vehicles-veh01	Transport modelling.

Dataset	Data owner	Link	Use
Energy consumption in the UK 2020	BEIS	https://www.gov.uk/government/statistics/energy-consumption-in-the-uk-2020	FES translation to the local area and modelling validation.
Digest of United Kingdom Energy Statistics	BEIS	https://www.gov.uk/government/statistics/digest-of-uk-energy-statistics-dukes-2021	FES translation to the local area and modelling validation.

The datasets compiled in Table 9—2 are not exhaustive but form the core of the analysis with various local datasets also added. These tend to require manual entry, one example being local authority owned car parks which were compiled by geolocating based on lists of car parks for each local authority (base dataset for car parks in GIS formats is surprisingly poor across the UK).

Many of the modelling assumptions are based on the table above and in Appendix A. However, diversity factors are a key component of the modelling approach these are based on standard assumptions developed in previous studies. The diversity factor refers to how likely peak demands are likely to occur simultaneously. The more demands considered, generally the less likely peaks are likely to coincide.

For electric vehicle charging the diversity factors used in Figure 9—18 forms the basis of diversity factors used.

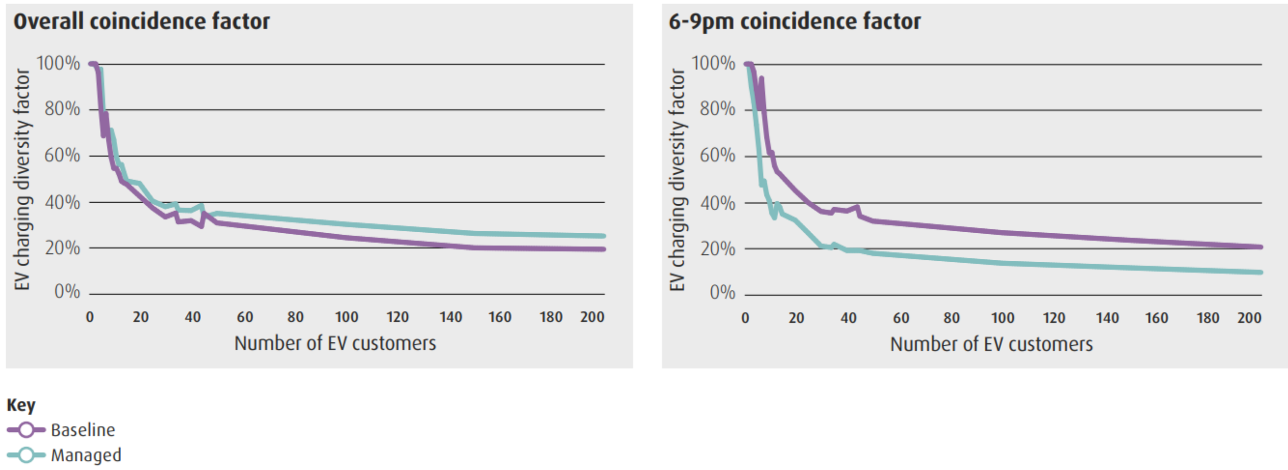


Figure 9—18 Electric vehicle diversity factors[52]

The Consumer Led, Area Aligned and Target Led scenarios use the managed diversity whilst the Hydrogen Heavy and Baseline.

For existing electricity demand the starting point is the same for all scenarios, these diversity factors are based on Figure 9—19 and Figure 9—20 for domestic and non-domestic demands, respectively.

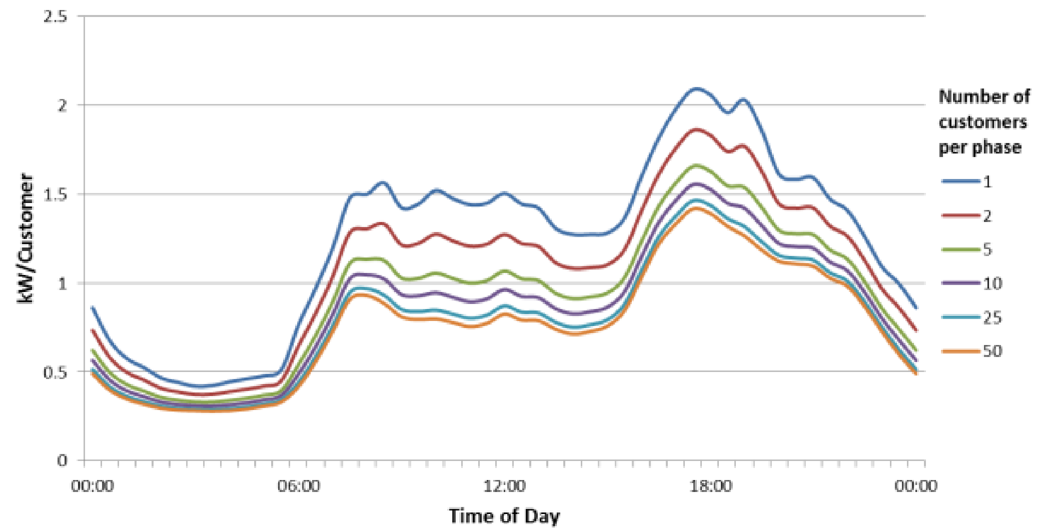


Figure 9—19 Impact of diversity on domestic demand[53]

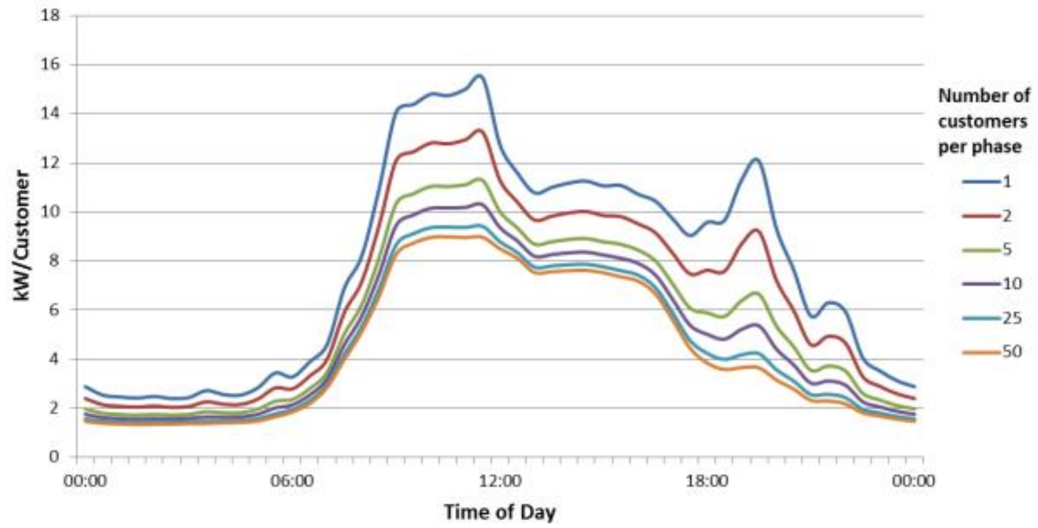


Figure 9—20 Impact of diversity on non-domestic demand[54]

The difference of timing between domestic and non-domestic demands is also considered in the modelling.

For heat decarbonisation DNOs generally assume no diversity, due to cold start of systems after a power cut. However, lagging of systems when restarting after a cold period could help avoid this issue. Consequently, diversity is assumed in the higher demand management scenarios (Consumer Led, Area Aligned and Target Led) – these are explored in Figure 9—21.

[52] https://innovation.ukpowernetworks.co.uk/wp-content/uploads/2022/06/UKPN_Project-Shift_2022_Web-PDF-v2.pdf
[53] https://www.westernpower.co.uk/downloads/18622
[54] https://www.westernpower.co.uk/downloads/18622

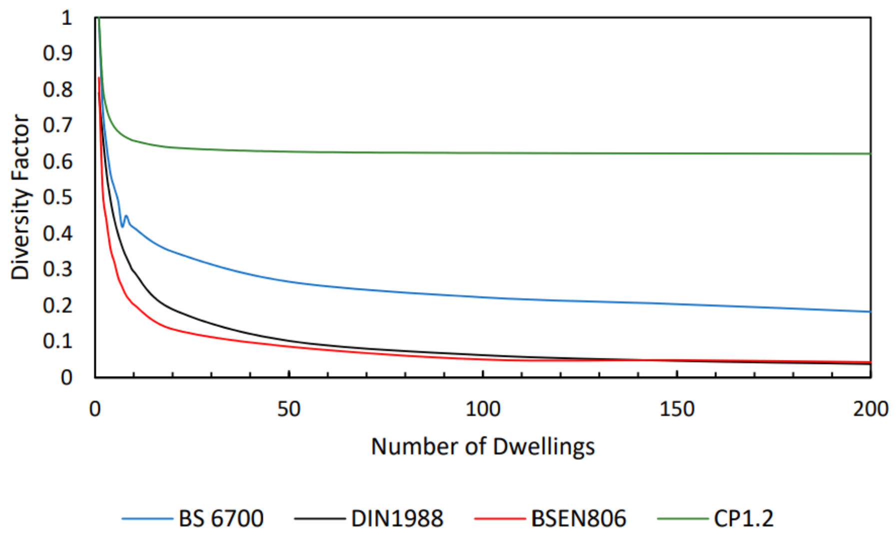


Figure 9—21 Demand diversities used for electric heating systems[55]

The diversity considered in the modelling for relevant scenarios most strongly aligns to CP1.2 (CIBSE guidance relating to space heat demand – which is the majority of heat demand for most buildings). The other three lines in Figure 9—21 relate to water demand. The hot water diversity factor used in the analysis is from DS439 (a Danish standard which is commonly used in UK heat network modelling), this closely aligns to DIN1988 in Figure 9—21.

Demand profiles are based on a combination of Elexon data (this is presented in Figure 9—19 and Figure 9—20), information gathered from previous Buro Happold projects and industry standards, such as CIBSE. These were adapted to the local climate for Staffordshire using CIBSE standard guidance.

[55] https://www.mdpi.com/1996-1073/13/22/5893

Appendix E Power BI Analysis

A power BI workspace has been developed to provide easy to use data visualisation for domestic properties at the following geographical area levels:

1. Local authority
2. MSOA
3. Ward

The data visualisation provides quick insights into the domestic property analysis results derived from Home Analytics. Each Power BI report is set out to provide insight into the following building data sets:

- Property tenure type
- Building thermal envelope status including insulation and glazing type,
- Building typology
- Existing Heating systems

The categorisation results are also displayed in a summary table showing the number of properties in the area requiring certain decarbonisation measures. In addition to this the data visualisation has been set up to provide insight for both off-gas and on gas grid properties.

An example tutorial is set out on the following page showing how the power BI report can be navigated to derive insights.

A link to the Power BI report can be accessed here: https://app.powerbi.com/groups/me/reports/ba34b0ca-75ed-4109-98bd-358b2ecde7fd?ctid=50ee6418-869e-48f5-a982-3607fcee1e1d&pbi_source=linkShare

To access the Power BI report a licence will be required, a free licence should enable access. A copy of the Power BI workbook can also be provided on request

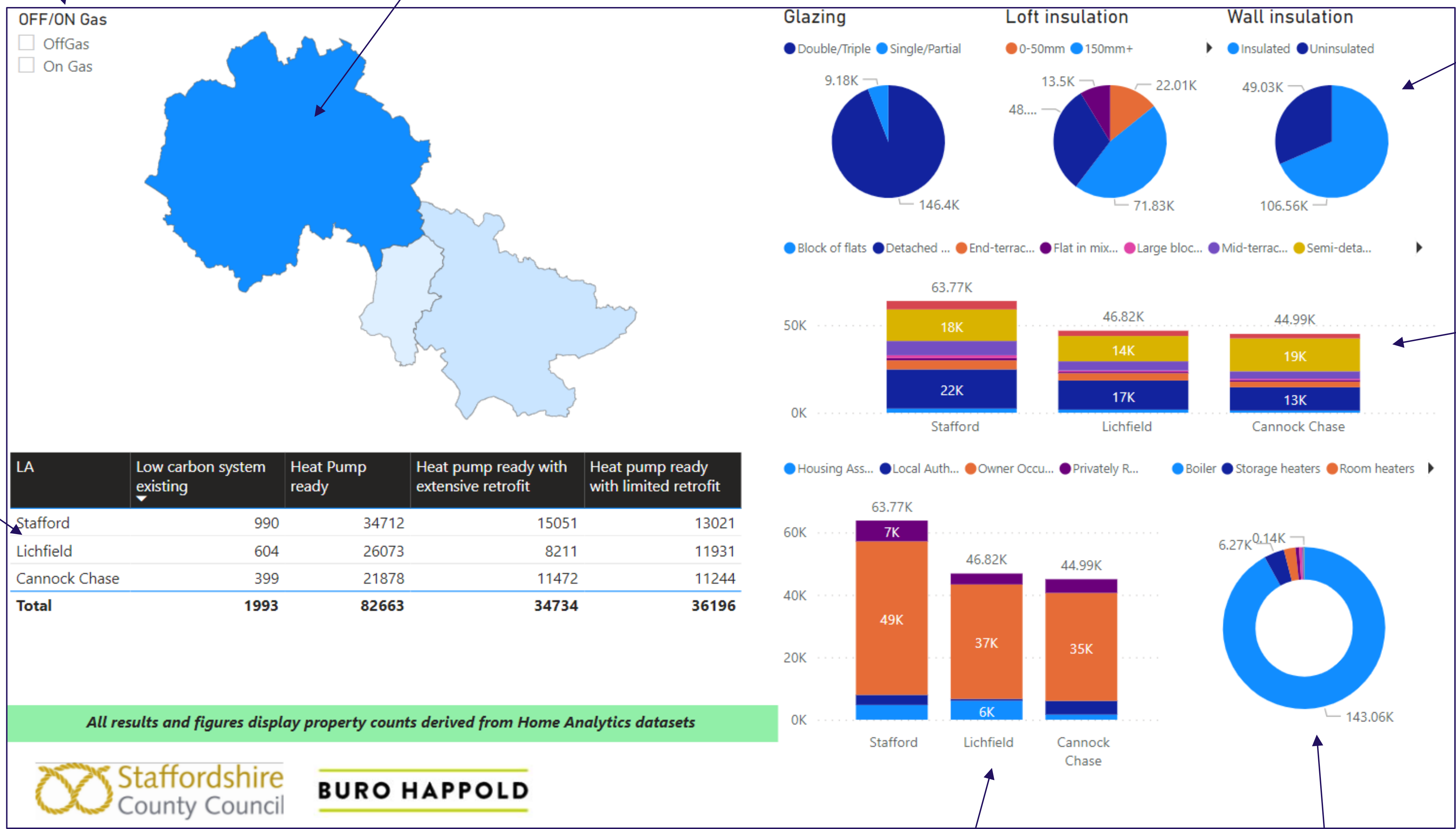
On gas/off gas filter selection

Area filter selection

Property building envelope status linked to area selection

Property type linked to area selection

Property categorisation LAEP results



LA	Low carbon system existing	Heat Pump ready	Heat pump ready with extensive retrofit	Heat pump ready with limited retrofit
Stafford	990	34712	15051	13021
Lichfield	604	26073	8211	11931
Cannock Chase	399	21878	11472	11244
Total	**1993**	**82663**	**34734**	**36196**

Property tenure type linked to area selection

Existing heating system linked to area selection

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