Programme Area: Smart Systems and Heat

Project: WP2 Manchester Local Area Energy Strategy

Title: Greater Manchester Spatial Energy Plan Evidence Base Study Full Report

Context:

The Spatial Energy Plan for Greater Manchester Combined Authority project was commissioned as part of the Energy Technologies Institute (ETI) Smart Systems and Heat Programme and undertaken through collaboration between the Greater Manchester Combined Authority and the Energy Systems Catapult. The study has consolidated the significant data and existing evidence relating to the local energy system to provide a platform for future energy planning in the region and the development of suitable policies within the emerging spatial planning framework for Greater Manchester.

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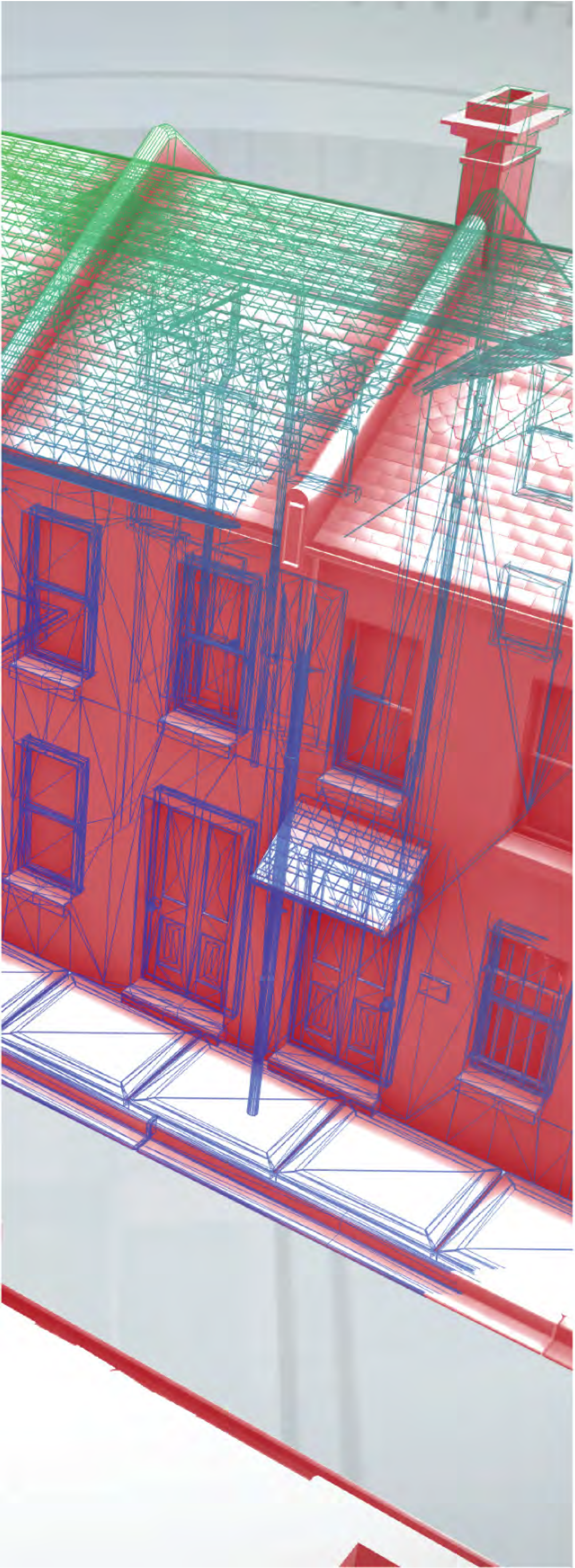

Greater Manchester Spatial Energy Plan

Evidence Base Study

Full Report

Delivered by

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The Spatial Energy Plan

The Spatial Energy Plan for Greater Manchester Combined Authority project was commissioned as part of the Energy Technologies Institute (ETI) Smart Systems and Heat Programme and undertaken through collaboration between the Greater Manchester Combined Authority and the Energy Systems Catapult.

The study has consolidated the significant data and existing evidence relating to the local energy system to provide a platform for future energy planning in the region and the development of suitable policies within the emerging spatial planning framework for Greater Manchester.

1.1.2 About the Greater Manchester Combined Authority

The Greater Manchester Combined Authority is made up of the ten Manchester councils and Mayors, who work together with other local services to improve the City-region. The ten councils (Bolton, Bury, Manchester, Oldham, Rochdale, Salford, Stockport, Tameside, Trafford and Wigan) have worked together voluntarily for many years on issues that affect everyone in the region, fore example transport, regeneration, and attracting investment.

1.1.3 About the Energy Technologies Institute

The Energy Technologies Institute[1] as a public-private partnership between global energy, engineering companies and the UK Government provide a role to act as a conduit between Academia, Industry and the Government to accelerate the development of future low carbon technologies. This is focussing on targeted commercial investments in the various technology programmes across heat, power, transport and the infrastructure that links them.

1.1.4 About the Energy Systems Catapult

The Energy Systems Catapult [2] is the UK's technology and innovation centre set up to support Companies and Government for the development of new products and services to address the new commercial opportunities created by the transformation of UK and global energy systems (covering electricity, heat and combustible gases).

The Catapult's mission is to bring the worlds of industry, academia and Government together to encourage and support the development of new technology-based products and services in the energy sector. It is a non-profit, non-partisan company limited by guarantee.

In April 2015 The Energy Systems Catapult took over the responsibility for the delivery of the Energy Technologies Institute's, Smart Systems and Heat programme, with a clear remit to create future-proof, economic local heating and associated energy solutions for the UK. The Energy Systems Catapult has

1 http://www.eti.co.uk/

2 https://es.catapult.org.uk/

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been appointed to deliver Phase One of the Smart System and Heat programme as suppliers to the Energy Technologies Institute.

Published by the Energy Systems Catapult 2016

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Foreword

Greater Manchester is the area covered by ten neighbouring Local Authorities. In 2011 the Greater Manchester Combined Authority (GMCA) was formed giving more local control over issues that affect people who live in the area. The Greater Manchester Spatial Framework (GMSF) provides the overarching framework to manage the supply of land across the conurbation for the period to 2035. It aims to identify particular strengths and opportunities, highlighting the barriers and ensuring growth is supported by good quality, low carbon infrastructure[3].

The National Planning Policy Framework[4] recognises that planning has a key role to play in helping shape places to secure radical reductions in greenhouse gas emissions, minimising vulnerability and supporting the delivery of renewable and low carbon energy and associated infrastructure. It states that Local planning authorities should adopt proactive strategies to mitigate and adapt to climate change and plan for new development in locations and ways which reduce greenhouse gas emissions and actively support energy efficiency improvements to existing buildings.

Under the Climate Change Act 2008 By 2050, the UK must reduce its carbon dioxide emissions by at least 80 % from a 1990 baseline. Meeting the 2050 target will likely require near-complete decarbonisation of heat by switching away from gas boilers[5] and Local Authorities across the UK are taking responsibility for reducing carbon emissions, leading innovations to improve efficiency and reduce energy consumption in buildings and public services.

Greater Manchester has set an ambitious near term local carbon reduction target to cut emissions by 48 % from a 1990 baseline. The GMSF growth projections forecast a significant increase in population which will impact on its energy systems, residents and businesses. To ensure that this growing demand is managed while meeting its low carbon targets, Greater Manchester needs to adopt a whole systems approach, to energy that will improve energy efficiency in buildings, and support decarbonisation of heat and power that reflects the opportunities and constraints of the local area.

This study has been prepared as an evidence base to support the GMSF. It assesses the current and future energy demand and existing energy systems within Greater Manchester, and provides a simple high level overview of the opportunities and challenges for low carbon transition over the lifetime of the GMSF to 2035, and ultimately beyond to 2050.

The study has been delivered by The Energy Systems Catapult (ESC) on behalf of the Energy Technologies Institute (ETI) as part of the Smart Systems and Heat Programme. This programme is focused on creating future-proof and economic local heating solutions for the UK. As part of the Programme the Catapult is also working with the GMCA to pilot advanced whole energy systems modelling tools at a more detailed Local Authority level in evaluating local energy system transformation and infrastructure investment to support design of cost effective local energy systems with the aim of delivering a large scale

[3] Greater Manchester Spatial Framework Consultation https://www.greatermanchester-ca.gov.uk/downloads/file/17/greater_manchester_spatial_framework_consultation

[4] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/6077/2116950.pdf

[5] Committee on Climate Change: Buildings July 2015

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demonstration project, that will empower consumers and stimulate innovation in low carbon domestic energy services[6].

The UK can achieve an affordable transition to a low carbon energy system most cost effectively through effective forward planning[7]. Greater Manchester's future energy system will be dependent on the evolution of UK society and global influences. It is likely to see greater deployment of heat networks and heat pumps and other electric heat technologies to meet domestic energy demands . There is also likely to be an increasing role for Smart Energy Services enabling demand and supply connectivity through information creation and sharing combined with increasing local renewable and low carbon energy generation. This could see a changing role for communities and the consumers in the energy system and increasing pressure on the local electricity distribution network as well as a changing role of gas infrastructure in the long term that needs to be managed and planned.

This study provides a high level strategic context and supporting evidence to inform the Spatial Framework to 2035 including consolidation and spatial mapping of Greater Manchester's existing local building and energy system data to support transition to a low carbon energy system. It provides a foundation for the development of supporting policies and strategies for Greater Manchester. Combined with the application of more detailed whole systems analysis within individual districts, GM is well placed to achieve the conurbation's carbon reduction and energy security ambitions, meet the challenge of climate change and position Greater Manchester as the Northern Powerhouse within the UKs future low carbon economy.

[6] Future Cities: UK Capabilities for Urban Innovation

7 ETI options and choices

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Executive Summary

Energy is the foundation stone of our society and economy. The food we eat, the cars we drive, the goods we make, transport and buy as well as the heat, light and hot water that make our homes comfortable all rely on energy in one form or another. Greater Manchester (GM) uses 51.6 TWh/ year of energy. This is around 3 % of total UK energy use.

There is a wide disparity in energy use between the different districts of Greater Manchester with the highest consumption district, Manchester, using around 2.5 times more total energy than Oldham, the district with the lowest energy consumption. Different fuels are used depending on the service they provide. Gas is primarily used for space and water heating and is the predominant fuel within GM making up 42 % of total energy consumption. Electricity makes up 23 % of GM's total energy consumption. It is used to provide domestic light and heat and power domestic appliances. It is also used for a wide variety of purposes in non-domestic buildings. Liquid fuel accounts for most of the remaining energy consumption. 28 % of GM's annual energy consumption is transport fuel. Other fuel makes up the remaining 7 % of energy consumption in GM. Forecast growth of new homes and non-domestic buildings in GM could increase energy demand by around 3 % by 2035.

Whilst 95 % of postcodes in GM are connected to the gas grid, coal and oil heating are still a significant part of the energy mix in some districts. These areas often have domestic buildings with poor thermal efficiency and high levels of fuel poverty.

The UK has a legally binding target to reduce emissions of greenhouse gases by 80 % from 1990 levels by 2050. The UK's fifth carbon budget has been set to reduce emissions by 57 % by 2030. This includes international shipping, but not aviation. National policy recognises the important role of spatial planning in meeting the challenge of climate change. The Greater Manchester Combined Authority (GMCA) has committed to achieving emissions reductions of at least 80 % by 2050 and has adopted a carbon target to deliver a 48 % reduction, or 11 million tonnes by 2020 against a 1990 baseline and 41 % by 2020 from 2005 levels. GMCA has also committed to a maximum of 2 tonnes CO_2 per capita by 2050. Current energy consumption in GM results in total carbon emissions of 13.5 $MtCO_2$ per year, equivalent to 5.0 tonnes CO_2 per capita.

Achieving GM's long term decarbonisation ambitions will require significant changes to the types of energy that are used; as well as how, and when, they are used. For GM to continue to grow and thrive during this change future energy sources must be secure, affordable and sustainable. This will require action at both a local and a national scale. Business-As-Usual will not be sufficient to meet the goals that have been set.

Electricity will remain an integral part of the energy system in GM and will be used increasingly for both heat and transport. Recent years have seen a growth in local installed renewable energy capacity stimulated by national policy initiatives. However, the opportunities for GM to generate low carbon electricity locally are limited. This study has established that up to 9 % of GM's electricity could, technically, be generated locally using renewable sources. It is likely, however, that only a small proportion of this will be economically viable. Options might also be limited by the need to ensure reliable supplies at all times. It is expected that the majority of GM's future electricity demand will still be met from the National Grid. National action will be required to decarbonise central generation of electricity by moving

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away from coal and gas fired generation. With increased use of electricity for both heat and transport the local electricity network has a key role to play. This study suggests that the electricity distribution network within GM has the capacity to accommodate new demand although some areas have limited spare capacity and growth of decentralised renewables, electrification of heat and increased use of electric vehicles will all pose significant future challenges.

To meet long term carbon targets there will have to be a significant reduction in the use of gas and it is expected that buildings will have to change almost entirely to different sources of energy for heat and hot water. This is likely to include use of electrically powered heat in individual buildings and heat provided from central locations via district heat networks. The dense urban nature of some parts of GM means that there are opportunities for significant growth of heat networks aligned with, and building out from, strategic development sites. In some areas there might be opportunities to provide heat to these networks using waste heat.

In addition to changing sources of energy there are opportunities to improve the thermal efficiency of the existing building stock and reduce energy consumption contributing to a cost-effective decarbonisation strategy. Over 60 % of the domestic buildings in GM have low thermal efficiency, slightly better than the average situation across England. It is expected that as many as 90 % of these buildings will still be in use in 2050. Cost-effective retrofit to improve these homes thermal performance will improve the overall economics of switching to low carbon sources of heat through awhole systems approach to meeting climate change targets.

GM has seen increasing deployment of low carbon and renewable technologies in recent years, supported by national policy and subsidy such as the Feed-in-Tariff and Renewable Heat Incentive. There remains significant technical potential for further deployment in support of GM carbon targets. The technologies with the highest technical potential to contribute to a new, low carbon energy system in GM include district heating, individual electric heat pumps, bio-fuels and solar technologies for both hot water and electricity.

Technical potential is the starting point for identifying economically feasible routes to maintain security of supply and meet decarbonisation targets. New networks will need to be built for district heating. These can be sized to ensure that maximum demand can be met. In contrast, increased deployment of electric heat pumps is likely to require reinforcement of electricity networks with associated cost and disruption. Solar technologies have the potential to make a significant contribution in summer months but are unlikely to provide the energy needed at times of peak demand during cold winter months. Storage of heat and battery storage can transfer energy between seasons at a cost; the solutions for heat and electricity are different.

Smart energy systems and markets could empower both consumers and suppliers in GM to manage energy supply and demand more cost effectively and support a low carbon transition. In this context GMs future energy systems might be better thought of as a constantly evolving supply chain where the primary driver is customer service. Energy retailers currently compete on price and consumers purchase units of energy. What they actually want is the warmth, comfort and wellbeing provided by that energy. If consumers could make real choices around those energy services, they would be much more likely to engage with the changes required to meet carbon reduction targets cost effectively.

The shift to lower carbon and decentralised energy provides an opportunity for innovative business models, governance and funding solutions to support energy systems change. Smart systems can enable an ecosystem to be established within which the consumer is empowered with data and control.

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Deployment of new low carbon energy networks and buildings technologies in combination with smart systems can also enable Local Authorities and communities to be active participants in the delivery of GMs future energy system.

New development within GM provides the opportunity to act as a catalyst for low carbon energy infrastructure. Local policy including that to be defined within the emerging Greater Manchester Spatial Framework can support low carbon transition and devolution presents an opportunity for GM to be a low carbon innovation leader.

It will be important for GM to establish an ambitious long term carbon reduction target recognising that it is more cost effective to tackle emissions from buildings than cutting deeper in other sectors. Positive energy planning at a local level within individual districts can identify specific low regret activities in the near term and cost-effective long term pathways to support a consumer and community driven low carbon transition. There is a significant potential for local decarbonisation of heat in GM, however, this will require an understanding of the existing buildings and energy networks as well as local priorities and constraints which might influence future low carbon pathways for homes and buildings.

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Summary Report

1.1 Context

Greater Manchester (GM) is a metropolitan county in North West England, with a population of **2.7 million people** and approximately **1.1 million homes**[8]. It encompasses one of the largest metropolitan areas in the United Kingdom and comprises ten metropolitan boroughs: Bolton, Bury, Oldham, Rochdale, Stockport, Tameside, Trafford, Wigan, and the cities of Manchester and Salford.

National policy recognises the important role of spatial planning in meeting the challenge of climate change and the requirement for regional and local responses. This report provides an assessment of existing GM energy demand and supply, analysis of the impact of planned future growth to 2035, and technical potential for decentralised, low carbon and renewable energy in supporting GM energy and climate change goals. It focuses on those technologies that are technically mature, taking a whole systems perspective, whilst also considering the potential role of future innovation, research and development.

It provides an evidence base to support planning policy as part of the emerging Greater Manchester Spatial Framework (GMSF) and takes account of the wider evidence base documents on the topic of energy and climate change within GM. This is needed alongside complementary enabling mechanisms, including new business and development models, delivery vehicles and planning approaches, for GM to achieve its publicly committed goal of reducing emissions to a maximum of two tonnes per capita by 2050. This, in turn will help GM in doing its part in keeping global mean temperature rises below 2 degrees as part of its Under 2 Memorandum of Understanding and Compact of Mayors commitments[9].

The provision of decentralised, low carbon and renewable energy is critical to the delivery of economic growth and prosperity and reducing carbon emissions within GM. The Climate Change Act 2008 established a target for the UK to reduce its greenhouse gas emissions by at least **80 %** from 1990 levels by 2050. This target represents an appropriate UK contribution to global emission reductions consistent with limiting global temperature rise below 2° C. The fifth carbon budget has been set to reduce carbon emissions by **57 %** by 2030[10].

The Greater Manchester Combined Authority (GMCA) has adopted a carbon target to deliver a **48 %** reduction, or **11 million tonnes CO_2** by 2020 against a 1990 baseline and 41 % by 2020 from 2005 levels. GM has achieved a **36 %** decrease between 1990 and 2014, however, it still faces a number of challenges to meet its long term targets. In order to meet 2050 carbon targets near-full decarbonisation of both buildings and surface transport by 2050 is likely to be required[11]. The Committee on Climate Change (CCC) suggest 'there may be a small amount of room for residual emissions in buildings and/or surface transport. Where emissions remain will depend on how different low-carbon technologies develop. It is therefore

[8] https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/bulletins/subnationalpopulationprojectionsforengland/2014basedprojections/relateddata

[9] http://www.compactofmayors.org/press/the-compact-of-mayors-alliance-of-peaking-pioneer-cities-sign-mou-2/

[10] https://www.theccc.org.uk/publication/the-fifth-carbon-budget-the-next-step-towards-a-low-carbon-economy/

[11] https://documents.theccc.org.uk/wp-content/uploads/2015/11/Fifth-Carbon-Budget_Ch3_The-Cost-effective-path.pdf

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sensible to plan now to keep open the possibility of near-full decarbonisation of both buildings and surface transport by 2050.

1.2 Existing Energy System

Energy is the foundation stone of our society and economy. The food we eat, the cars we drive, the goods we make, transport as well as the heat, light and hot water that make our homes comfortable all rely on energy in one form or another. GM uses 51,600 GWh (51.6 TWh) / year of energy. This is around 3 % of total UK energy use.

- Homes in GM account for **37 %** of energy demand and the non-domestic sector **35 %.**

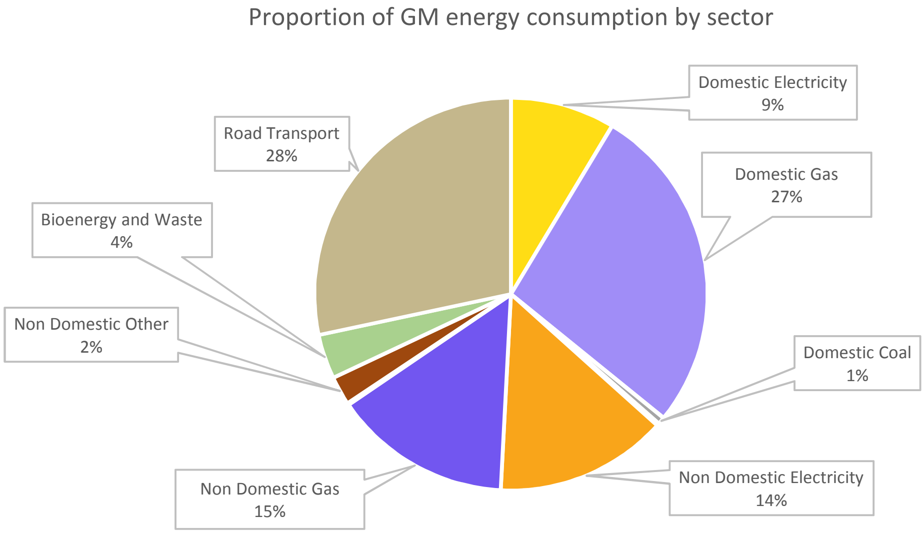

Figure 0-1 Proportion of GM energy consumption by sector

- There is a wide variation in domestic and non-domestic energy demand by district with Manchester being the largest energy consumer.
- **Space Heating and Hot Water** are estimated to account for **77 %** of domestic energy demand. **Manchester, Salford** and **Trafford** are the districts with the highest heat demand density areas.
- Gas is the primary heating fuel for homes in GM (**96 %**), with electricity accounting for less than **2 %**. Coal and oil (2 %) still form part of the energy mix in some GM districts, particularly Wigan.
- 3,316 postcodes have never had a gas connection and can be considered off-grid. This is around 5 % of the postcodes in GM. This is equivalent to around **35,000 domestic properties** or 3 % of homes in GM.

1.3 Homes and Buildings

GM has a wide range of building ages and types which influences energy consumption across the region. domestic housing stock in GM has wide variations between districts.

- GM Housing stock is predominately **pre 1980s**, with **Manchester** and **Salford** having the largest proportion of newer stock, **Trafford** and **Stockport** the largest proportion of older stock.

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- **126,000 GM households** are estimated to be in **fuel poverty**[12] with the greatest areas of fuel poverty concentrated in **Manchester, Rochdale** and **Oldham**.
- The vast majority of the existing homes in GM are likely to be in existence by 2050[13]. Identifying cost effective pathways for the domestic retrofit of energy efficiency and low carbon heating systems as part of a coherent whole systems approach is essential to support GM's long term decarbonisation targets.

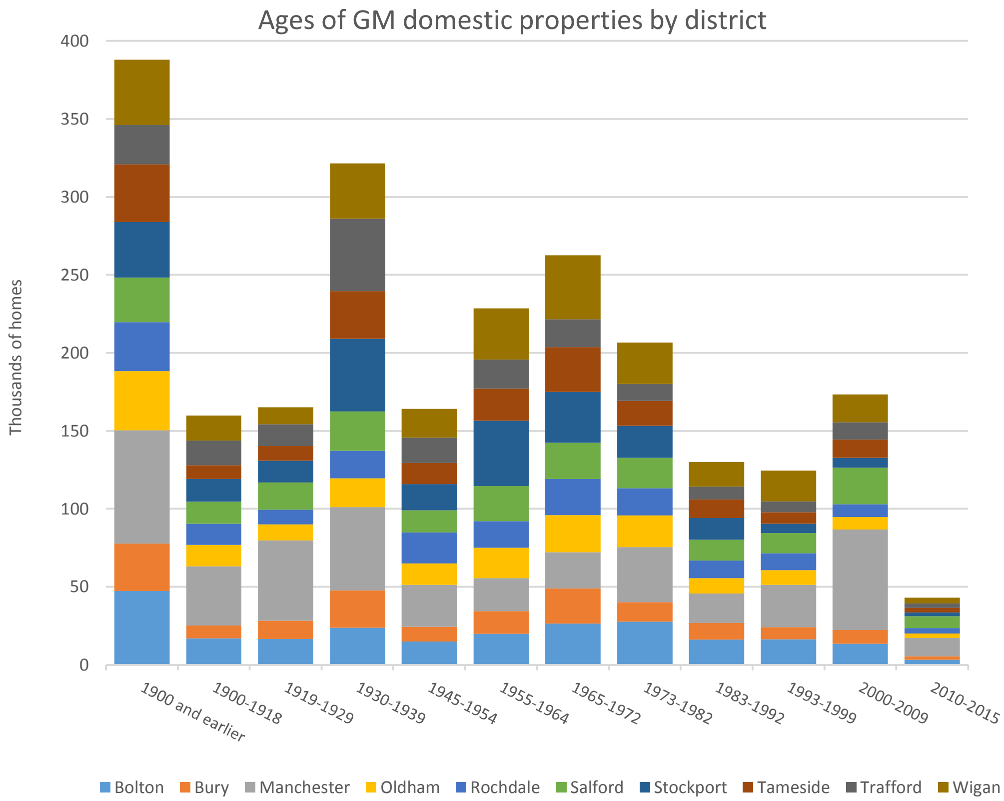

Figure 0-2 Age of GM domestic properties by district

- Older housing stock and buildings in GM are likely to be more energy intensive due to lower levels of insulation and less efficient heating systems. Newer buildings are typically more energy efficient; older properties are an important source of GM carbon emissions.
- Some districts in GM have very high proportions of low performing domestic stock. **Trafford, Stockport** and **Tameside** have areas that have a proportionally low energy efficiency rating[14]. Almost three quarters (67 %) of domestic properties have an Energy Performance Certificate (EPC) of any rating lodged.

[12] https://www.gov.uk/government/statistics/annual-fuel-poverty-statistics-report-2015

[13] DCLG figure quoted in http://www.lcmp.eng.cam.ac.uk/wp-content/uploads/081012_kelly.pdf

[14] Based on % of homes achieving an EPC rating of A, B and C

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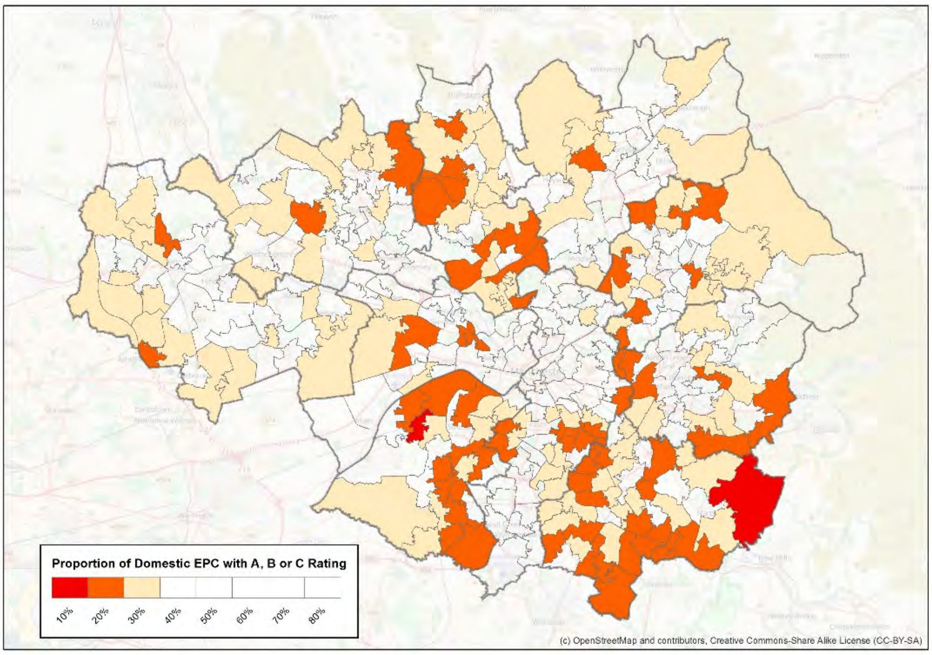
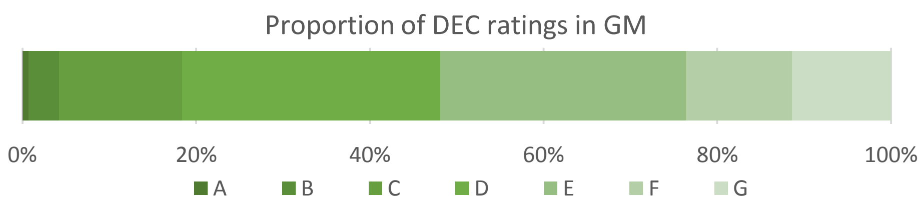


Figure 0-3 Domestic properties EPC rating

- 48 % of public buildings (out of 2,053 buildings[15]). with a DEC (Display Energy Certificate) achieve a D rating or better



- Total energy usage in non-domestic buildings is complex to estimate due to sparse and inconsistent data, the wide variety of construction methods, multiple uses and constant change of use. Less than 1 % of non-domestic floor area in GM has an associated EPC.

[15] https://www.gov.uk/government/statistical-data-sets/live-tables-on-energy-performance-of-buildings-certificates

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1.4 Carbon Emissions

The UK has a legally binding target to reduce emissions of greenhouse gases by 80 % from 1990 levels by 2050. The GMCA has adopted a carbon target to deliver a **48 %** reduction, or **11 million tonnes** by 2020 against a 1990 baseline.

- GM has achieved a **36 %** decrease between 1990 and 2014.

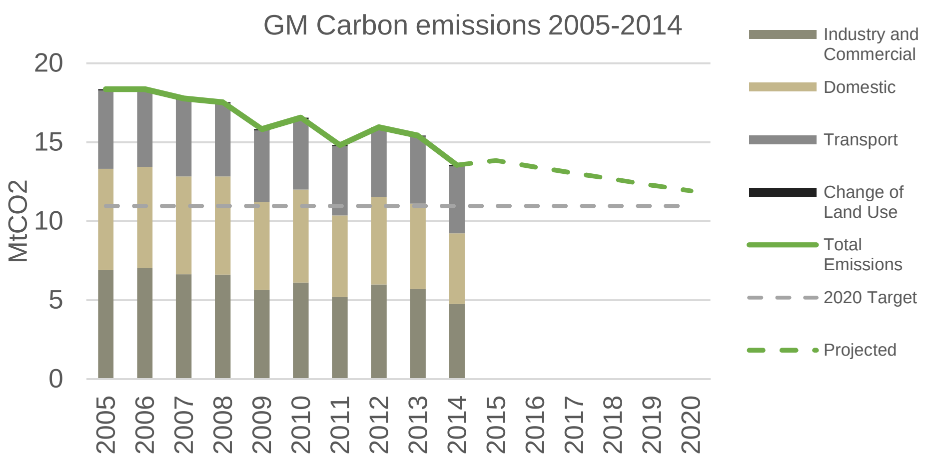

Figure 0-4 GM Carbon emissions

- GM total annual carbon emissions are **13.5 $MtCO_2$ (2014)** equivalent to **5.0 tonnes CO_2** per capita. The UK national average is **6.3 tonnes CO_2** per capita[16].

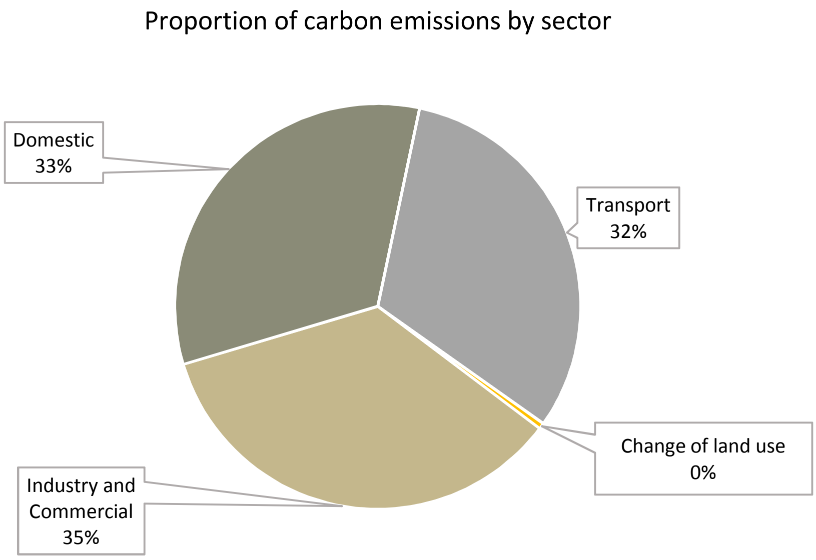

Figure 0-5 Proportion of carbon emissions by sector

- There is a wide variation in domestic and non-domestic energy demand and associated carbon emissions by district with Manchester being the largest emitter.

[16] Change of land use

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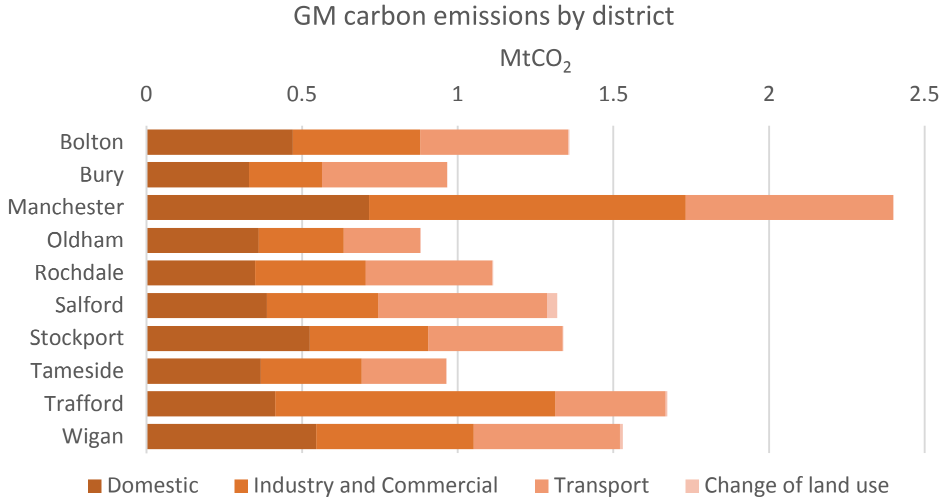

Figure 0-6 GM carbon emissions by district

- The capacity of GM's electricity network to accommodate increased demand is considered **generally robust**. There are a number of areas with **limited capacity** to accommodate new demand[17].
- The Entire North West region has **221 MW** of accredited non-domestic renewable heat capacity installed[18] equivalent to 10 % of the UK total as of March 2016.
- GM currently has **29MW** of installed renewable heat capacity and **140MW** of installed renewable electricity capacity.
- The majority of regional renewable electricity generation in GM is from Landfill, sewage and AD gas (74 %).

[17] Data from Electricity North West (ENW)

[18] Accredited installation claiming the renewable heat incentive (RHI) at March 2016

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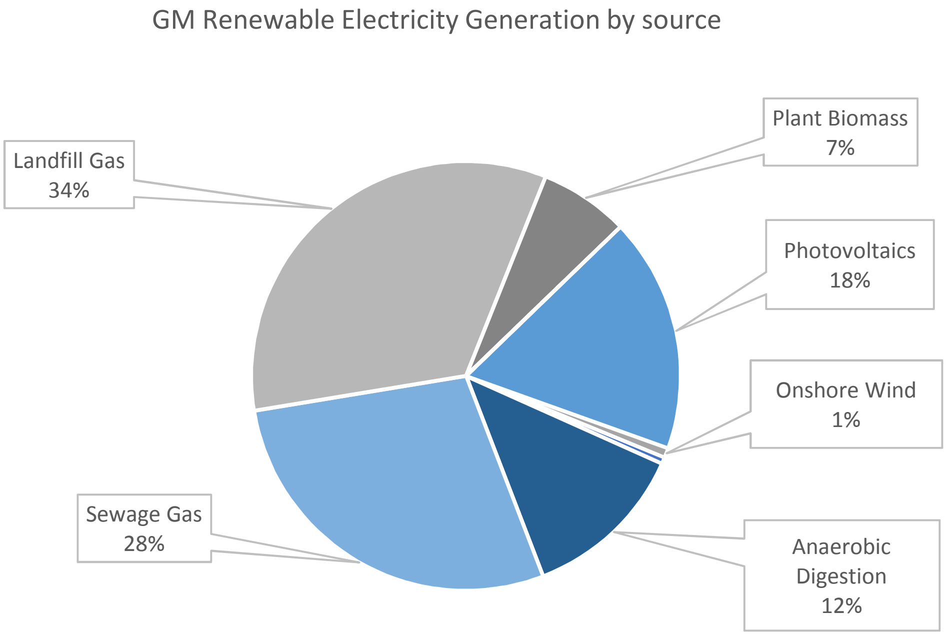

Figure 0-7 GM Renewable electricity generation by source

- There is a wide variation in installed renewable capacity across GM districts. GM is below UK national average for total installed renewable capacity per person. Solar PV deployment is 40 % of the England average on non-domestic property.
- Policy could support greater deployment in areas that have strong opportunities to implement schemes or technologies that will reduce carbon emissions or fuel poverty.

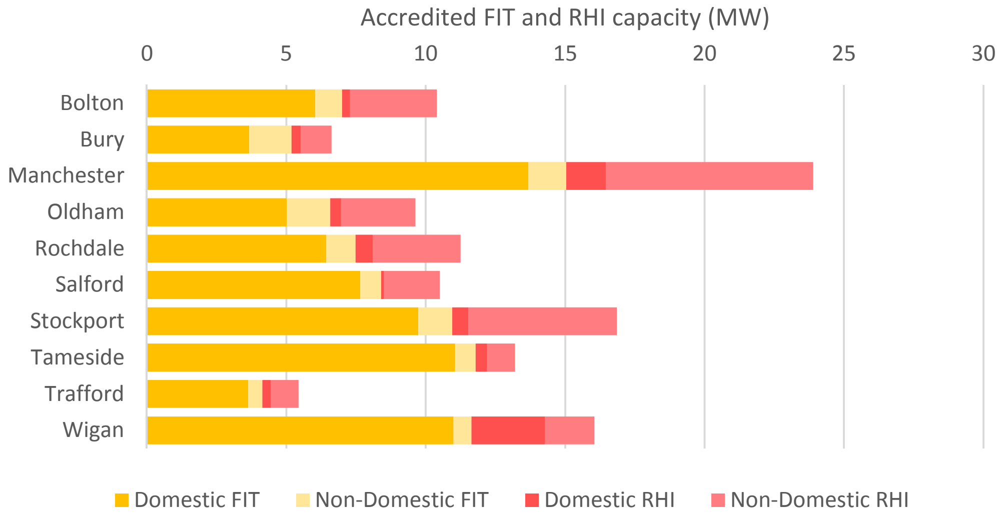

Figure 0-8 Accredited FIT and RHI capacity

- There is currently 6.8 MWe of accredited combined heat and power (CHP) installed across the 10 districts.
- **District Heating** currently supplies energy to two main sites at Media City and St Mary's Oldham, this is around **2,000 homes** (>0.002 % of homes in GM). It is estimated that 182,000 homes in the UK are currently connected to District Heating networks (0.7 % of UK households). GM has

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currently identified networks that could connect 6,000 households (0.01 % of existing households)[19] and a number of non-domestic properties. 161,000 households are within 500 m of an identified potential heat network.

1.5 Future Growth

Future growth in GM will lead to increasing energy demand arising from heating and electricity use in new homes and buildings. By 2035 GM is forecast to have **233,000 new homes (**an increase of **17 %)** and **6.6 million m^2** of **additional commercial and industrial floor space** (an increase of **22 %)**. This will result in an increasing demand on the local energy system and poses a significant additional challenge to meeting GM decarbonisation targets. This study has found that:

- New development is estimated to increase energy demand by **2,400 GWh/yr which** could increase carbon emissions by **0.4MtCO_2/yr** under business-as-usual activity. This is equivalent to a **3 % in energy** increase if no other factors are taken into account.
- New development in GM provides an opportunity to deliver high standards of energy efficiency with **future proofing** for transition to low carbon and renewable energy and to plan positively for low carbon energy infrastructure.
- A number of planned GM growth sites are located in areas of opportunity for District Heating[20]. New development could act as a catalyst for establishing new energy centres and decentralised heat infrastructure when located in areas of opportunity.

1.6 Low Carbon and Renewable Energy Potential

There is significant technical potential for further deployment of low carbon technologies in support of GM carbon targets. This technical potential represents the opportunity for energy generation within the limitations of existing technology performance, local resource availability and identified constraints. In each case the economic feasibility will need to be assessed to establish what is realistically viable whilst maintaining security of supply and meeting decarbonisation targets. The technologies with the highest technical potential to contribute to a new, low carbon energy system in GM include district heating, individual electric heat pumps, bio-fuels and solar technologies for both hot water and electricity. In each case the economic feasibility will need to be assessed to establish what is viable whilst maintaining security of supply and meeting decarbonisation targets.

- Up to **1,030 GWh/yr (9 %)** of existing electricity consumption could technically be generated by renewable energy sources within GM, delivering annual CO_2 reductions of **2.6 million tonnes (19 %) from 2014 levels.**
- Up to 68 % of existing gas demand could technically be replaced with renewable heat from **heat pumps**, **solar thermal** and **bioenergy** within the GM region.

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[19] Heat network masterplan for Greater Manchester, Ramboll 2014

[20] DH opportunity area is an area with existing or planned heat networks or areas with significant heat demand that could be feasible for heat network development

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- **Ground Source** and **Air Source Heat Pumps** have the technical potential to contribute to **12,400 TWh/yr (50 %)** of current GM domestic and non-domestic heat consumption. Heat pumps could play a significant role in the decarbonisation of existing homes, particularly in the less built up areas, and 300 homes in GM have been fitted with air source heat pumps in Wigan, Bury and Manchester as part of the NEDO Smart Heat project[21].

- **Solar thermal** has the technical potential to provide **2,770 GWh/yr**. This is **13 %** of current gas demand.

- **Biomass** is an extremely versatile energy source that can be used to support a range of energy demands and the scale of use could have a significant effect on the cost of meeting carbon targets in the UK. Previous studies suggest around 10,000 tonnes of biomass could be available within the GM boundary with a wider regional supply chain of 325,000 tonnes[22]. Biomass in GM is estimated to have the technical potential to provide **1,173 GWh/yr** of heat. This is **5 %** of current gas demand.

- **Solar PV** has the technical potential[23] to provide **834 GWh/yr.** This is **7.3 %** of current GM electricity consumption. In 2014 PV provided **around 50 GWh** of renewable energy.

- **Wind power** is likely to play a large role in UK decarbonisation and is the most established renewable energy technology, producing almost 10 % of the UK's electricity[24] GM Wind power generation currently delivers **2.2GWh/yr** and has the technical potential to increase and provide a further **140 GWh/yr** focused principally in **Bury** and **Oldham**.

- **Hydropower** has a technical potential to provide **4.4 GWh/yr** of electricity (0.04 % GM electricity demand) based on recent studies completed in **Bury** and **Stockport** with additional unconfirmed potential in Bolton, Rochdale and Oldham and Ashton.

- Unconventional gas (Shale) and coal bed methane is a potential future energy source for GM, and a number of exploration licences been granted across the GM region[25].

- Increasing decentralised electricity generation within GM, in combination with electrification of transport and heat will all provide significant challenges. In some regions of the UK decentralised generation is placing increasing **pressure on the UKs energy networks**[26].

- Potential heat pump capacity in GM could increase electricity consumption by **30** %. Uptake of electric vehicles could add 0.5 MWh per year to the electricity consumption of each GM household by 2035.

- **District Heating** has the technical potential to expand significantly in GM. District Heating can utilise a range of low carbon and renewable technologies and the technical potential for gas CHP

[21] https://www.greatermanchester-ca.gov.uk/news/article/52/greater_manchester_smart_energy_project_hits_halfway_mark

[22] URBED, AECOM and Quantum Strategy and Technology (2010)

[23] Technical potential is that identified through standard DECC methodologies or further specific studies

[24] DUKES

[25] https://www.gov.uk/government/publications/about-shale-gas-and-hydraulic-fracturing-fracking/developing-shale-oil-and-gas-in-the-uk

[26] https://www.ofgem.gov.uk/publications-and-updates/ofgem-challenges-power-grid-companies-connect-more-renewables

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led high efficiency District Heating in the North West has been estimated as **37,000 GWh/yr** with a cost-effective potential of **4,000 GWh/yr**[27] under current market and regulatory arrangements.

- Urban areas are most likely to move towards heat networks and GM has previously identified feasible opportunities for approximately **35** individual **District Heating Networks** with technical potential to reduce GM carbon emissions by **413 ktCO_2 (3 %).**
- District Heating provides an opportunity to utilise recovered surplus waste heat from industry, power stations and waste incinerators. The **North West** technical potential for recovering **power station heat** is estimated as **6,000 GWh/yr** and **industrial waste heat 1,000 GWh/yr**[28]. There is potential for use of waste heat where district heat networks are installed.
- District heating could supply as much as 15 >30 % of UK space heat generation by 2050 compared to 1 > 2 % currently[29]. This shift across GM would be equivalent to up to **330,000 homes** connected to District Heating by 2050.
- Mine water heat extraction in GM has the technical potential to provide **176 MWth/yr.**

Future Scenario

Consumer attitudes alongside policy drivers and enablers will significantly influence uptake of low carbon technologies and the make-up of GMs future energy system. The most attractive mix of technologies will be dependent on the evolution of GM and the rest of the UK society in a global context. The GMCA should aim to identify "contenders" and low-regret activities in the near term to ensure the most cost effective routes to decarbonisation, reflecting uncertainty and future innovation. Our analysis suggests:

- It is possible to achieve cost effective decarbonisation through deployment of known, but underdeveloped low carbon technologies[30], however, 'Business as usual' will not be enough for to GM achieve its long term carbon targets.
- A strategy for decarbonising existing energy demand within GMs homes and buildings is a priority, projected to account for over 56 % of carbon emission by 2035 under 'Business as usual'. Co-ordinated action is needed to develop low carbon transition pathways for existing homes and businesses.
- Scenario analysis for this study suggests that GM could achieve an 80 % CO_2 reduction target by 2050 with the right combination of drivers and action.

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[27] National Comprehensive Assessment of the Potential for Combined Heat and Power and District Heating and Cooling in the UK Report for DECC

[28] As above

[29] ETI options and choices

[30] as above

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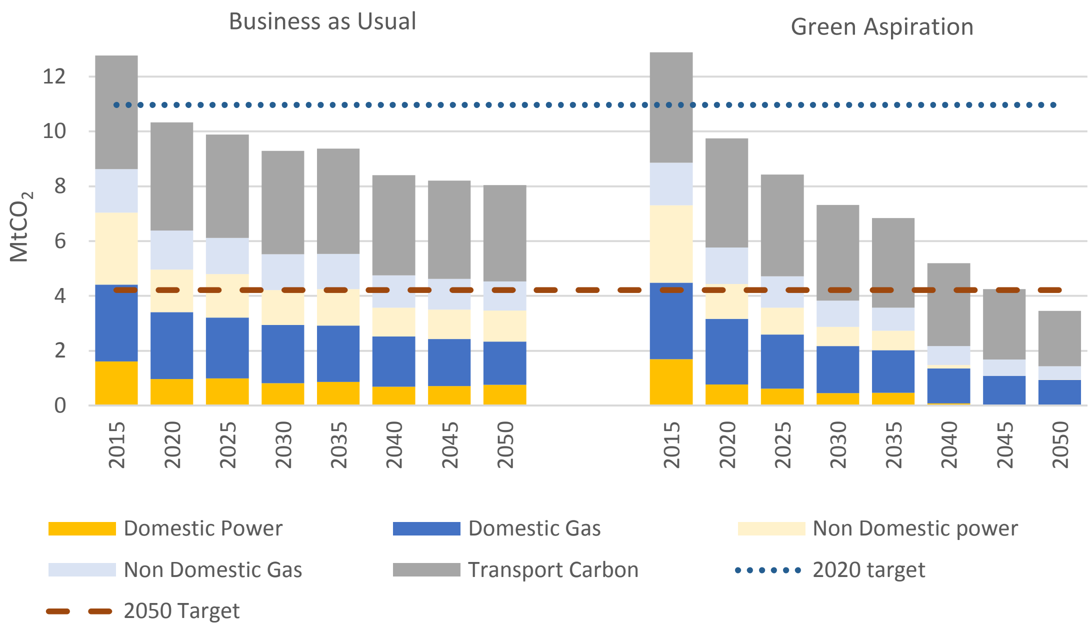

Figure 0-9 Future scenarios

- The transport sector plays an important role in meeting carbon targets. In GM green aspiration, emission from the transport sector make up 58 % of total emissions in 2050. Changing the transport decarbonisation to a different data source leads to much higher emissions (67 % due to transport).

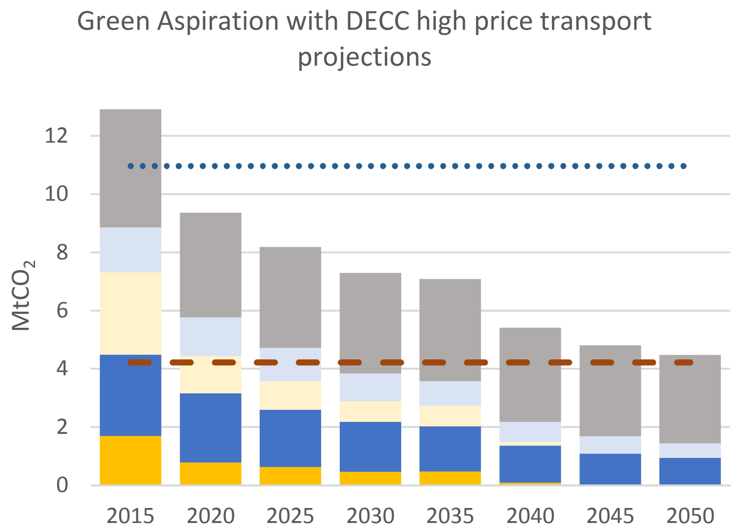

Figure 0-10 Green Aspirations with DECC high price transport projections

- More detailed modelling is needed to evaluate and identify possible cost-effective transition pathways within individual districts of GM that considers the whole energy system and interactions between demand, generation, heat, electricity and gas networks. This should engage key stakeholders including network operators and the Local Authority to build a shared plan of the local energy system to support near term action and longer term transition.

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1.7 Smart Systems, Emerging Technologies and Innovation

GM is recognised as an **innovation leader**, with a number of digital and smart city initiatives built upon the long history of co-operation across GM's ten districts[31]. **Smart energy systems** and markets could empower both consumers and suppliers in GM to cost effectively manage energy supply and demand, and support a low carbon transition.

- Deployment of renewable energy technologies in GM, many of which are intermittent generators, can benefit from smart metering and management systems allowing local demand aggregators to manage and regulate generation at a local level.
- Increased deployment of renewable generation alongside future electrification of heat and transportation in GM mean that **electricity storage** could play an increasing role in managing the intermittency inherent in many renewable energy technologies.
- Low carbon heating solutions in GM will need to be consumer focused and appeal to households if they are to achieve their potential[32]. Smart-user interfaces and intelligent heating controllers could deliver greater control for householders and/or energy services providers to better manage energy use in the home and help in balancing demand and supply.[33] The ability for devices to share data across different platforms is an important part of a smart energy system. To promote innovation, it is anticipated that businesses providing smart heating systems or home automation controls and related services and products will be able to access energy and tariff data from smart metering systems[34].
- Intelligent devices could all form part of a smart energy system within GM including electric vehicles, smart appliances and industry processes to improve efficiency and decrease strain on the distribution network.
- **New heat network infrastructure** in GM provides the opportunity to design-in **smart metering** and **intelligent controllers** to manage supply and demand as an integrated part of new energy infrastructure.
- **Thermal storage** could form an integral part of GMs future energy system and play an important role in domestic and communal heating efficiency and delivering cost-effective low carbon transition pathways for existing homes in GM.
- **Hydrogen** could technically provide a flexible power source when produced from fossil fuel using carbon capture and storage or by the electrolysis of water[35]. This can be stored and then used in power stations to produce electricity when required. Hydrogen might provide an alternative to the retrofit of electric heat pumps and district heating, however there are a number of challenges to be

[31] City Initiatives for Technology, Innovation and Entrepreneurship – The Northern Powerhouse Analysis (2016)

[32] ETI Smart Systems and Heat Consumer challenges for low carbon heat (2016)

[33] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/397291/2903086_DECC_cad_leaflet.pdf

[34] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/397291/2903086_DECC_cad_leaflet.pdf

[35] http://www.bbc.co.uk/news/uk-england-leeds-36749604

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overcome and evidence questions the ability to produce sufficient quantities of hydrogen for it to make up a significant part of the UK energy generation system.

- Low carbon transition of the energy system in GM presents an opportunity for disruptive and **innovative business models** that place the consumer at heart of the energy system and could enable Local Authorities to fund and implement energy systems projects. This includes supporting community-led initiatives for renewable and low carbon energy building on the number of community energy projects already going on across GM[36].

1.8 Future Policy Framework

GM has been proactive in planning positively for energy and low carbon transition for a number of years. Statute contains clear parameters for the GMCA and its constituent Local Authorities to take policy action to mitigate and adapt to climate change. Despite this there remains complexity and uncertainty surrounding policy relating to energy efficiency and use in buildings. Many Local Authorities in GM already have a range of low carbon and decentralised energy planning policies and strategies, albeit varied in nature. The GMSF provides an opportunity for greater consistency of policy aligned to common goals across the metropolitan area, and establish an energy planning framework to support a low carbon future[37]. Our analysis has identified clear evidence that:

- The planning system has a crucial role in securing radical reductions in greenhouse gas emissions, providing resilience to the impacts of climate change and supporting the delivery of low carbon energy and supporting infrastructure which is integral to achieving sustainable development.
- The National Planning Policy Framework states that Local Authorities should identify opportunities where development could draw its energy supply from decentralised, renewable or low carbon energy supply systems and for co-locating potential heat customers and suppliers[38]. This study has identified a number of heat network opportunity zones within GM based on previous heat mapping and feasibility studies that could support policy.
- The advent of national Technical Housing standards, affects the ability to set energy efficiency standards for new homes above building regulation standards. However, the abolition of the national commitment to deliver zero carbon new homes by 2016, means the planning system could have an important role in supporting decarbonisation at a local level.
- The Planning & Energy Act 2008 still supports the ability of Local Authorities to set local requirements for renewable energy from new development. This study has identified that the deployment of small scale renewable generation in GM is behind the national average and planning policy could support increased uptake within districts.
- There is an opportunity for GM to consider the role of carbon ‘off-set’ obligations or payments from new development as part of the planning process which could be repurposed to fund retrofit improvements to tackle decarbonisation of existing homes and buildings.

[36] https://www.cegm.org.uk/

[37] AGMA decentralised energy study (2010)

[38] https://www.gov.uk/government/publications/national-planning-policy-framework--2

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- There are no legislative requirements that promote a compulsion for the improvement of existing homes beyond current building regulations[39], although residential Minimum Energy Efficiency Standards[40] could stimulate private rented tenants demanding improvements. This approach might however be unpopular with homeowners as consumer research shows few households are motivated by energy efficiency improvements.
- A robust retrofitting policy as part of the GMSF could support and encourage decarbonisation of existing homes which this study suggests will need to be achieved to meet long term targets. Spatial mapping from this study and further analysis can support identifying priorities zones for retrofit within GM.
- Despite a lack of consumer demand and the limited uptake of the Green Deal, there remains the opportunity for more consumer focused schemes in existing homes and buildings. Subsidising Pay-as-you-save (e.g. 'Green Deal'-type) loan interest rates and/or allowing loans with a shorter term could address credit constraint and finance barriers and improve uptake – however, the cost coupled with lack of interest in energy efficiency shown by around one-third of consumers may require a different approach. An alternative to a 'Green Deal'-type scheme could be a "Home Improvement Fund" where loans could be made to consumers to fund home improvement which could include energy efficient measures. GM Policy could support and encourage uptake of any such 'Green Deal'-type schemes in the future.
- Reforms to national policy and subsidies for renewable energy technologies such as the Feed-in-Tariff and Renewable Heat Incentive will impact future take-up and it will be important for GM to understand the implications of such changes and what further changes may be required to support future capacity, and what other technologies could be included.
- To achieve any low carbon transition and implementation of effective long term energy planning will require the right skills, expertise and knowledge are in place to deliver GM's future energy system.

1.9 Future GM Policy Recommendations

- The GMSF provides the opportunity to establish a strategic overarching GM energy planning policy framework. This could comprise a suite of policies at GM level that support the low carbon vision for the conurbation, whilst providing flexibility for individual districts to develop specific strategies and policies informed by more detailed evidence reflecting local opportunities, priorities and constraints.

[39] Building (Amendment) Regulations 2016 Part L1B (Conservation of Fuel and Power in existing Dwellings) relates to major extensions.

[40] http://www.legislation.gov.uk/ukdsi/2015/9780111128350/contents

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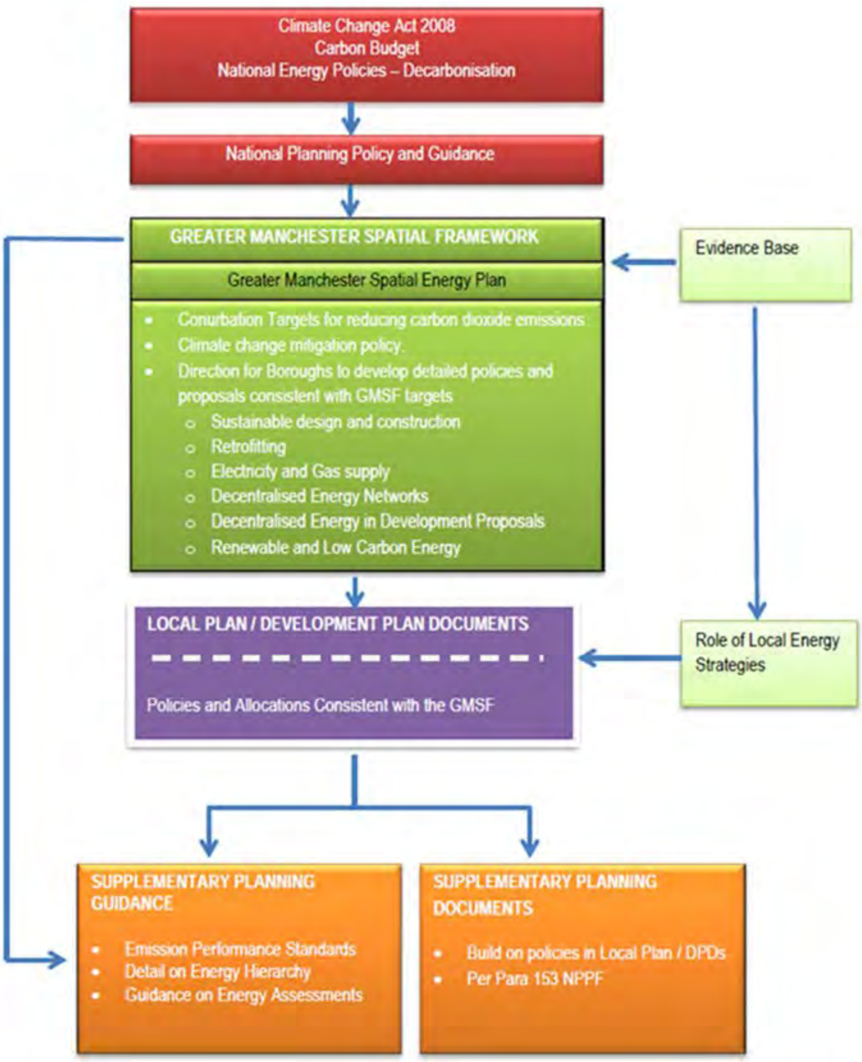

Figure 0-11 Policy framework

- The GM Energy Planning Policy Framework could:

  1. Support development of Local Area Energy Strategies within individual districts to evaluate the impacts and trade-offs across the whole energy system and develop a plan and develop cost-effective pathways to replace energy supplies to buildings with very low carbon sources by 2050.

  2. Establish a consistent and ambitious local carbon target for GM, using a base line year for which most robust data is available and supporting the significant reductions in emissions from buildings and transport needed to cost effectively meet the challenge of climate change.

  3. Establish a policy supporting deployment of low carbon and renewable energy within new development reflecting the technical potential in GM. This policy could require new development to install a percentage of energy from low carbon or renewable sources. Any such a policy should be technology agnostic and include suitable flexibility to reflect varying constraints of different developments energy demands. This policy could also encourage deployment of smart energy t systems and innovative technologies.

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4. Establish a positive retrofitting policy supporting the decarbonisation of existing homes and buildings. This study has shown existing energy demand is significant across GM with the vast majority of the existing homes likely to still be in existence by 2050. This policy could prioritise retrofitting zones across GM informed by the spatial mapping of this study, and more granular analysis within each district.

5. Establish a positive District Heating policy for both new development and renovation/refurbishment that is subject to planning permission. This could reflect the areas of opportunity identified in this study and assessment of technical and economic feasibility of:

    - Connecting to existing district heating networks
    - Potential for new energy centre and heat network delivery.

6. Establish a presumption-in-favour of connection where growth sites are identified in heat network opportunity areas. This could also support retrofitting of district heating in opportunity zones and innovation demonstrators. Local Development Orders (LDOs) could be used to secure planning permission for Energy Centres, heat networks, including pipes, heat exchange equipment, street furniture, informational signage and ancillary engineering works. The Introduction of Standard Contractual Structures for District Heat, Consumer Protection, and Building Skills/Capabilities to Support District Heat at a national level could all support uptake.

7. Establish standardised requirements and related guidance for submission of energy or carbon budget statements with planning applications across GM. This could include standardised data templates and calculation methodologies to enable future data collation, analysis mapping, and forecasting by districts and at a GM level.

8. GM could facilitate a centralised carbon offsetting fund for all ten districts as an alternative to the delivery of renewable energy by new development along a similar model to the Milton Keynes Carbon Offset Fund. This allows as part of the planning application process energy and carbon impact of new development to be defined and an obligation on the applicant to achieve the carbon reduction or payment of a defined sum[41]. This could provide developers with the option to make a carbon off-set payment for new build domestic properties, in-lieu of meeting on-site renewable energy or carbon reduction targets. This fund could be managed either by Local Authorities or centrally by the GMCA and channelled into retrofitting of energy efficiency and heating system transitions, smart and innovation initiatives.

9. There is the opportunity to support community-led initiatives for renewable and low carbon energy and GM has a number of community energy projects under development across the city region[42]. The shift to a low carbon energy system could represent a

[41] http://www.nef.org.uk/about-us/insights/milton-keynes-pioneering-carbon-offset-fund-six-years-on

[42] http://gm-communityenergypledge.org.uk/

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significant opportunity for renewable energy generating infrastructure and a range of energy services to be funded, owned and operated by local communities in GM[43].

10. There are a range of voluntary sustainability initiatives for new homes and buildings that support higher standards of energy efficiency, use of low carbon and renewable energy. GM policy could support consideration of these by individual districts in terms of suitability and setting of local policies where supported by appropriate evidence.

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[43] http://gm-communityenergypledge.org.uk/#CommunityEnergy

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2 Introduction

This study provides a strategic analysis and evidence base to support the emerging Greater Manchester Spatial Framework. This evidence base collates existing information regarding the current energy system in Greater Manchester, examines the impact of planned future growth, the potential for low carbon and renewable energy, and considers the future opportunities and challenges that will affect the region and its districts.

National policy recognises the important role of spatial planning in meeting the challenge of climate change and the requirement for regional and local responses. This report provides an assessment of existing GM energy demand and supply, analysis of the impact of planned future growth to 2035, and potential for decentralised, low carbon and renewable energy in supporting GM energy and climate change goals. It focuses on those technologies that are technically mature, whilst also considering the potential role of future innovation, research and development.

It consolidates the available spatial data and information relating to Greater Manchester's energy system and provides a robust evidence base to support emerging energy planning policy as part of the Greater Manchester Spatial Framework (GMSF). This is needed alongside complementary enabling mechanisms, including new business and development models, delivery vehicles and planning approaches, for GM to achieve its publicly committed goal of reducing emissions to a maximum of 2 tonnes per capita by 2050. This, in turn will help GM play its part in keeping global mean temperature rises below 2 degrees as part of its Memorandum of Understanding and Compact of Mayors commitments.

2.1 Study Area

Greater Manchester (GM) is a metropolitan county in North West England, with a population of **2.7 million people** and approximately **1.1 million homes**[44]. It encompasses one of the largest metropolitan areas in the United Kingdom and comprises ten metropolitan boroughs: Bolton, Bury, Oldham, Rochdale, Stockport, Tameside, Trafford, Wigan, and the cities of Manchester and Salford.

In this report the Boroughs and Cities of Manchester and Salford will be referred to as 'Districts'.

[44] https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/bulletins/subnationalpopulationprojectionsforengland/2014basedprojections/relateddata

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Figure 2-1 Greater Manchester

Almost all of the Greater Manchester region is classified as Urban major conurbation, with some fringe areas classified as Urban city and town and a small number of rural town and village areas. No areas are considered completely rural.

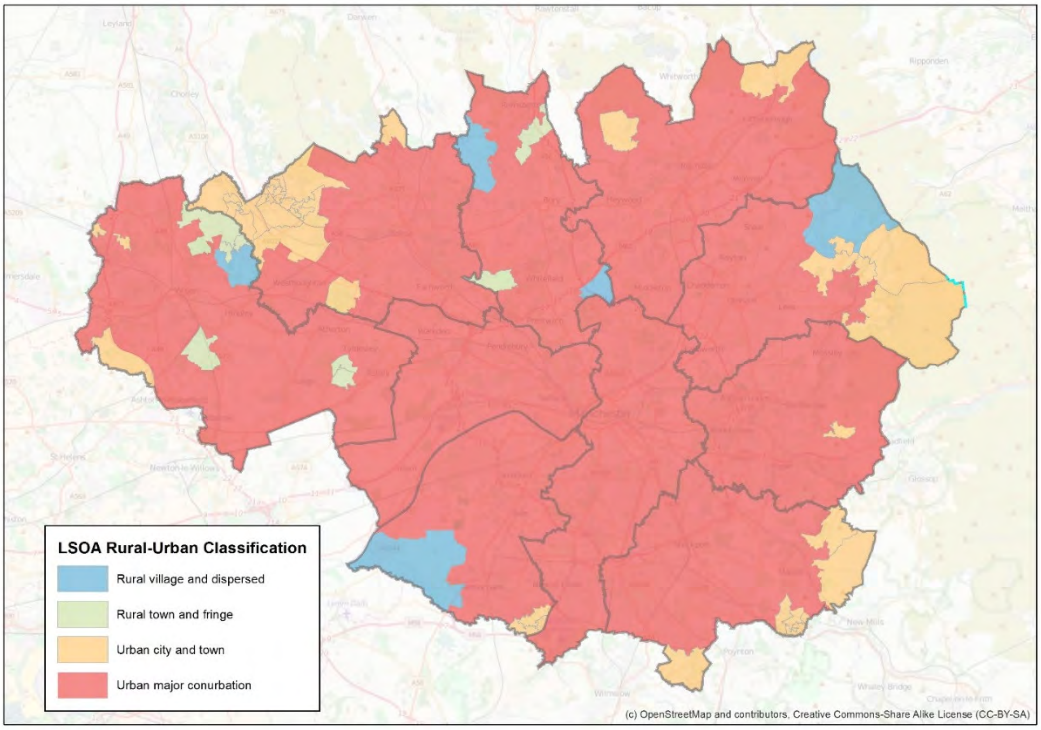

Figure 2-2 Rural-urban classification

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2.2 Objectives

The objective of the study is to provide updated strategic evidence and consolidation of current available spatial and other data including previous evidence base studies to support low and zero carbon energy use and related policies as part of the emerging Greater Manchester Spatial framework. This includes:

- Understand existing energy demand and supply system and current contribution of low carbon and renewable energy in the context of existing carbon and climate change targets;
- Understand potential impact of planned growth forecast through the Greater Manchester Spatial Framework on the local energy system and meeting carbon reduction targets;
- Identify existing and assess technical potential, opportunities and constraints to further deployment of decentralised, low carbon and renewable energy in support of a low carbon energy system;
- Identify opportunities associated with new development and strategic growth sites and supporting energy infrastructure with existing communities;
- Outline potential policy framework and evidence to support a low carbon future for Greater Manchester.

2.3 Methodology

This section provides a high-level description of the approach and methodologies used in assessment of the GM energy system and impact of planned growth and opportunities for energy system transition.

2.3.1 Existing energy demand and supply system

In order to gain an understanding the full energy landscape that exists within Greater Manchester a systematic approach has been adopted.

The energy system has been split into four areas of study; demand, supply, consumption and carbon emissions. Figure 2.3 gives an overview of the approach with examples of the data and information that has been collated and analysed for the study.

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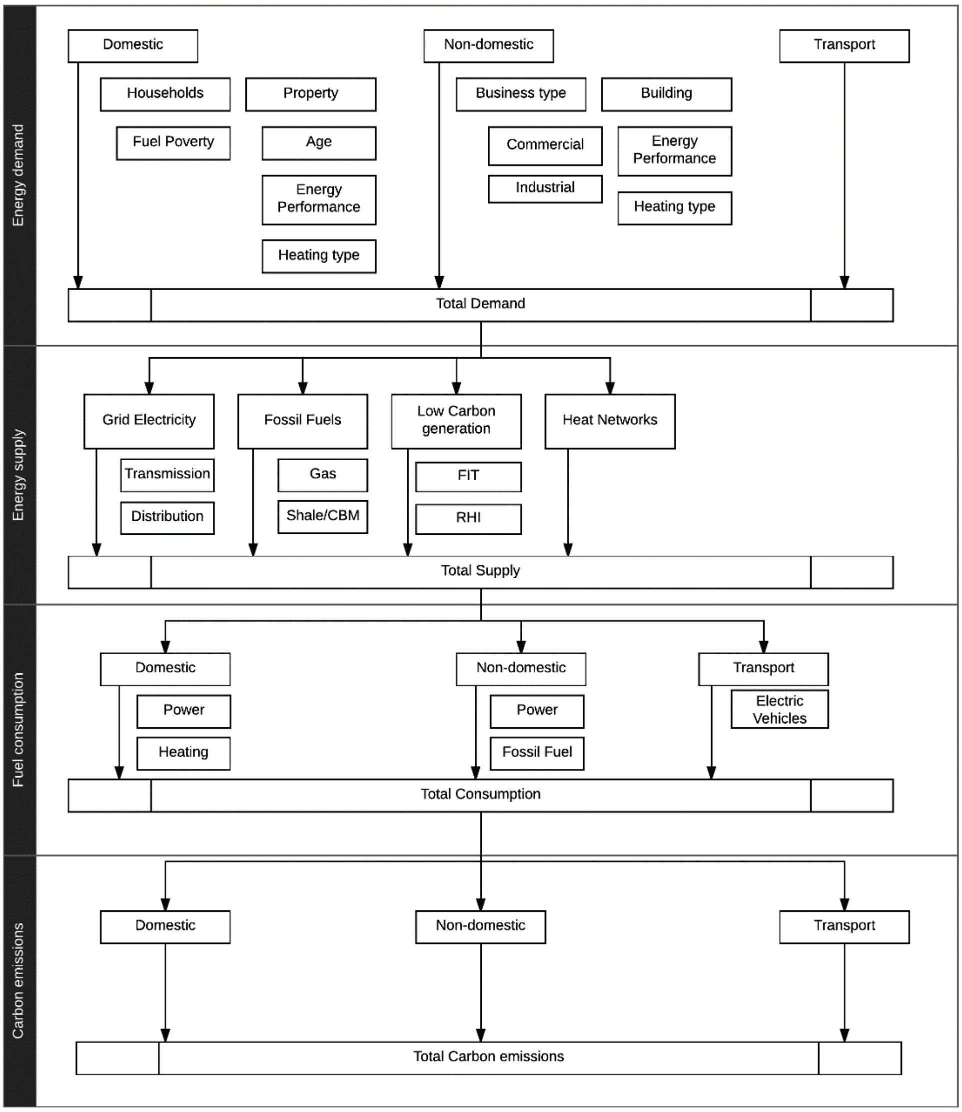

Figure 2-3 Approach to analysing existing energy system and carbon emissions

Where previous reports and studies have been identified of relevance by the Energy Systems Catapult or GMCA, relevant information has been incorporated and referenced accordingly.

All input data used within the study is accessible within the public domain, or has been issued by the GMCA for the purposes of this study. Where calculations have been carried out, they are in line with accepted conventions, publicly available methodologies or the methodology given in the report.

The analysis has principally been completed using a bespoke model constructed in Microsoft Excel. Some elements of the process have been completed using geographic information system (GIS) software to complete spatial mapping of data sets, and undertake spatial analysis of trends and opportunities.

2.3.2 Technical Potential

In order to estimate the technical potential of energy supply from regional resources, a hierarchical approach is used. With information available from a number of source the following hierarchy is used.

Existing detailed studies

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- GM has a number of detailed studies for a specific area or technology. These have been assessed as the best quality available data and information relating to technical potential and are used in preference.
- Examples of the detailed studies used include:
  - Heat network masterplan for Greater Manchester
  - Wind studies carried out in 6 districts

Existing capacity studies

- GM has a number of existing evidence base studies available for some technologies that are more in depth than the DECC methodology covers. These are used where no detailed studies are available.
- Examples of the detailed studies used include:
  - Decentralised and zero carbon energy planning study for GM

DECC renewable capacity methodology[45]

- This is a standardised approach that uses local data regarding number of households and businesses to make high level projections of the potential capacity available in any one renewable or low carbon technology. This approach is used where no previous study has been identified.

2.3.3 Future Scenarios

Potential future energy scenarios have been created using an approach similar to that employed by the National Grid's Future Energy Scenario's methodology.

This entails making a number of projections of various factors that affect future energy demand and consumption. Figure 2-4 shows an overview of the methodology used. Buildings are dealt with on a domestic, commercial and industrial basis with new build and existing buildings modelled separately. Transport is modelled from an energy viewpoint but projections are provided for the carbon emissions.

[45] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/226175/renewable_and_low_carbon_energy_capacity_methodology_jan2010.pdf

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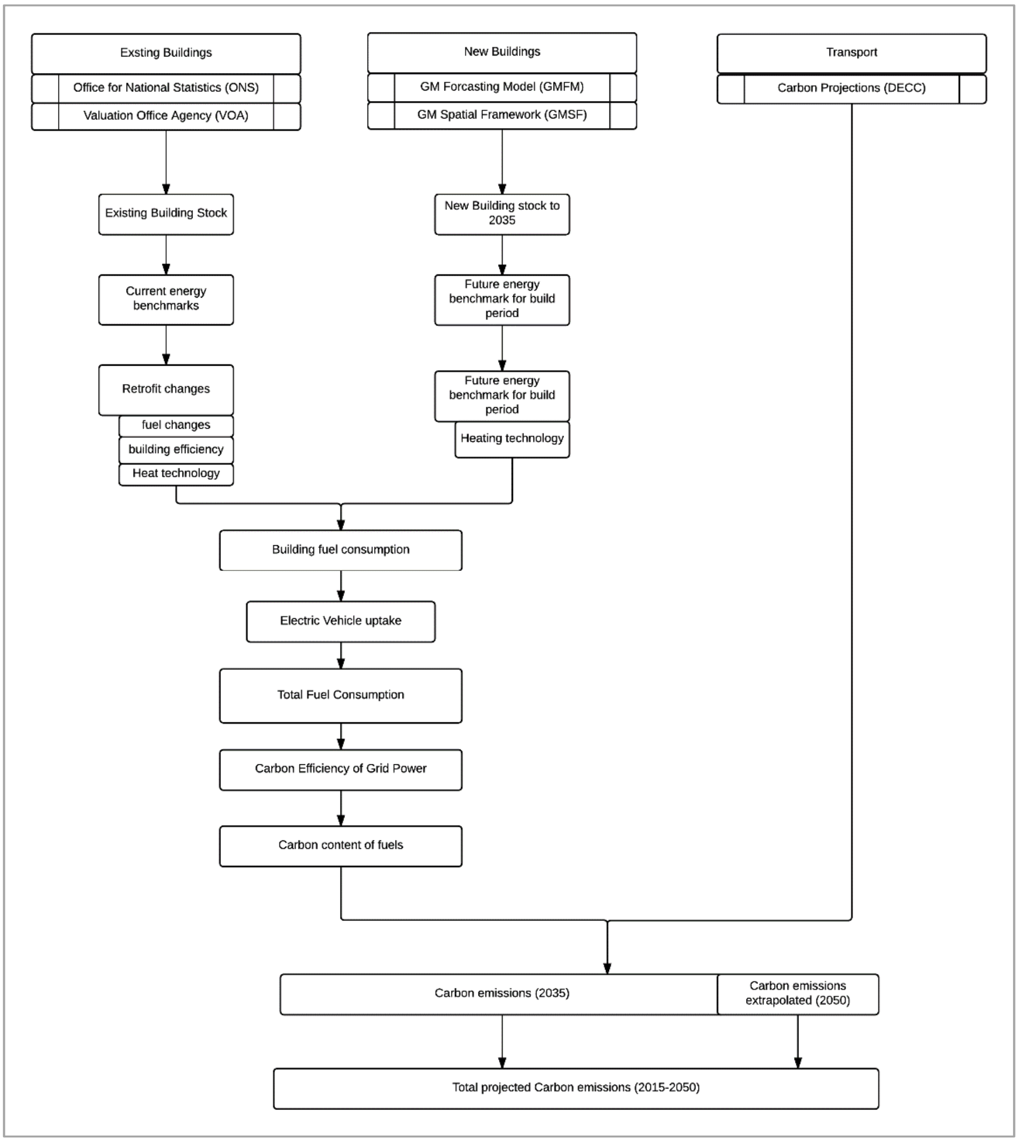

Figure 2-4 Future Scenarios methodology

The future energy scenario modelling has been undertaken at a high-level for this study and the approach cannot fully capture the inherent complexities and interaction of the national, regional and local energy system. It should therefore be taken as indicative of the general direction of travel and range of possible outcomes. More details are given in the future scenarios section of the report.

Household and non-domestic growth projections have been taken from the Greater Manchester Forecasting Model (GMFM) prepared for the Greater Manchester Spatial framework (GMSF)

2.3.4 Limitations and Exclusions

A study of this nature is subject to significant limitations and uncertainty as high-level data has been the principle basis in many cases. detailed assessment adopting a building by building approach has not been possible or appropriate for the purposes of this study.

Where data has not been available or is of insufficient quality, assumptions have been made. Assumptions are clearly indicated where used with reference to any background data or information that informs the assumption.

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This study is only applicable at a GM level. More detailed analysis of data has been carried out in some cases, but only where it has been useful in assessing issues within individual GM districts or in providing a specific example.

Assessment of technical potential using the DECC methodology provides an indication of the theoretical potential capacity of technologies within the conurbation based on available resources. It is not a reflection of commercial viability or feasibility of projects that could be delivered.

The study is focussed principally on energy used within buildings, both domestic and no-domestic. It does include industrial process and transport in the overview, however no work has been undertaken by the Catapult to investigate these areas further. In the case of industrial processes, detailed review is outside the scope of this study and is difficult due to the variable nature of each business and processes. Transport, although an important factor in relation to carbon emissions within the conurbation and potential impacts on the energy system is not considered in detail and is assumed to be assessed independently as a key issue for the Greater Manchester Spatial Framework (GMSF). Both current and future impacts of transport have been included within assessment of carbon emissions to enable a strategic view of emissions impacts to be given. However, the limitations of this approach are acknowledged.

2.3.5 Data Sources

Data has been taken from publicly available data sources. Where possible government publications and data sources have been used. Some data and information has been provided by the Greater Manchester Combined Authority (GMCA). All sources are referenced.

Where domestic data is used, it is presented both in total and normalised by household to allow spatial comparisons. This is considered the best approach for comparisons between local authorities as each LA varies in its population and housing stock.

Where non-domestic data is used, it is presented normalised by non-domestic building footprint area. Non domestic types have been treated together is most cases, and only where there is a specific understanding required are the non-domestic sectors split and analysed separately.

The latest data and publications available at time of writing are used. This may lead to small discrepancies between datasets as figures from different years is used due to the release dates for specific datasets. For example, the latest sub-regional energy consumption data is from 2014, while the latest sub-regional carbon emissions dataset is from 2013. This is not considered to be a concern as the discrepancies year on year are small. Where disparity is considered an issue, it is noted and any assumptions or corrections clearly recorded.

Data is available at different levels of resolution, where possible Middle Super Output area (MSOA) data has been used. Where this is not available district and regional level datasets are utilised. Where extrapolations or trends are calculated, this is clearly noted. Other resolutions, such as postcode level, have been used where appropriate.

Where detailed geographical data has been used it has been sources from Ordnance Survey through the Master map (OSMM) product. The OS Address base product has been used for a breakdown of buildings and types in specific geographic area.

Data analysis has been carried out primarily in Microsoft Excel. Spatial mapping and analysis has been carried out using a number of GIS mapping tools, including ESRI Arcmap and QGIS.

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Geographic boundaries have been sourced from the Office for National Statistics (ONS) geoportal.

During the compilation of this report the Department for Energy and Climate Change (DECC) and Department for Business, Innovation and Skills (BIS) have merged to form the Department for Business, Energy and Industrial Strategy (BEIS). Where data used was released by DECC this report references the DECC source. No BEIS data is used.

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3 Policy Context

3.1 Regulation and Policy

This section describes existing relevant national, regional and local policies and measures affecting energy planning within Greater Manchester. It is not exhaustive and provides an overview of the most pertinent policies and measures relevant to the study.

National legislation and guidance covers a range of primary and secondary legislation related to the UK energy system and its future decarbonisation. This includes "the Planning Acts" in addition to a range of additional documents such as the National Planning Policy Framework (NPPF) and the Planning Practice Guidance (PPG).

3.1.1 Current UK Energy Policy

The Climate Change Act 2008

The Climate Change Act 2008, established a framework to develop an economically credible emissions reduction path. It established the UK as an international innovator, highlighting the role it would take in contributing to urgent collective action to tackle climate change. The act commits the UK to reducing emissions by at least 80 % in 2050 from 1990 levels. This includes Greenhouse Gas emissions from the devolved administrations [Northern Ireland, Scotland & Wales], which currently accounts for around 20 % of the UK's total emissions.

The Energy Act 2008

The Energy Act 2008 was introduced by the Secretary of State for Business, Enterprise and Regulatory Reform on 10th January 2008 and gained Royal Assent on 26th November 2008. The Act introduced the provisions which allow for Feed in Tariffs and the Renewable Heat Incentive

The Renewables Obligation

The Renewables Obligation (RO) was introduced to support electricity generation from renewable sources. The RO came into effect in 2002 in England and Wales, and Scotland, followed by Northern Ireland in 2005. It places an obligation on UK electricity suppliers to source a growing percentage of electricity from eligible renewable generation capacity.

Feed-in Tariff

The Feed-in Tariff (FiT) was introduced by the UK Government in order to support renewable electricity generating technologies of up to 5 MWe.

Renewable energy subsidies are paid for via energy bills through a number of schemes including the Feed-in Tariff scheme and Renewable Obligation scheme. Government decided on a set amount that would be paid to renewables by 2020 and in 2015. The Office for Budget Responsibility projected that the amount would be exceeded, meaning bill payers would have to pay more. Government has since taken action to

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reduce this overspend through reductions in renewable energy subsidies which is now being managed through staged degression of supporting tariffs[46].

Contracts for Difference

The Contracts for Difference (CfD) regulations came into force in Great Britain on the 1st August 2014 and will replace the Renewables Obligation for new projects 1st April 2017. Under CfD a generator party is paid the difference between the 'strike price' (a price for electricity reflecting the cost of investing in a particular low carbon technology) and the 'reference price' (a measure of the average market price for electricity).

Renewable Heat Incentive

The Renewable Heat Incentive (RHI), launched in November 2011, is designed to provide support to renewable heat technologies and provides support where heat is used in a building for 'eligible purposes': heating a space, heating water or for carrying out a process where the heat is used. Unlike the RO and FIT, the RHI is funded through general taxation, which means the scheme budget is set at each Government Spending Review, however spending is still controlled by tariff degression, which works by gradually lowering the tariffs that are paid to new applicants as more renewable heating systems are installed[47].

Heat mapping

The government has developed a heat map of England, which helps to identify areas of high heat consumption and potential sources of heat supply. It identifies heat consumption for public, commercial, industrial and residential buildings and Combined Heat and Power (CHP) installations. It was developed to assist local authorities in initial heat mapping and supporting local energy planning before feasibility studies for heat networks are undertaken.

The Challenge of a Low Carbon Energy Future

The Committee on Climate Change (CCC) has stated that the Government's current low carbon policy framework will not deliver the carbon savings that will be required beyond 2020. According to the CCC, extending current policies into the 2020s will not deliver the emissions savings required to meet the fourth carbon budget period (2023 – 2027). Evidence suggest that currently there is no visibility of specific policies driving low carbon heat supply and energy efficiency retrofit beyond the next 1-2 years, even though there are long-term targets in place for carbon and fuel poverty reduction[48]

Decarbonising heat is essential if the UK is going to meet its 2050 target of reducing emissions by 80 % below 1990 levels. To do this will require greater involvement of Local Authorities, to support local decarbonisation strategies of the energy system. Improving energy efficiency could also help increase the sustainability, resilience and affordability of the energy system reducing fuel poverty.

The recent vote for the UK to leave the EU has created a great deal of uncertainty which could translate to the future energy policy framework. However, the UKs climate change obligations and targets remain enshrined in UK legislation through the 2008 Climate Change Act. The other major uncertainty that may

[46] https://www.gov.uk/government/news/changes-to-renewables-subsidies

[47] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/324724/Domestic_degression_factsheet.pdf

[48] report by Carbon Connect on the future of heat policy in the UK

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affect the implementation of the GMSF surrounds the ability to obtain finance. It is not yet clear how these uncertainties will be resolved.

3.1.2 Planning

Primary Legislation

The Planning and Compulsory Purchase Act 2004

The Planning and Compulsory Purchase Act 2004 was introduced by the Deputy Prime Minister on 4th December 2002 and gained Royal Assent on 13th May 2004. Although substantially altered by subsequent legislation, the Act made significant changes to the planning system including the introduction of the Local Development Framework approach to Development Plan preparation.

Section 19 (1A) includes a specific requirement for Local Planning Authorities (LPAs) to include policies relating to climate change in Development Plan Documents:

"Development plan documents must (taken as a whole) include policies designed to secure that the development and use of land in the local planning authority's area contribute to the mitigation of, and adaptation to, climate change"

The Planning Act 2008

The Planning Act 2008 was introduced by the Secretary of State for Communities and Local Government on 27th November 2007 and gained Royal Assent on 26th November 2008. The Act deals with larger infrastructure projects and established the Infrastructure Planning Committee and the provision of National Policy Statements.

Although the Act is concerned with larger projects, the threshold for energy projects to be decided by the Infrastructure Planning Committee was set at 50 MW, below which development is to be decided upon locally.

The Localism Act 2008

Introduced by the Secretary of State for Communities and Local Government on 10th December 2010, the Bill completed its third reading in Parliament on 31st October 2011 and gained Royal Assent on 15th November 2011. The Act enacts a number of key pledges made in the 2010 Conservative Party manifesto, focussing on the reorganisation of Local Authority powers, seeking to deliver greater decision making powers to local residents, away from national and local Government.

With specific regard to energy planning in Greater Manchester, the following elements of the Act are of note:

- Schedule 2 of the Act provides a significant alteration to the Local Government Act 2000 including provisions for the referenda and elections of directly elected mayors. AGMA agreed to make use of these powers to elect a directly elected mayor under whom the GMSF will be adopted.
- Part 6, Chapter 1 abolished Regional Spatial Strategies and replaced these formal plans with a requirement for LPAs to cooperate and consult with neighbouring authorities known as the Duty to Cooperate.

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- Part 6, Chapter 3 provides further support for Neighbourhood Planning and includes the need for such plans to undergo inspection and be adopted following a referendum.

The Housing and Planning Act 2016

The Housing and Planning Act was introduced by the Secretary of State for Communities and Local Government on and was adopted on 12th May 2016. The Act has limited impact on the deployment of Smart Energy Systems however a number of provisions relating to the intervention by the Secretary of State in plan making are included.

The National Planning Policy Framework

The National Planning Policy Framework (NPPF) was published on 27th March 2012 and contains national planning policy for England. The NPPF covers two themes of note relating to the deployment of Smart Energy Systems; the support for such technology in the promotion of sustainable development and the mitigation of climate change and guidance on the preparation of Local Plans, the means by which development is managed.

Achieving Sustainable Development

The NPPF states that the purpose of the planning system is to contribute to the achievement of sustainable development. Paragraph 7 outlines that sustainable development is considered to have a three elements; social, economic and environmental. These elements give rise to three key roles to be played by the planning system. The environmental role is considered to be:

"contributing to protecting and enhancing our natural, built and historic environment; and, as part of this, helping to improve biodiversity, use natural resources prudently, minimise waste and pollution, and mitigate and adapt to climate change including moving to a low carbon economy."

The NPPF sets out a presumption in favour of sustainable development and reiterates that "planning law requires that applications for planning permission must be determined in accordance with the development plan unless material considerations indicate otherwise". While the NPPF is a material consideration in the determination of planning applications, the NPPF does not change the status of the Development Plan as the starting point for decisions.

Core Planning Principles

Within the three roles identified above, paragraph 17 provides further specific "core principles" which govern development including:

- "support the transition to a low carbon future in a changing climate, taking full account of flood risk and coastal change, and encourage the reuse of existing resources, including conversion of existing buildings, and encourage the use of renewable resources (for example, by the development of renewable energy)
- take account of and support local strategies to improve health, social and cultural wellbeing for all, and deliver sufficient community and cultural facilities and services to meet local needs."

Chapter 10 Meeting the Challenge of Climate Change, Flooding and Coastal Change

Paragraph 93 frames the NPPF's approach regarding Climate Change:

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"Planning plays a key role in helping shape places to secure radical reductions in greenhouse gas emissions, minimising vulnerability and providing resilience to the impacts of climate change, and supporting the delivery of renewable and low carbon energy and associated infrastructure. This is central to the economic, social and environmental dimensions of sustainable development."

Paragraph 95 provides support to the deployment of decentralised energy systems by stating that Local Authorities should "plan for new development in locations and ways which reduce greenhouse gas emissions".

Furthermore, paragraph 97 highlights that all communities have a responsibility to contribute to a reduction in carbon emissions and requires that LPAs should:

- have a positive strategy to promote energy from renewable and low carbon sources;
- design their policies to maximise renewable and low carbon energy development while ensuring that adverse impacts are addressed satisfactorily, including cumulative landscape and visual impacts;
- consider identifying suitable areas for renewable and low carbon energy sources, and supporting infrastructure, where this would help secure the development of such sources;
- support community-led initiatives for renewable and low carbon energy, including developments outside such areas being taken forward through neighbourhood planning; and
- identify opportunities where development can draw its energy supply from decentralised, renewable or low carbon energy supply systems and for co-locating potential heat customers and suppliers"

Paragraph 98 informs LPA that when determining applications, Authorities should:

- "Not require applicants for energy development to demonstrate overall need for renewable or low carbon energy and also recognise that even small scale projects provide a valuable contribution to cutting greenhouse gas emissions;
- Approve the application if its impacts are (or can be made) acceptable. Once suitable areas for renewable and low carbon energy have been identified in plans, local planning authorities should also expect subsequent applications for commercial scale projects outside these areas to demonstrate that the proposed location meets the criteria used in identifying suitable areas".

Plan Making

Paragraphs 150 to 185 provide guidance for plan makers on a range of topics initially reiterating the importance of Local Plans in reflecting the aims and objectives of local communities and forming the basis upon which decision should be made while contribution to the delivery of sustainable development. Paragraph 153 allows for the use of additional Development Plan Documents (DPDs) and Supplementary Planning Documents (SPDs) where there is a justified need and will not cause unnecessary financial burdens to developers. Paragraph 156 sets out the need for LPAs to define the strategic priorities of the plan including:

- "the homes and jobs needed in the area;

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- the provision of retail, leisure and other commercial development;
- the provision of infrastructure for transport, telecommunications, waste management, water supply, wastewater, flood risk and coastal change management, and the provision of minerals and energy (including heat);
- the provision of health, security, community and cultural infrastructure and other local facilities; and
- climate change mitigation and adaptation, conservation and enhancement of the natural and historic environment, including landscape."

Paragraph 158, reiterates the need for Local Plans to be founded on "adequate, up-to-date and relevant evidence" relating to the local economy, environment and social needs. As part of the evidence base, Paragraph 162 states that Local Authorities should work with a range of other parties to assess the capacity and quality of infrastructure for a range of utilities and services such as "energy (including heat)".

Planning Practice Guidance

The Planning Practice Guidance (PPG) covers a wide range of topics relevant to applicants, decision takers and plan makers.

Climate Change

The statutory duty to conclude consideration of climate change in Local Plans is reiterated in the climate change section of the PPG. A number of suggestions relating to how climate change can be mitigated and adapted to in Local Plans including "Providing opportunities for renewable and low carbon energy technologies" and "Providing opportunities for decentralised energy and heating".

This section also highlights the opportunity to consult with third parties regarding the most appropriate approach for ensuring climate change is addressed:

"*Engaging with appropriate partners, including utility providers, communities, health authorities, regulators and emergency planners, statutory environmental bodies, Local Nature Partnerships, Local Resilience Forums, and climate change partnerships will help to identify relevant local approaches."*

Renewable and Low Carbon Energy

The PPG provides a full section on Renewable and Low Carbon Energy which includes decentralised energy as defined in the NPPF: "Local renewable energy and local low-carbon energy usually but not always on a relatively small scale encompassing a diverse range of technologies."

The chapter provides an informative guidance section on how decentralised energy opportunities can be identified which is included in full below.

"There is an important contribution to be made by planning that is independent of the contribution from other regimes such as Building Regulations. For example, getting the right land uses in the right place can underpin the success of a district heating scheme. Similarly, planning can influence opportunities for recovering and using waste heat from industrial installations.

Planning can provide opportunities for, and encourage energy development which will produce waste heat, to be located close to existing or potential users of the heat. Planning

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can also help provide the new customers for the heat by encouraging development which could make use of the heat.

Information on local heat demand is published by the Department of Energy and Climate Change to assist planners and developers in identifying locations with opportunities for heat supply. See the national heat map and the UK CHP development map. This information will be supplemented in future by further work, including detailed mapping, on the potential for combined heat and power and district heating and cooling."

3.1.3 Community Energy

The first national Community Energy Strategy: People Powering Change was published in 2014[49] by DECC and updated in 2015[50]. This established the potential benefits of community energy and a vision of a flexible, devolved, competitive and innovative energy system that serves local people. It highlighted that local communities can make an important contribution to maintaining energy security, tackling climate change and keeping costs down for consumers.

The strategy defined the key benefits of community energy as:

- maintaining energy security and tackle climate change
- saving money on energy bills
- Bringing wider social and economic benefits, including generating income streams for the community, increasing community cohesion, and building confidence and skills.

It established the Governments support for a spectrum of community models to energy generation, demand reduction, demand management and purchasing. This included wholly community-led and owned, and at other times, partnership working with the private, public and voluntary sectors supporting transition to a low carbon energy system.

In March 2016 DECC published a Community Heat Toolkit[51] to help communities and smaller local authorities identify and develop community heat schemes. This found community groups and local authorities at all scales are looking at how their heat is generated and used and coming up with innovative projects to help address fuel poverty, reduce energy bills and increase sustainability. It identifies opportunity for community heat in the UKs future energy system, guidance and information to support community heat network projects and the need for heat networks to be considered as part of wider plans for the community and associated socio-economic impacts

3.1.4 Building Regulations

The Building Regulations are minimum set standards for design, construction and alterations to buildings to ensure the safety and health for people using the building. They also include requirements to ensure that fuel and power is conserved and facilities are provided for people, including those with disabilities, to access and move around inside a building.

[49]https://www.gov.uk/government/publications/community-energy-strategy

[50]https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/414446/CESU_FINAL.pdf

[51]http://hub.communityenergyengland.org/media/resources/files/Community_Heat_Introduction_Document_2.1.pdf

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The 2014 Building Regulations aim to achieve a further 6 % reduction in a dwelling's carbon footprint by assessing the energy efficiency of the materials used in the build, as well as the CO_2 calculations.

Document L1B sets out the energy efficiency requirements in the Building Regulations. Regulation 2(1) of the Building Regulations defines the energy efficiency requirements of existing dwellings as the requirements of those in regulations 23, 28 and 40 of, and Part L of Schedule 1.

The Building Regulations is the main mechanism at present for the upgrade of the energy performance of existing housing stock when undertaking major renovations.

Part L controls the insulation values of building elements, the allowable area of windows, doors and other openings, air permeability of the structure, the heating efficiency of boilers and the insulation and controls for heating appliances and systems together with hot water storage and lighting efficiency. It also sets out the requirements for SAP (Standard Assessment Procedure) calculations and Carbon Emission Targets for dwellings. Part L was intended as a stepping stone to Net Carbon Zero Homes to be introduced in 2016.

Energy Performance of New Homes

This Chapter provides an overview of the legislative context for energy and carbon emission reduction of new homes in the UK and major residential renovations which would require planning permission. The purpose is to provide insight into the national policy framework supporting energy efficiency and carbon reduction standards for new development.

Code for Sustainable Homes

The Code for Sustainable Homes (CfSH) was a national standard for the sustainable design and construction of new homes in the UK. First introduced into legislation in 2008, CfSH rates the sustainability of homes on a scale from one to six by assessing nine measures of sustainable design; energy/CO_2, water, materials, surface water run-off (flooding and flood prevention) waste, pollution, health and well-being, management and ecology.

A primary aim of the CfSH was to reduce the energy demands of new homes and resulting carbon emissions. The CfSH aimed to ensure that reductions in the carbon emissions produced in the operation of homes increase with each code level as shown in the table below

Code Level	% CO_2 reduction compared to Part L 2006
Level 3	25 %
Level 4	44 %
Level 5	100 %
Level 6	Zero Carbon

Table 3-1 Code of sustainable home emissions reduction

Changes to Part L of the Building Regulations in 2010 required all new dwellings to be built to the equivalent of code level 3 regardless of whether a CfSH level certification was sought. The 2010 policy also set out plans to increase this to the equivalent of code level 4 in 2013, however these were amended as part of the Government's Housing Standards Review which was launched in 2012.

This approach led to Local Authorities' 'cherry picking' aspects of the CfSH by developing local sustainability standards. This meant that the sustainability performance of homes built in different

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regions varied depending on the planning requirements that the respective Local Authority had put in place. This resulted in developers having to have different designs for standard housing types between different regions. The combination of these impacts led the Government to launch a review of housing standards in 2012.

3.1.5 The Housing Standards Review

The Housing Standards Review was completed in 2014 and passed into law in 2015. It aimed to cut 'red tape' in the planning system by placing restrictions on technical items that Planning Authorities could request as part of planning permissions and created national standards by incorporating some aspects into the Building Regulations. Both technical and non-technical design and building standards have been rationalised into three areas: planning, Building Regulations and technical standards.

Figure 3.1 illustrates the rationalisation of design and building standards following the housing standards review:

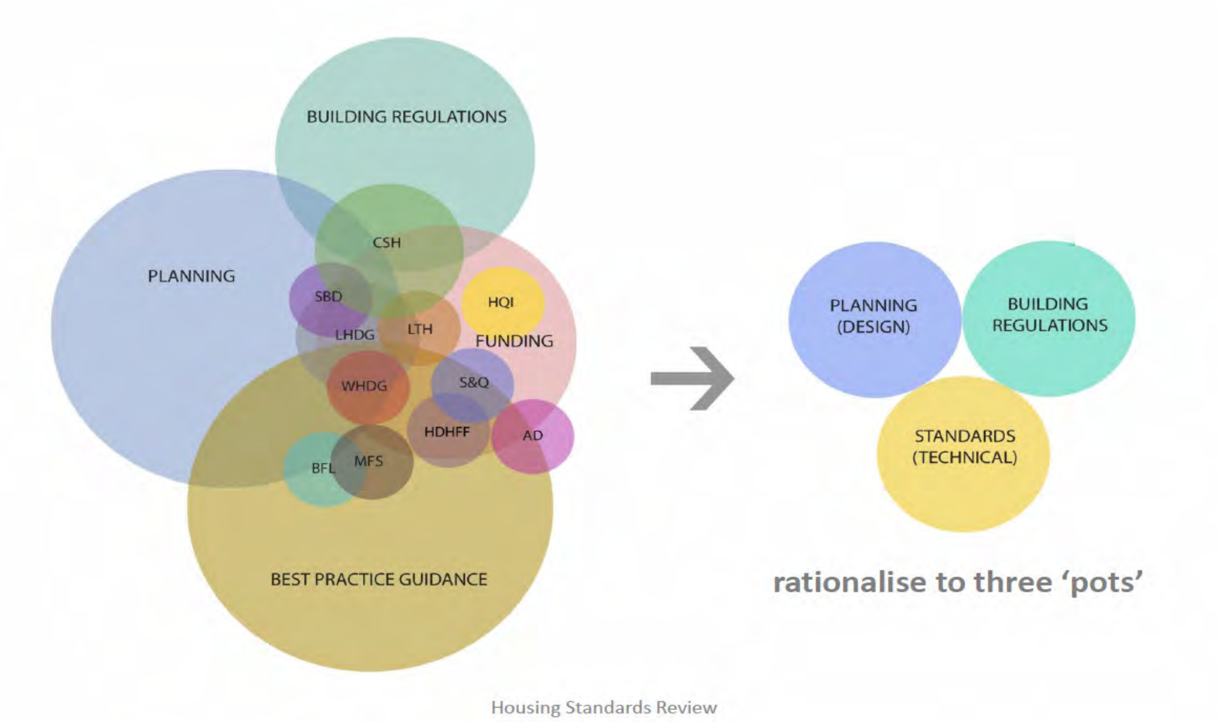

Figure 3-1 Housing standards review 2015

Part of the rationalisation process included the decoupling of CfSH from legislation, meaning that planners can no longer require compliance with the Code as part of granting planning permission. Some aspects of CfSH, including energy efficiency were incorporated into the Building Regulations providing a national standard which planners and cannot require developers to exceed:

- Part L 1A. 2013 requires all new homes to be designed to reduce operational carbon emissions by 29.5 % compared to Part L 2006.

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- Part L 1B 2013 requires that all major renovations (more than 50 % of the elements surface area or an area of over 1000m2) comply with Part L1A in so far as it is technically, functionally and economically feasible.

Part L 2013 exceeds CfSH level 3 standards of energy efficiency (25 % reduction in CO_2 compared to 2006), but does not meet CfSH level 4 (44 % reduction in CO_2 compared to 2006) as was planned in 2010 policy on energy efficiency of homes.

At the time of publication of the Housing Standards Review, Part L was to be amended in 2016 to reflect higher energy efficiency standards which would be used in combination with Allowable Solutions (renewable energy) to meet the Government's zero carbon homes target (see section 2.5). The Housing Standards Review was designed to create a 'level playing field' for energy efficiency in new homes across all regions in the UK, and prepare the sector for meeting the Government's 2016 zero carbon homes commitment which has since been abandoned.

3.1.6 Zero Carbon Homes Policy and the Housing and Planning Act (2016)

In 2006 the then Chancellor Gordon Brown made a commitment for all new homes to be zero carbon by 2016. Zero carbon homes were to generate enough renewable energy (originally on site) to off-set the carbon emissions produced in the operation of each home. Since then, Zero Carbon Buildings policy has formed part of successive Governments' wider strategy of achieving an 80 % reduction in carbon emissions by 2050 compared to 1990 levels, as part of the Climate Change Act 2008.

Following the Housing Standards Review, this commitment was to be achieved through a combination of building energy efficiency as defined by Part L 2016 and Allowable Solutions. Allowable Solutions was a mechanism that would allow developers to use off-site renewable energy and carbon reduction initiatives to off-set carbon emissions, which could not be cost effectively off-set on-site.

In July 2015 the Government announced that it would no longer pursue its 2016 zero carbon homes target. This included scrapping both Allowable Solutions and the proposed increase in on-site energy efficiency through Part L in the Housing and Planning Act 2016. As a result, planners remain unable to require on-site energy efficiency standards that exceed 2013 Part L. The Housing and Planning Act 2016 does require: "a review of any minimum energy performance requirements approved by the Secretary of State under Building Regulations in relation to dwellings in England".

The scrapping of Allowable Solutions means that on-site renewables and low carbon infrastructure remains the subject of planning requirements. This means that Local Planning Authorities (LPAs) continue to stipulate different low carbon strategies between developments and Local Plans, leading developers to redesign their developments according to different environmental standards from one LPA area to another. These differences are likely to be the subject of legal challenge by developers following the implementation of the Housing and Planning Act (2016), which seeks to remove all barriers to the supply of new homes.

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3.1.7 EU Energy Performance of Buildings Directive 2010 (EPBD)

Despite the scrapping of zero carbon homes policy in the UK, there remains in place EU legislation requiring all buildings to be nearly zero-energy by 2020. Clearly how this may change as a result of the June 2016 EU Referendum result remains to be seen.

Article 9 of the Energy Performance of Buildings Directive 2010 (EPBD) states that all new buildings should be nearly zero-energy by 31 December 2020.

"Nearly zero-energy means that a building has very high energy performance. The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby23".

The Directive provides a definition of the end result, but as noted, leaves it up to Member States to decide how to adapt their domestic laws in order to achieve this goal. The Commission's guidelines on the delivery of nearly zero-energy buildings includes a clause on cost optimality: meaning that Member States must demonstrate progress towards nearly zero-energy buildings to the point that it is economically viable. It is widely held that this dilutes the effectiveness of this legislation in the UK context, particularly as energy efficiency in new homes far exceeds those in other EU Member States.

3.1.8 Energy Performance of Existing Homes

There is a range of existing legislation and policy relating to the energy efficiency and carbon emissions of existing homes and buildings in the UK.

Residential Minimum Energy Efficiency Standards (MEES)

MEES and tenant rights' regulations aim to improve energy efficiency in the UK residential private rented sector, utilising the Green Deal framework and Energy Performance Certificates (EPC) ratings. The Green Deal is used to identify what improvements are reasonable and cost-effective. EPC Ratings identify which properties fall below an acceptable energy efficiency standard for letting. The final regulations were laid before Parliament in February 2015 following an industry consultation in 2014.

New regulations for domestic private rented (PR) properties come into effect from April 2016, implementing provisions of the UK Energy Act (2011):

- Tenants will have the right to request reasonable energy efficiency improvements from landlords (and superior landlords) that are at no cost to landlord from April 2016.
- MEES come into effect in April 2018 for new leases and 2020 for existing leases. MEES require landlords of domestic PR properties with F or G Energy Performance Certificate (EPC) ratings to implement cost-effective energy efficiency improvements.

MEES and tenant rights' regulations aim to improve energy efficiency in the UK residential private rented sector, utilising the Green Deal framework and Energy Performance Certificates (EPC) ratings. The Green Deal is used to identify what improvements are reasonable and cost-effective. EPC Ratings identify which properties fall below an acceptable energy efficiency standard for letting. The final regulations were laid before Parliament in February 2015 after an industry consultation in 2014.

Domestic Private Rented (PR) Properties

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Energy Efficiency Regulations (2015) apply only to domestic private rented (PR) properties. Tenancies provided by social landlords; low cost rental accommodation provided by a registered social housing provider; and low cost home ownership accommodation are excluded. All other tenancies falling into the categories below are considered domestic private rented (PR) properties:

- Assured tenancies for the purposes of the Housing Act (1988); or
- Regulated tenancies for the purposes of the Rent Act (1997); or
- Certain agricultural tenancies.

Energy Performance Certificates (EPC)

Tenants will have a right to request energy efficiency improvements whether or not the property has an EPC rating. However, the minimum standard for letting (E) applies only to properties with an Energy Performance Certificate. The broad timelines for the introduction of these changes is set out in the table below.

Phase	Compliance Date	Improvements	Responses	Timing	Appeals
	Date from which tenants may request	*Measures that a tenant can request for energy efficiency improvement*	*Landlords can respond in several ways*	*Landlords must respond to requests according to a specific timetable*	*Tenant may appeal landlord decision*
1	1 April 2016	Measures listed on the Green Deal schedule; measures to be connected to gas network; measures that tenant has another method of funding at no cost to landlord.	• **Approve** request • Make a **counteroffer** • **Refuse** on the basis that request is not reasonable (e.g. inappropriate to the property, 3rd party consent refused, existing HHSRS order in place, property devalued by +5 %, same request responded to within 6 months, etc.)	• 1 month to respond • Plus 3 months for a counteroffer • Plus 2 months for obtaining 3rd party consent • Plus 2 months for obtaining expert opinion	Tenants may appeal to a "First-Tier Tribunal." The Tribunal can consent to the tenant request if landlord has not acted in accordance with the regulation in any part of the process.

Table 3-2 Tenants' Right to Request Reasonable Energy Efficiency Improvements Timetable and Compliance Criteria

Compliance Date	Tenancies	Extensions	Exemptions	Penalties
Date by which all qualifying properties must have an E or better EPC rating	*Tenures requiring compliance by this date*	*Landlords may be allowed a 6-month extension to comply in certain cases*	*Landlords may rent F or G rated properties in certain cases*	*Penalties are on a per property basis.*
1 April 2018	New tenancies to **new** tenants **Renewal** or **extension** of existing tenancies	A landlord is forced to offer a new lease involuntarily A new landlord takes ownership of a non-compliant property	All cost-effective measures have been installed; unable to obtain Green Deal finance due to poor credit of landlord or tenant; third party consent withheld; occupying tenant refuses consent where it is	Cumulative up to £5,000 for a single offense Additional cumulative penalties up to £5,000 for

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1 April 2020	**All** tenancies within the domestic PRS, including existing leases	A new landlord takes over a non-compliant property	required; measures are expected to cause devaluation of more than 5 % to the property	non-compliance with initial penalty notice. Additional penalties awarded when tenant changes or 2020 regulatory backstop comes into effect

Table 3-3 Minimum Energy Performance Standards Timetable and Compliance Criteria

The Residential Minimum Energy Efficiency Standards will drive energy efficiency in the UK residential private rented sector. This should support consumer demand for domestic retrofit and decentralised heat and energy solutions across different house types. Landlords may seek innovative solutions that will help improve the EPC of their properties. One of the fundamental issues with the roll out of MEES will be the effective collapse of the Green Deal which is considered further in the section below.

3.1.9 The Green Deal

The 'Green Deal' was officially launched by the Government in January 2013 to permit loans for energy saving measures for properties in the UK following its inclusion in the Energy Act (2011). The scheme was based on, homeowners and long-term tenants employing an official Green Deal Advisor to identify energy improvement measures in their homes. Improvement measures were then to be financed through a low interest loan from the Green Deal Finance Company, which was originally in part funded by Government. Loans are repaid through energy bills of the homes where the improvements were performed and the debt is passed on to new occupants in the event that the landlord or tenant moves on. All loans apply the Green Deal's 'golden rule' that the energy savings a property makes in 25-year period must be equal to or more than the cost of implementing the changes in the first place.

Green Deal energy improvements included upgrades to:

- Insulation: Solid wall, cavity wall and loft insulation;
- Heating;
- Draft-proofing;
- Glazing; and
- Renewable energy generation.

On the 23 July 2015 the Government announced that it would cease financing the Green Deal Finance Company citing the low take-up of the Green Deal – only some 15,000 loans were issued or in progress between January 2013 and July 2015. Although the Green Deal is still technically available through finance from Green Deal Providers the lack of Government funding effectively renders the scheme obsolete as private finance is difficult to secure.

An audit of Green Deal was carried out and established that the loans were too expensive, the scheme was frequently changed and householders did not take up the finance plans at the expected rate. The scheme's failure to persuade households that energy efficiency measures were worth paying for meant it cost the taxpayer around £17,000 per loan plan, according to the report. Auditors concluded the Green Deal did not achieve value for money and delivered "negligible" carbon savings.

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3.1.10 Energy Company Obligation (ECO)

The Energy Company Obligation (ECO) is a Government energy efficiency scheme designed to reduce carbon emissions and tackle fuel poverty. ECO requires larger energy suppliers to deliver energy efficiency measures to UK homes as part of their carbon reduction targets. Targets for each supplier are determined by the size of their share of the domestic energy gas and electricity markets.

There are three main obligations under the scheme as follows:

1. *Carbon Emissions Reduction Obligation (CERO): Under CERO, obligated suppliers must promote 'primary measures', including roof and wall insulation and connections to district heating systems.*
2. *Carbon Saving Community Obligation (CSCO): Under CSCO, obligated suppliers must promote insulation measures and connections to district heating systems in areas of low income. The CSCO target has a sub-obligation which states that at least 15 % of a supplier's CSCO must be achieved by promoting measures to low income and vulnerable households in rural areas or deprived rural areas.*
3. *Home Heating Cost Reduction Obligation (HHCRO): Under HHCRO, obligated suppliers must promote measures which improve the ability of low income and vulnerable households (the 'affordable warmth group') to heat their homes. This includes actions that result in heating savings, such as the replacement or repair of a boiler.*

ECO focuses primarily on energy efficiency improvements within housing stock where residents are at risk of fuel poverty. In addition, the scheme tends to focus on those "hard to do measures" such as large scale solid wall insulation. As a result, ECO has been widely used by social housing providers who can access a subsidy through the scheme to improve the energy efficiency of their stock.

The first phase of ECO (ECO1) ran from January 2013 to March 2015 and during this period, energy providers were found to have met their obligations. However, the cost of ECO for energy suppliers and the impact this was having on household bills was raised as a concern by Government who simplified some of the requirements for the second phase (ECO2) which will run until March 2017. This has resulted in a reduction in overall carbon savings that will be achieved over both phases, as suppliers are able to carry over surplus savings from ECO1 to ECO2[9].

The changes to ECO2 have resulted in fewer subsidies available to social landlords which combined with other budgetary pressures, has led to a decrease in energy efficiency measures beginning implemented through ECO.

3.1.11 Smart Metering

Smart meters give near real time data on energy and gas use and are thought to help users to reduce their energy consumption.

The UK Government is pursuing a supplier led roll-out of smart meters and is requiring energy companies to offer smart meter installation to all customers by 2020. This will create a new platform for innovation in

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energy data which will support the development of a wide range of new technologies and services as well as empowering consumers[52].

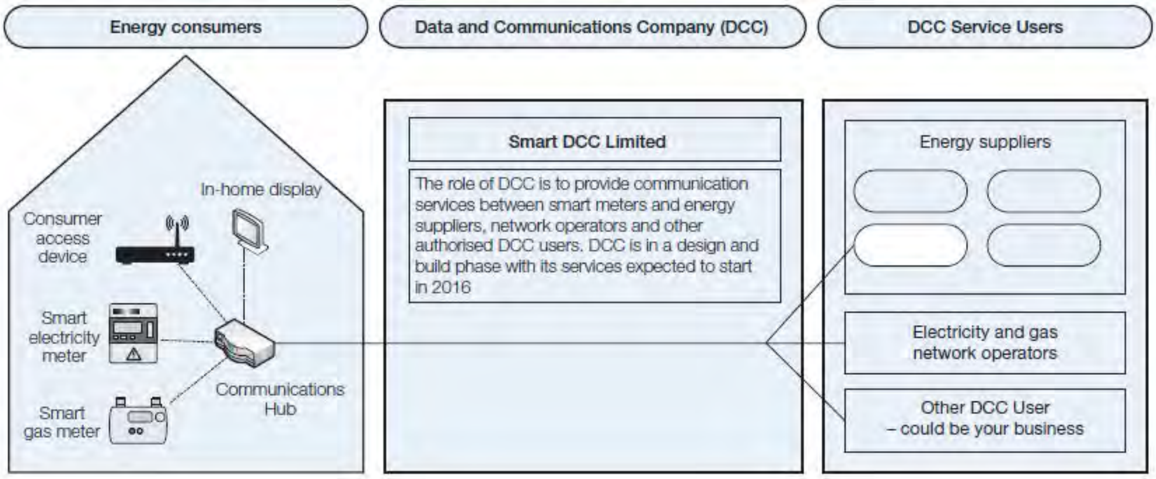

Figure 3-2 Smart Metering

Image © DECC 2016

Such services could include smart heating systems or home automation controls able to access energy and tariff data from the smart metering system. This could connect time-of-use tariffs with smart appliances and control systems as well as actual consumption data and costs to inform consumers and service providers.

3.2 Regional

3.2.1 The Greater Manchester Spatial Framework

In January 2014, the GMCA agreed to bring forward a Greater Manchester Spatial Framework (GMSF) in order to identify and guide future housing and employment land requirements, allowing GM to effectively steer development within the city region. The stated purpose of the GMSF is:

"to manage the supply of land across the conurbation thus supporting sustainable growth over the next two decades. It will provide the basis to secure the strategically important sites which will drive future economic growth and bring forward the supply of land necessary to accelerate housing development to meet forecast housing requirements."

The most recent public consultation on the GMSF, the "Strategic Options Consultation" which ran from November 2015 to January 2016 highlighted the integral consideration of climate change and development of Greater Manchester as a Smart City:

Climate Change

"Climate change will therefore be a key theme running throughout the GMSF, for example in terms of ensuring that development is located so as to reduce the need to travel, maximise the use of sustainable travel modes,

[52] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/397291/2903086_DECC_cad_leaflet.pdf

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support low carbon energy use and minimise the impacts of extreme weather events. It will also further enhance the importance of high quality green infrastructure, helping to reduce the impacts of the urban heat island and enabling plants and animals to adapt to a changing climate."

A Smart City

"The GMSF will support Greater Manchester's development as a smart city, and a key component of this will be ensuring high levels of digital connectivity across the urban area."

History of Energy Planning in Greater Manchester

In 2008 Manchester City Council approved a Report entitled 'The Principles of Tackling Climate Change in Manchester', from which the Council could develop an action plan outlining how Manchester would become a low carbon city by 2020.

The principles covered issues ranging from appropriate target setting and consistency with the UK Climate Change Act, through to the need to build climate change awareness and skills into the mainstream education system. The principles provided a base from which a range of activity has been undertaken, including the use of Manchester's Local Area Agreement to make further commitment to reducing carbon emissions.

Building on the commitments made in the 'Principles' Report, the 'Climate Change Call to Action' was then released in 2009. This set out new ways of thinking about climate change and described how taking early action on climate change could deliver an even better city in which to live and work. The Call to Action stated that by 2020 the City would have reduced emissions by at least one-third. The Call to Action was followed by 'Manchester: A Certain Future' in late 2009.

In addition, the Greater Manchester Climate Strategy 2011-2020 provides a useful overview of energy planning in Greater Manchester to date, including:

- ***Low Carbon Economic Area** – the Greater Manchester area was designated a Low Carbon Economic Area in 2009 which resulted in a range of work being undertaken by AGMA to establish carbon efficient buildings and infrastructure across GM. This work includes retro-fitting buildings, decarbonising GM's energy supply and training businesses and the workforce within the area.*
- ***Greater Manchester Energy Plan** – Launched in 2010, the Greater Manchester Area Plan provides an overview of Greater Manchester's energy system and sets out Greater Manchester's core energy challenges and priorities to 2020.*
- ***Decentralised and Zero Carbon Energy Report** – published in 2010, this work sought to provide strategic evidence to enable Core Strategies to set minimum targets for low and zero carbon energy, identify opportunities for linking new development and supporting energy infrastructure with existing communities, identify the most appropriate energy mix for delivering new development and growth aspirations across Greater Manchester. It set out the spatial planning actions required to deliver this 'new' critical infrastructure, supported by targets for low and zero carbon energy. The document goes into some detail in terms of spatial planning approaches for energy and was written in the context of Regional Spatial Strategies being in place.*
- ***Greater Manchester Climate Change Strategy** – the GM Climate Change Strategy was launched in July 2011 and identifies four key objectives; to make a rapid transition to a low*

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carbon economy, to reduce collective carbon emissions by 48 % by 2020, to be prepared for and actively adapting to a rapidly changing Climate and ensure 'Carbon literacy' is embedded into the culture of our organisations, lifestyles and behaviours.

3.3 Local Authority

3.3.1 Local Authority Planning Policy in Greater Manchester

Each of the 10 constituent Authorities which constitute Greater Manchester have a range of local planning policy which will be redrafted in due course in order to incorporate the contents of the GMSF. The Development Plan of each constituent Authority has been reviewed and relevant policies included in Appendix 1 of this document.

The following policies are of particular note:

- *Policy EN5 of the Manchester City Council Core Strategy which identifies strategic areas within the city for the deployment of decentralised energy;*
- *Policy EN7 of the Manchester City Council Core Strategy which promotes a presumption in favour of decentralised energy proposals;*
- *Policy SD-4 of the Stockport Metropolitan Borough Council Core Strategy which actively encourages district heating schemes for both new and existing developments;*
- *Policy DMP 16 of the Tameside Metropolitan Borough Council which addresses a range of decentralised and renewable energy issues.*

3.4 Summary

- **There is clear and well defined existing national and local policy supporting decarbonisation of the energy system and positive local energy planning.**

- **The national policy landscape is changing. Whilst supporting a transition to a smart energy system changing incentives and support mechanisms is creating an environment of uncertainty.**

- **There is well-developed existing evidence of the opportunities and barriers to deployment of low carbon energy networks and technologies within GM.**

- **There is growing policy evidence and support for locally led community energy solutions.**

- **Local authorities in GM have a range of existing policies supporting deployment of low carbon and renewable energy although with limited consistency.**

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4 Current Energy System

This section describes the existing energy demand, supply systems and associated carbon emissions for Greater Manchester (GM). The current existing annual energy consumption of GM is **51,600 GWh** (**51.6 TWh**)**/yr** (DECC, 2016). Figure 4.1 shows the breakdown of energy consumption in GM, domestic homes account for **37 %** of energy demand and non-domestic buildings **31 %.** Transport and waste make up the remaining **32 %.** The largest energy source by consumption in GM is gas, which accounts for **42 %** of all energy consumption.

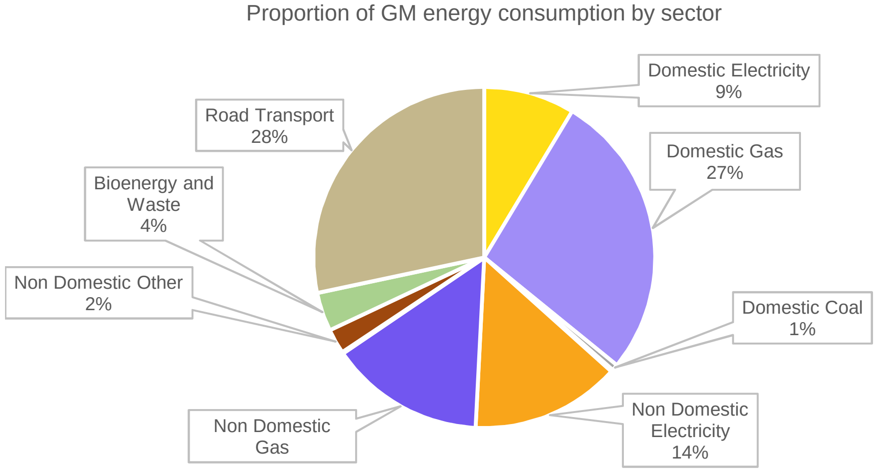

Figure 4-1 GM Energy use by sector

The Combined Authority has adopted a carbon target to deliver a 48 % reduction or 11 million tonnes by 2020 (Association of Greater Manchester Authorities (AGMA)) against a 1990 baseline. New targets for beyond 2020 are being established as part of the development of a Climate Change Implementation Plan for 2016-20.

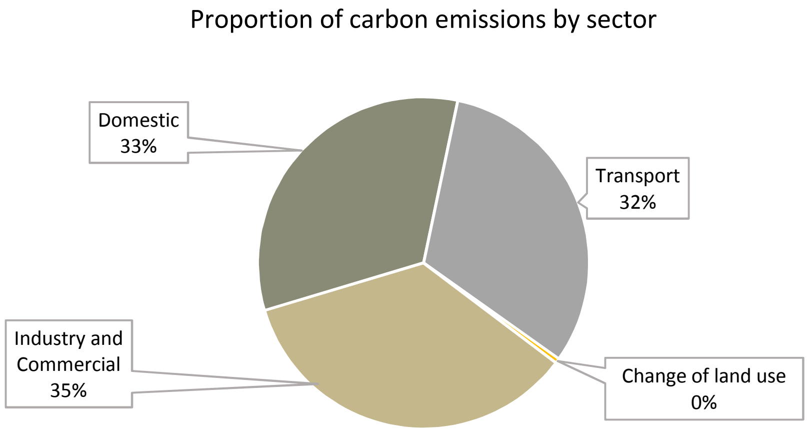

Figure 4-2 GM carbon emissions by sector

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GM total annual carbon emissions are **13.5 MtCO_2**, equivalent to **5.0 tonnes CO_2** per capita. This is **21 %** lower than the UK average of **6.3 tonne CO_2** per capita. This lower value is due to much lower carbon emissions from heavy industry in the GM region, in comparison to the England average (DECC, 2016) .Carbon emissions due to change of land use[53] are defined as emissions and removals of greenhouse gases resulting from direct human-induced land use, land-use change and forestry activities.

In 2014 renewable generation within GM provided for 292 GWh of energy for the GM region. This is less than 1 % of GM total energy consumption and 2.5 % of electricity consumption (DECC, 2016).

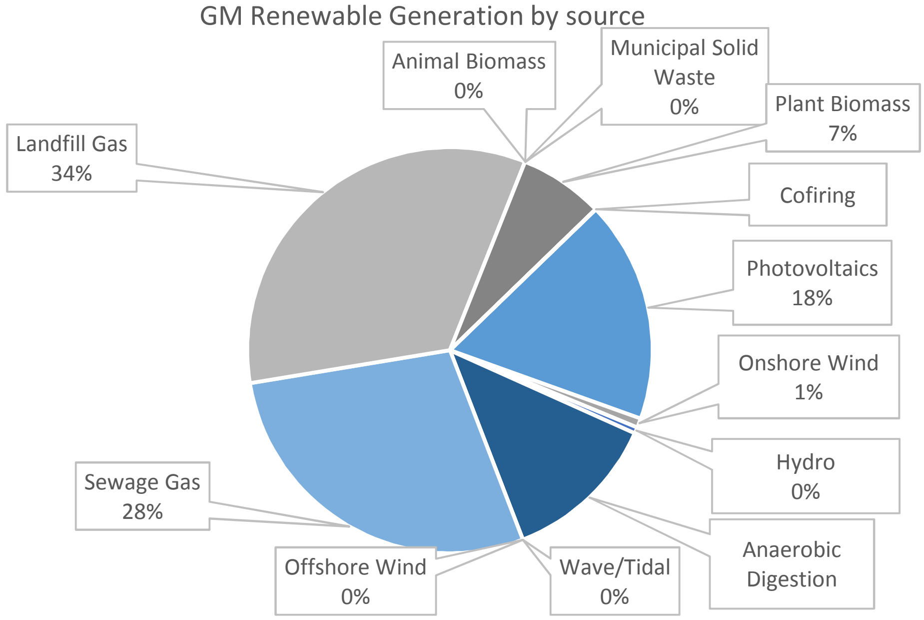

Figure 4-3 GM renewable generation by source

4.1 Domestic Building Stock

4.1.1 Efficiency of Domestic Stock

The efficiency of the housing stock is an important driver in providing an understanding of total energy demand for domestic properties. This drives the energy requirement for heating which is fulfilled for the main part by gas. Data on the energy performance of domestic stock is available through the registration of Energy Performance Certificates (EPC) for all properties that are rented, built or sold.

Energy Performance Certificates (EPC)

Energy Performance Certificates (EPCs) were introduced in England and Wales on 1 August 2007 as part of Home Information Packs (HIPs) for domestic properties with four or more bedrooms. Over time this requirement was extended to smaller properties. When the requirement for HIPs was removed in May 2010, the requirement for EPCs continued. The scheme for HIPs was extended to encompass three bedroom homes from 10 September 2007.

[53] Land Use, Land-Use Change and Forestry (LULUCF) http://unfccc.int/land_use_and_climate_change/lulucf/items/1084.php

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Rental properties are required to have an EPC on a new tenancy commencing on or after 1 October 2008. They are a result of European Union Directive 2002/91/EC relating to the energy performance of buildings, as transposed into British law by the Housing Act 2004 and The Energy Performance of Buildings (Certificates and Inspections) (England and Wales) Regulations 2007 (S.I. 2007/991).

The methodology used (SAP) is based on providing a comparison between buildings rather than an absolute measure of efficiency. Onsite generation, such as solar PV, is included in the rating, so a property may not be more efficient in terms of thermal performance but will score better due to lower overall energy demands.

EPCs can be of varying quality with respect to the actual energy in any individual building due to the calculation methodology, data collection and resident behaviour. They can give a good representation of the energy efficiency of the stock in an area. The data is more accurate where there is a turnover of rental properties and high levels of sales as these are the points at which EPCs are required to be produced. The number of EPCs available in the GM area is equivalent to around 67 % of stock.

EPCs give a performance rating of between A and G for a property. A is the best performing and G is the worst.

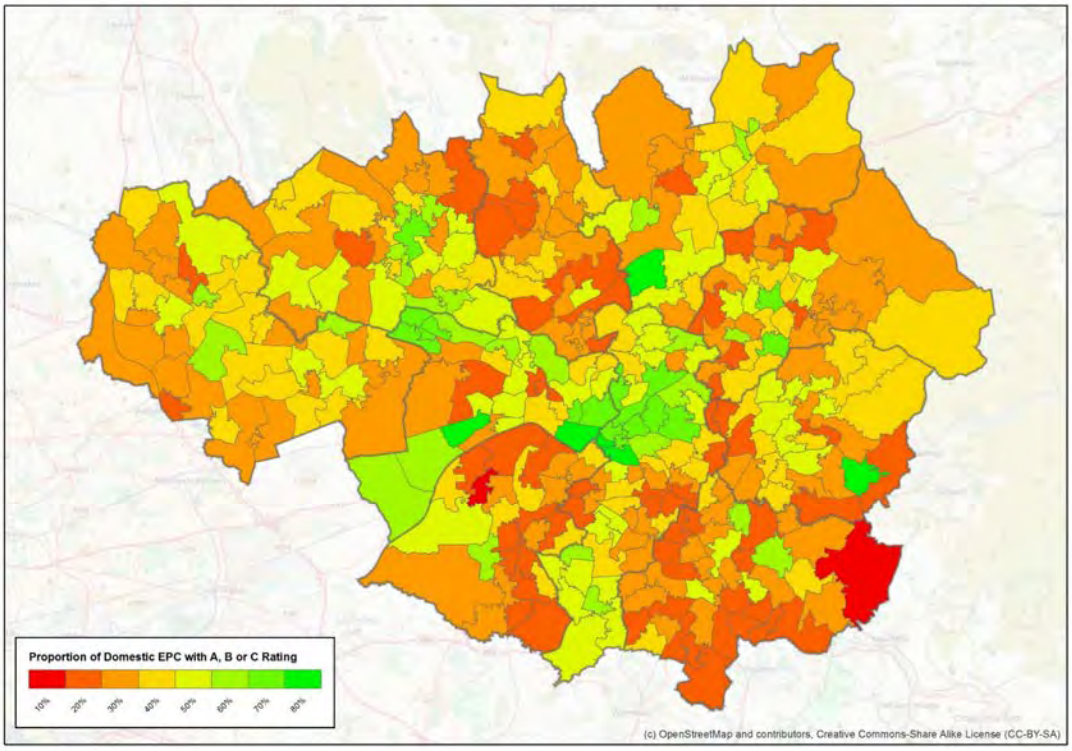

Figure 4-4 Percentages of EPC ratings of C or better

Figure 4-4.4 shows the distribution of Domestic Energy Performance Certificates (EPC) that score C or better at middle super output areas (MSOA) level. (DECC, 2014)

Figure 4-5 Proportion of Domestic EPC ratings) gives the distribution across each of the local authorities. The proportion of EPCs in each category varies considerably across the LAs. Trafford and Bury have the largest proportion of D or below properties, while Salford has the highest proportion at C or better. When related to property age the proportion of higher ratings in Manchester and Salford is aligned with the larger proportion of more recently built buildings.

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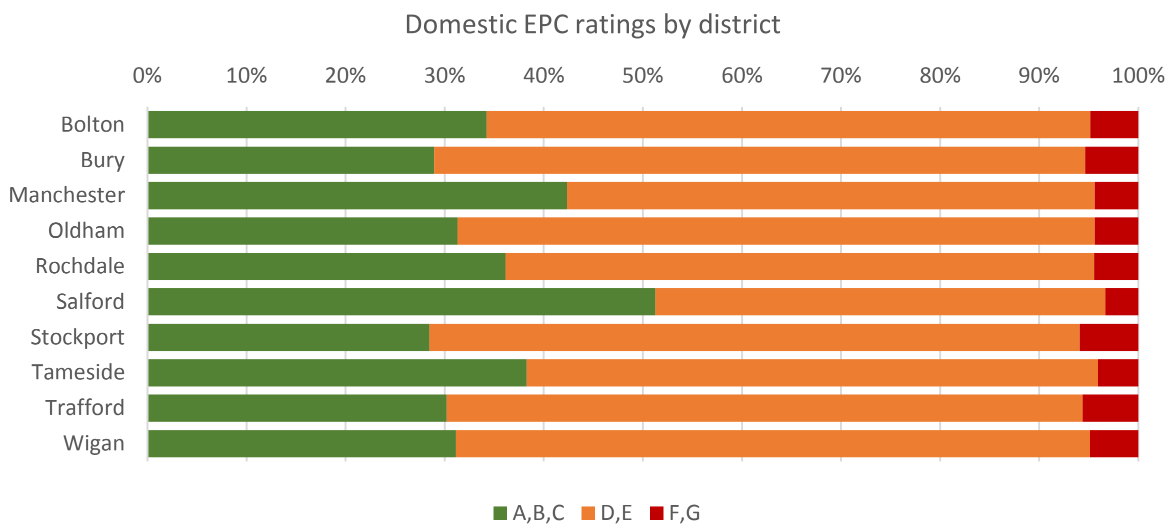

Figure 4-5 Proportion of Domestic EPC ratings by district

4.1.2 Property Age

Figure 4-6 shows the proportions of GM dwellings in different age category. The largest proportion of domestic properties are those from 1900 and earlier at around 17 %. Post 2000 properties make up less than 10 % of the total housing stock.

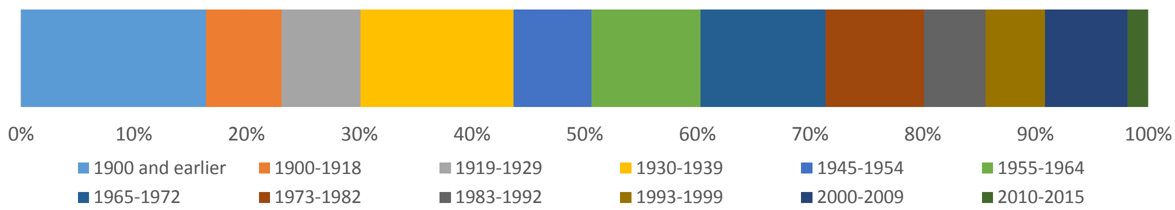

Figure 4-6 GM property ages

Older properties tend to have lower energy performance and therefore will demand more energy per household. Building regulations began to have energy related requirements in 1965, although these were not very stringent until more recently. Figure 4-7 shows this using data from the English Housing Survey 2009 (DCLG, 2009). Half of all properties from post 1990 have a rating of C or better compared to less than 5 % of pre-1919 properties.

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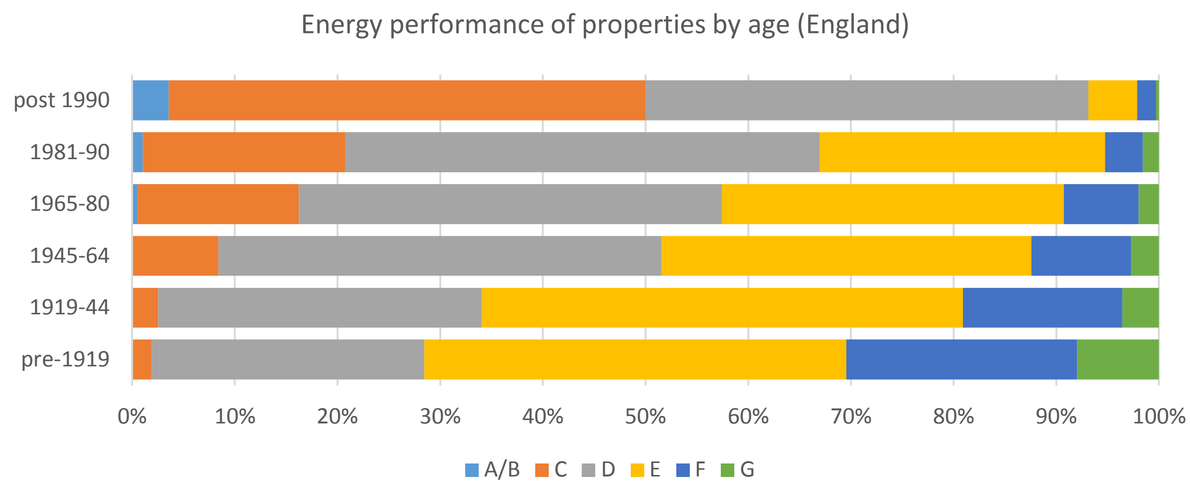
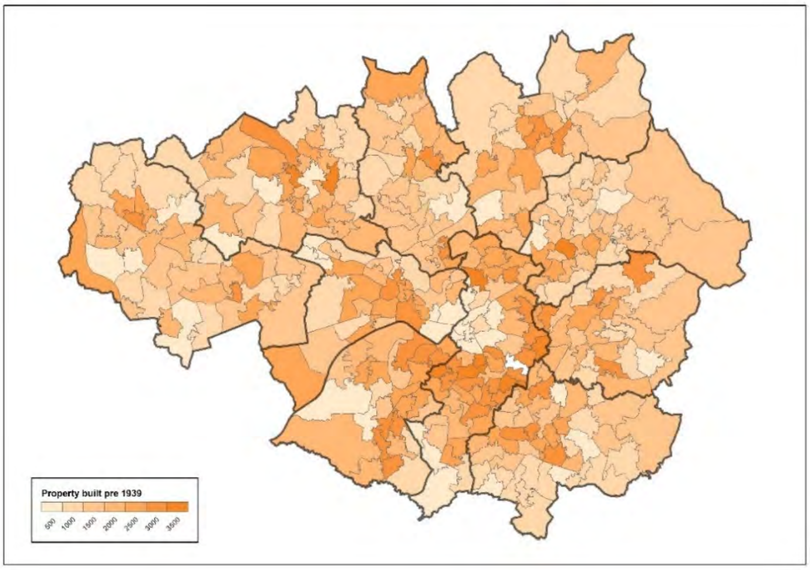
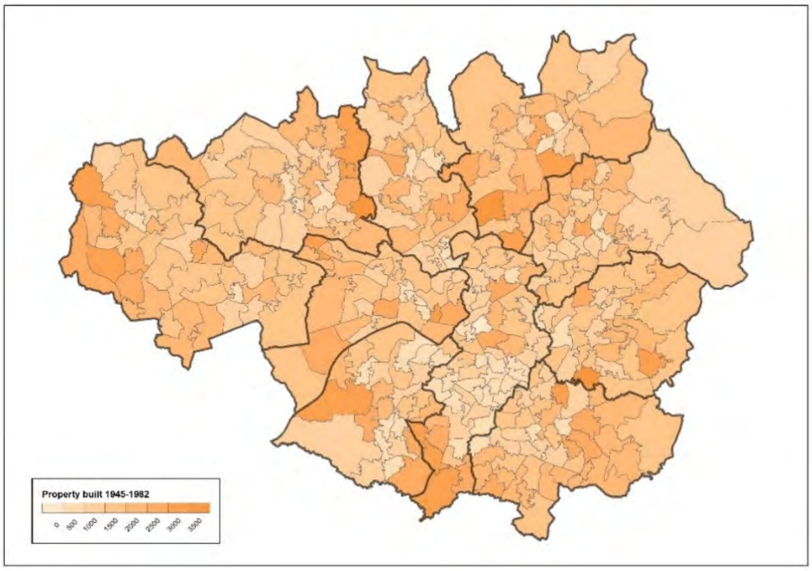


Figure 4-7 Energy performance by property age (DCLG, 2009)

Pre 1939



1939 - 1982



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Post 1983

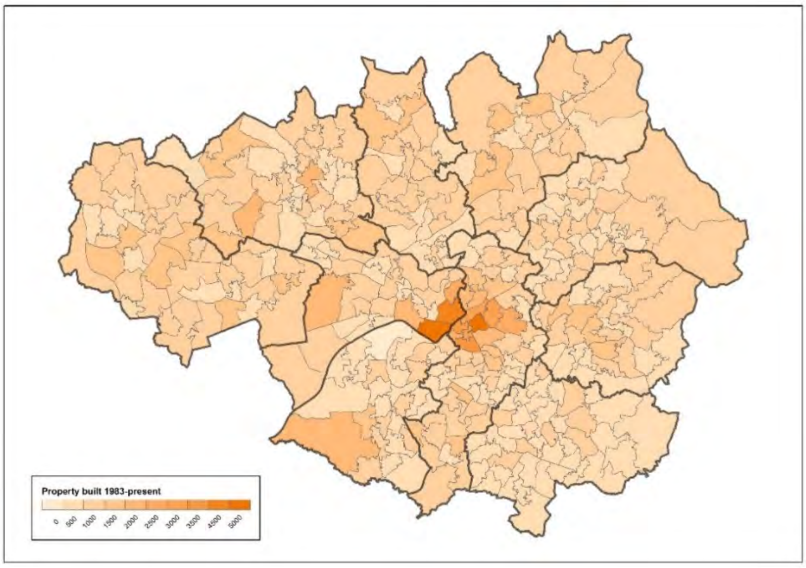

Figure 4-8 Development timeline for GM

Figure 4-8 Development timeline for GM shows the ages of properties in each MSOA and also demonstrates that pre 1900 properties are the largest single group of properties by age, with the period 1965-1972 being the largest group in the post war period. The most recent (1983-2015) being clustered around the city centres of Manchester and Salford. Until that time post war (1935-1982) building was much more equally distributed throughout the districts and also within the districts.

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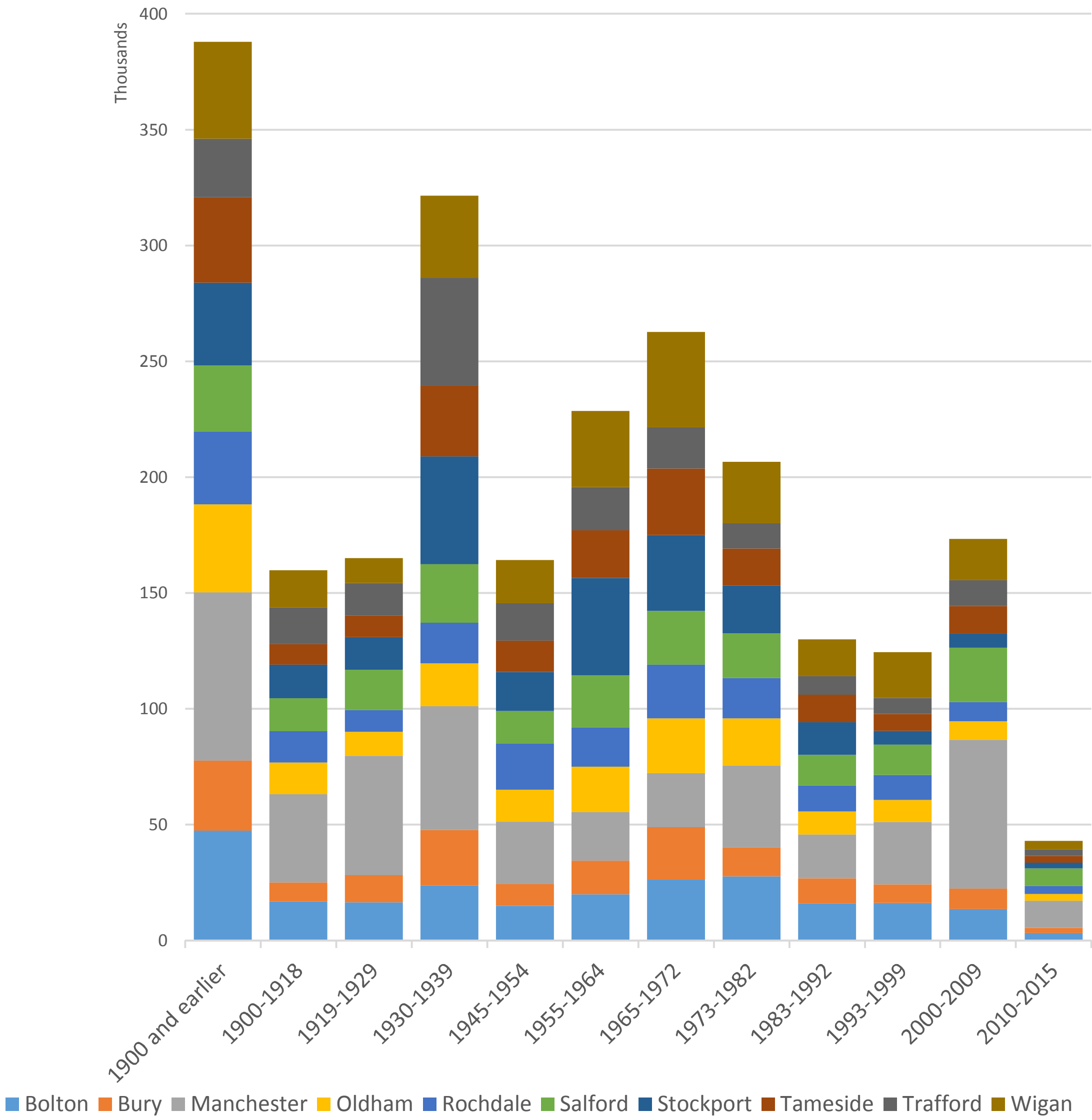

Figure 4-9 Domestic property ages by district

All districts have a wide range of property ages. Manchester and Salford have the greatest proportion of new build (2010-2015) with 3 %. They also both have the highest proportion of properties built since 2000, with 17 % and 14 % respectively. This does not take into account any distinction between houses and apartments. Bury has the lowest proportion of post 2000 new builds with only 6 % of housing stock falling into this category.

4.1.3 Fuel Poverty

Fuel poverty in England is measured using the Low Income High Costs (LIHC) indicator. In March 2015 the Government published 'Cutting the cost of keeping warm: a fuel poverty strategy for England', setting out in detail their statutory target to raise as many fuel poor homes in England as is reasonably practicable to Band C by 2030. The strategy also set out interim milestones to lift as many fuel poor homes in England as

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is reasonably practicable to Band E by 2020 and Band D by 2025, alongside a strategic approach to developing policy to make progress towards those targets.

Low Income High Costs

Under the Low Income High Costs definition, a household is considered to be fuel poor if:

- they have required fuel costs that are above average (the national median level)
- they were to spend that amount; they would be left with a residual income below the official poverty line.

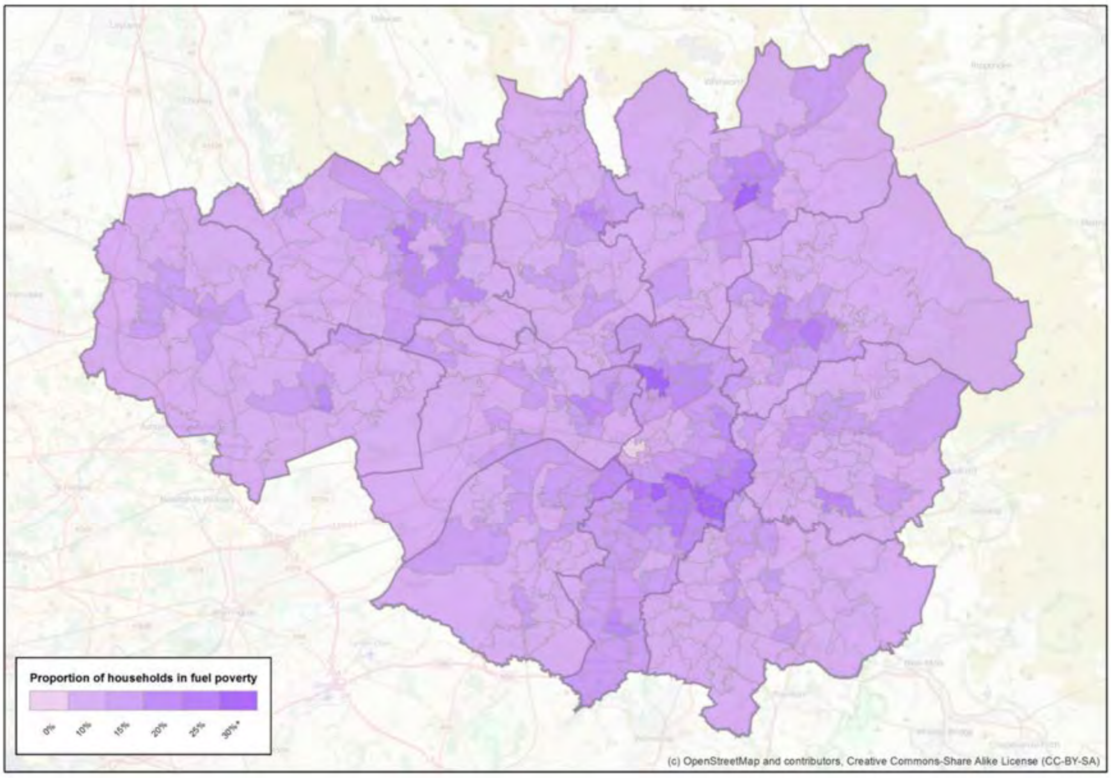

Figure 4-10 Proportion of households in fuel poverty

Figure 4-10 shows the distribution of fuel poverty throughout the region, with Manchester having the most areas with high proportions of households in fuel poverty. The northern areas within Trafford also have high levels of fuel poverty (DECC, 2016).

Fuel poverty can have many dimensions but an important factor is the performance of the building stock as this is directly related to heating and hot water bills which are commonly a large proportion of household bills. Central Manchester and the area around the University of Manchester Fallowfield campus have high fuel poverty but probably due to the high density of short term low income students and houses in multiple occupancy in the area, which are considered strong indicators of fuel poverty. Other districts

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are below the national average.

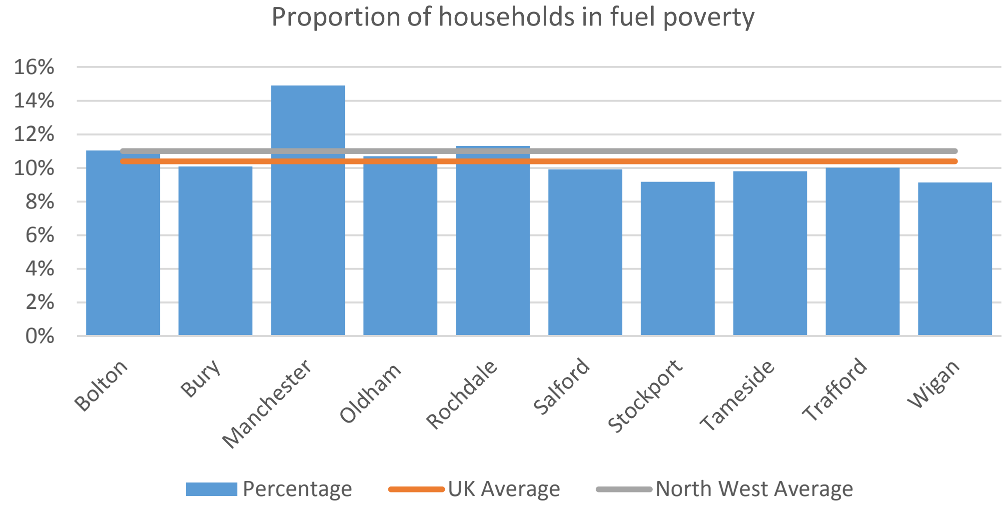

Figure 4-11 Proportion of households in fuel poverty by district

4.1.4 Summary

- Greater Manchester has a wide range of housing energy efficiency and energy consumption. Around 70 % of the housing is pre-1970.
- This is reflected in the energy efficiency of the residential stock. New development is limited to small areas of the region, mainly in the Manchester and Salford city centre areas.
- Fuel poverty is an issue across the whole region although Manchester has some of the highest proportions of fuel poverty.

4.2 Non Domestic Building Stock

4.2.1 Efficiency of Non Domestic Stock

Non domestic stock is more difficult to understand than domestic stock as the data on a per building use is not available. The available data is described and presented here.

Display Energy Certificates (DEC)

Since 2015 public buildings in the UK with a floor area of over 250m² must display a Display Energy Certificate (DEC) prominently at all times. Display Energy Certificates were introduced by the British Government in response to the EU Energy Performance of Buildings Directive which all EU member states must implement by January 2009.

DECs are designed to promote an improvement in the energy performance of buildings. They are based upon actual energy usage of a building and increase transparency about the energy efficiency of public buildings. This is displayed with a scale for energy efficiency, from A to G with A being the most efficient and G the least.

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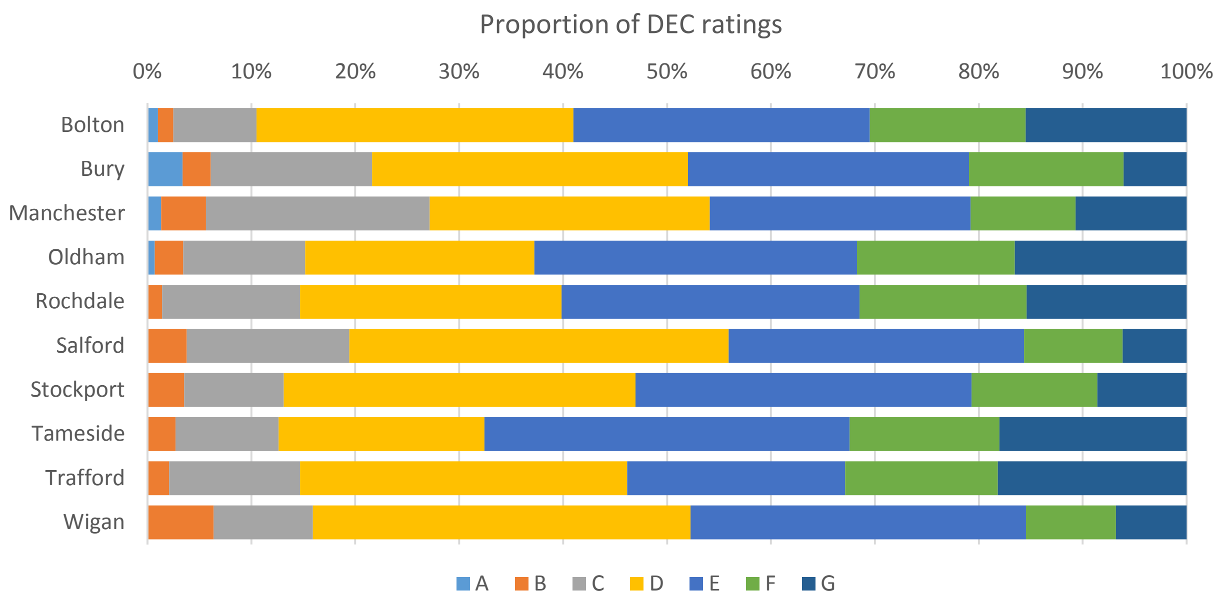

Figure 4-12 Proportional DEC rating

Figure 4-12 gives the breakdown of DEC ratings lodged in 2015 out 2053 lodged certificates (DECC, 2015). This shows that Oldham and Salford have the highest proportions of E, F and G rated properties, 50 % and 43 % respectively. Bury has the lowest with 15 % of lodged DECs in 2015 being the lowest ratings. Oldham has 1 registered building with an A rating.

Non-Domestic EPC

Non-domestic EPC ratings are fairly consistent across the districts with no obvious outliers. 26,080 certificates had been lodged at time of writing. GM EPC certificates are in line with national trends where the average rating is a D. Very few A rated buildings have DECs, will all districts having around 10 % of the worst performing rating.

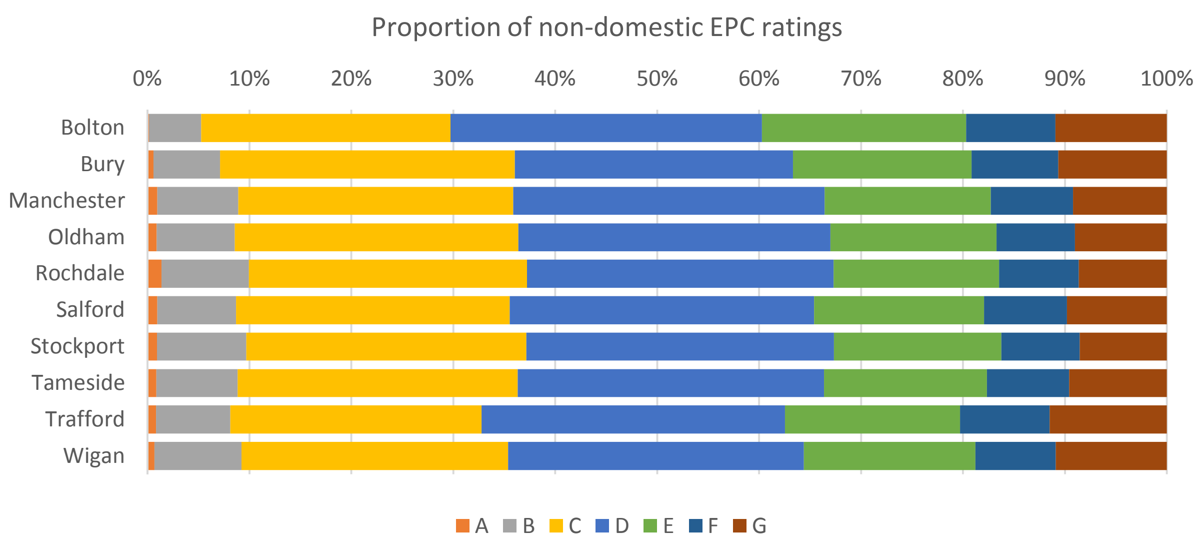

Figure 4-13 Proportion of non-domestic EPC ratings by district

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4.2.2 Summary

- The non-domestic building stock across GM is mainly (80 %) of D rating and below.
- Over 50 % of the lodged certificates are E or worse. Manchester has the best performing non-domestic building stock.

4.3 Heat Demand

Heat accounts for over 40 % of the UK's demand for energy, and almost 20 % of the UK's CO_2 emissions come from domestic heating. There is recognition that the vast majority of the existing 26 million homes in the UK will still be in existence by 2050.

Heat demand is a large proportion of the energy demand in Greater Manchester. The DECC heat map (DECC, 2016) is a tool developed to analyse heat demand across all sectors within a geographical region. Benchmarks are identified against floor areas of specific sectors and collated into a heat demand dataset that can be interrogated. Care must be taken with this heat mapping data as the demands are based on benchmark data and do not represent the actual energy demand for any particular buildings. In particular, industrial heat demand for process heat represents very high level view.

The total heat demand for the Greater Manchester region is identified to be 21.7 TWh/yr. This is split between residential (14.5 TWh/yr), non-domestic (5.8 TWh/yr) and transport (1.4TWh/yr).

A report carried out on behalf of DECC focussed on the nine most energy intensive industries and the power sector: Overall 48 terawatt-hours per year (TWh/yr) of industrial waste heat sources were identified in the UK, about 16 % of the industrial energy demand. The technical potential – the source-sink combinations that together deliver the highest CO_2-saving – was identified to be 11 TWh/yr (2.9 Mt CO_2/yr). The economic potential – projects with a positive net present value was 8 TWh/yr. A commercial potential of 6 TWh/yr from projects with a simple payback period of maximum two years was calculated. The study proves that there is technical and economic potential for decarbonizing the UK industrial energy demand by recovery and re-use of industrial waste heat (Element Energy, 2014).

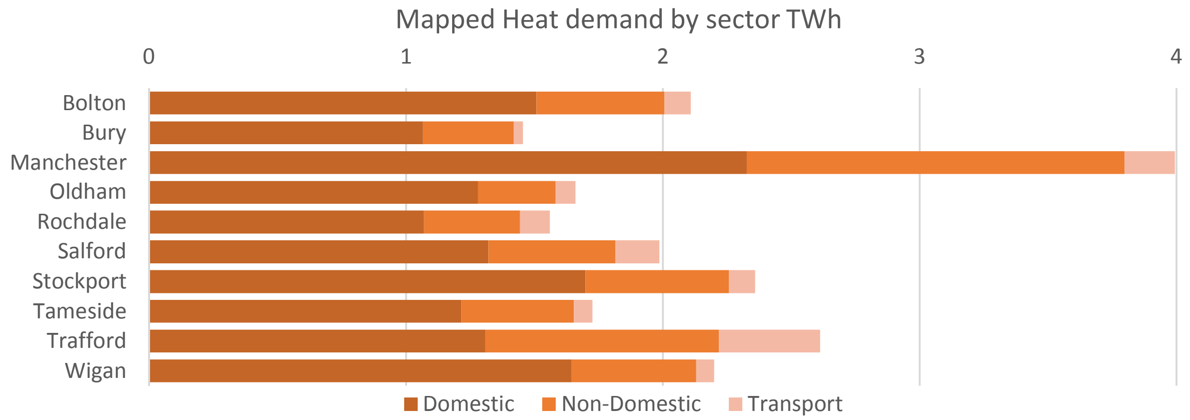

Figure 4-14 Total mapped heat demand by sector

Figure 4-14 shows the total mapped heat demand by sector in each district. Manchester has the largest heat demand with a total demand of 4TWh per annum. Bury has the lowest mapped heat demand at

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1.5TWh per annum. Transport is a small proportion of the heat demand, with residential heat demand consistently being the largest sector.

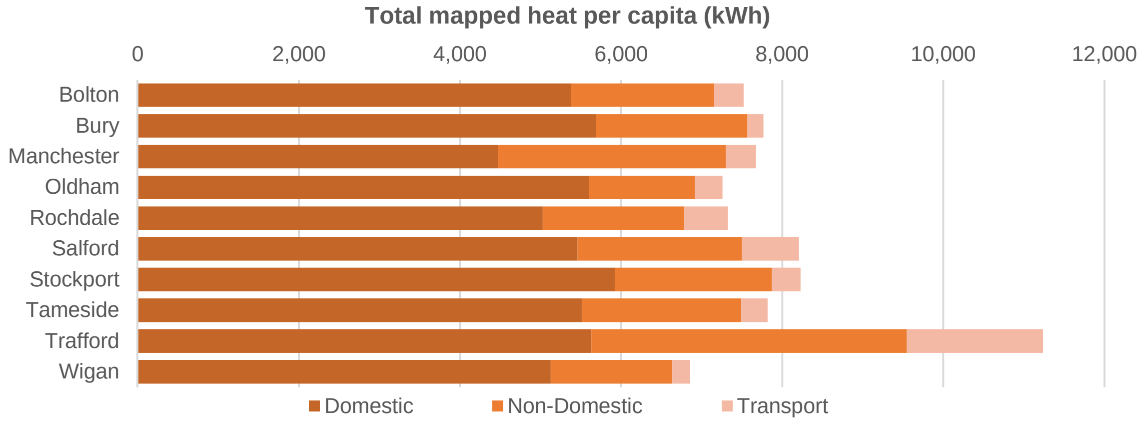

Figure 4-15 Total heat demand per capita

Figure 4-15 shows that the total heat demand per capita is very similar across most of the districts. Trafford stands out as having a much higher demand per capita (11MWh/year) than the other authorities due to a large concentration of heat demand in the transport and non-domestic sectors. This can be seen more clearly in Figure 4-16 which shows the modelled total heat demand broken down by sector.

Trafford has a large transport usage (394 GWh) and also the total highest industrial usage (310 GWh). Manchester has the largest total demand for commercial offices at 308 GWh per year.

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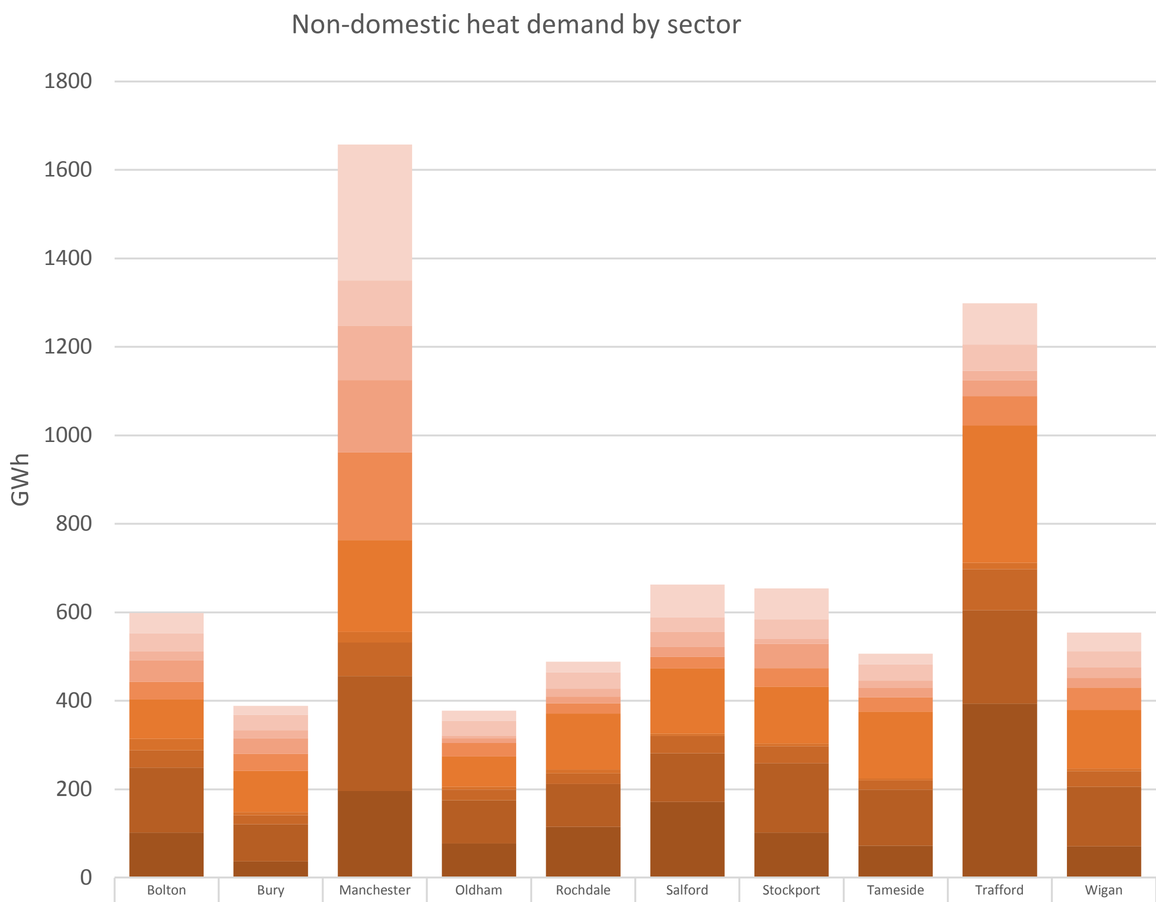

	Bolton	Bury	Manchester	Oldham	Rochdale	Salford	Stockport	Tameside	Trafford	Wigan
Commercial Offices	46	20	308	23	24	74	70	24	93	42
Education	41	35	102	33	37	33	44	37	60	37
Government Buildings	21	17	123	7	18	33	11	16	22	23
Health	48	36	164	10	15	23	55	22	36	22
Hotels	40	38	198	30	23	26	42	33	66	50
Industrial	89	93	208	69	127	147	129	151	310	132
Other	26	7	24	6	8	5	6	4	15	6
Recreational	39	20	75	24	24	39	38	21	93	36
Retail	147	84	260	97	97	110	157	127	211	134
Transport	102	37	196	78	115	172	102	72	394	71

Figure 4-16 Non Domestic heat demand by sector

Non domestic heat demand by sector as mapped using the DECC heat mapping tool shows that the proportion of heat demand across sectors varies considerably between districts. Figure 4-17 Proportion of non-domestic heat demand by sector) shows that Manchester has the largest proportion of demand for commercial offices (18 %). Government buildings and education make up around 10 % for each district. Retail, commercial and industrial demand make up about 50 % of the demand in each district with Tameside (59 %) being the standout.

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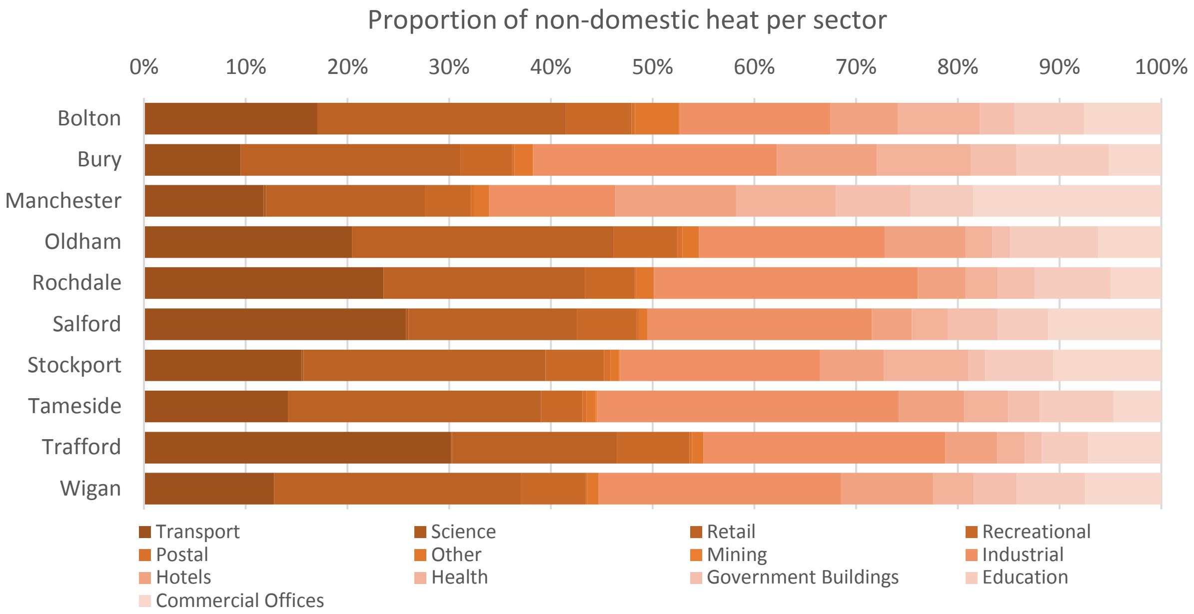

Figure 4-17 Proportion of non-domestic heat demand by sector

The largest heat demands identified by the DECC heat map at a GM level are the retail (20 %), transport (19 %), and industrial (20 %) sectors. The heat demand for industrial processes is variable depending on the exact nature of the products and processes involved. There may be large waste heat potential that can only be identified by direct engagement. These are concentrated around Manchester city centre, although each of the local city centres also have considerable demand.

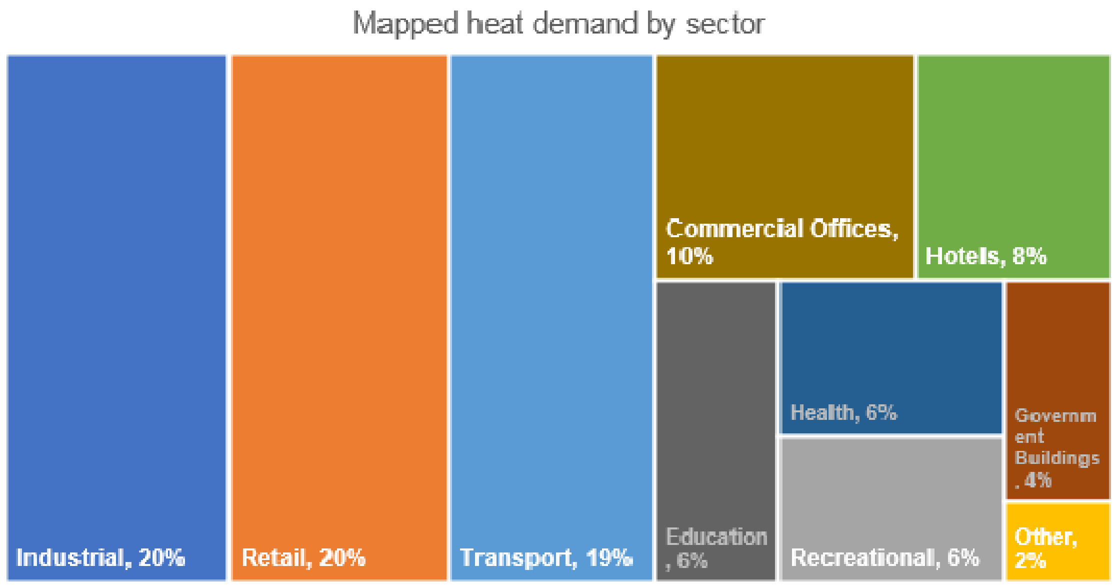

Figure 4-18 Mapped heat demand by sector

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4.3.1 Heat Density Maps

Figure 4-19 to Figure 4-22 show heat demand density maps for a number of sectors. These show the heat demand density in kWh/m², per year. These are represented as coloured contour areas, with each colour band representing a range of values.

These have been taken directly from the DECC heat map online tool which identifies m² of floor area. Sectoral heat densities, 'Residential' (Figure 20), 'Commercial' (Figure 21) and 'Industrial' (Figure 22), display heat demand density for the named sector these can allow planners to undertake more detailed assessment of priority areas.

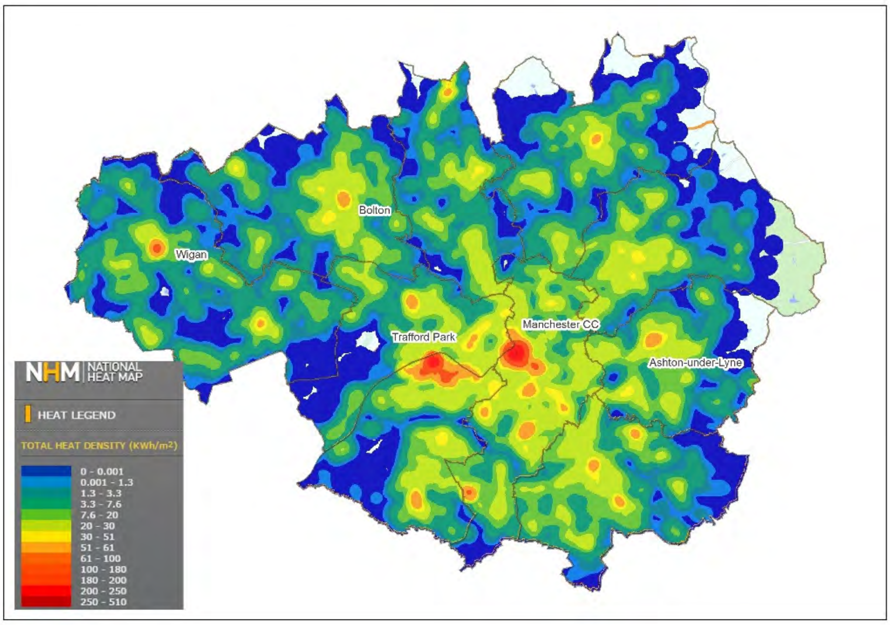

Figure 4-19 Total heat demand density

Figure 4-19 Total heat demand density, shows the distribution across the region. The highest density of heat demand is in Manchester city centre and Trafford Park. These two areas have heat densities in excess of 100kWh/m². The districts' urban centres have heat densities in between 50 and 100 kWh/m². The town centres of Wigan, Bolton and Ashton-under-Lyne have heat densities of over 50kWh/m².

Figure 4-20 Heat density map: Residential shows the distribution of residential housing and its heat demand density. Most residential areas have a heat density of under 50kWh/m² with some areas much lower.

Figure 4-21 Heat density map: Commercial shows the highest commercial heat demand is concentrated around the major centres of Manchester, Salford and Trafford park with heat densities of over 200kWh/m². All the other major urban areas have densities of below 60kWh/m².

The industrial areas shown on Figure 4-22 that have a high heat demand density are Trafford Park and Mosley, Ardwick and Bredbury (location of allied bakeries). These all have densities of over 100kWh/m².

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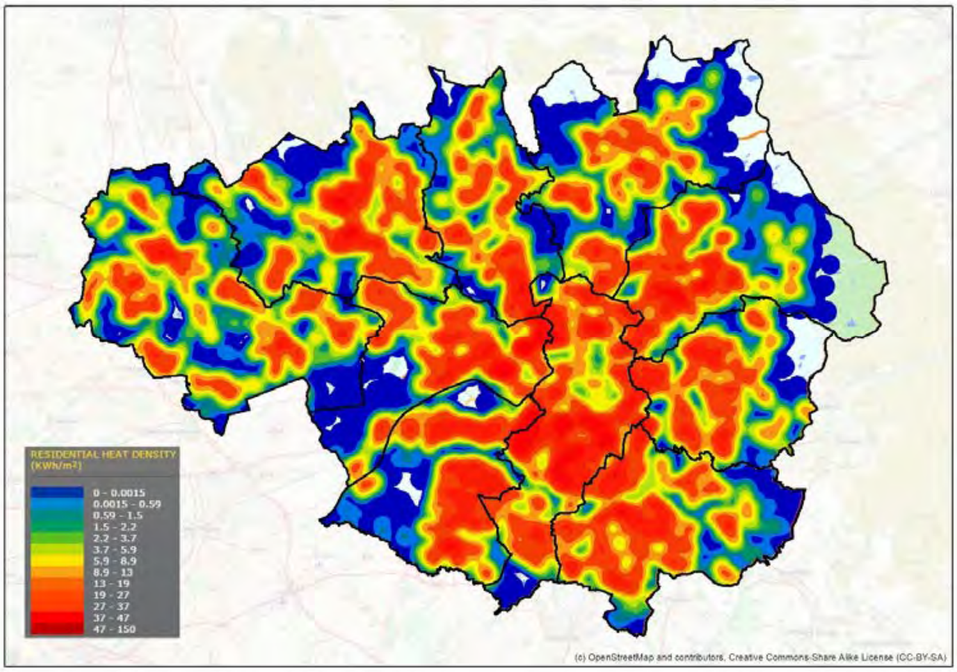

Figure 4-20 Heat density map: Residential

Residential heat demand is aligned with the built up areas within each district. When compared to the industrial and commercial heat demand the highest density is lower but heat demand is spread out over a wider area. This is to be expected with housing and residential areas being a large proportion of heat use in the Greater Manchester region.

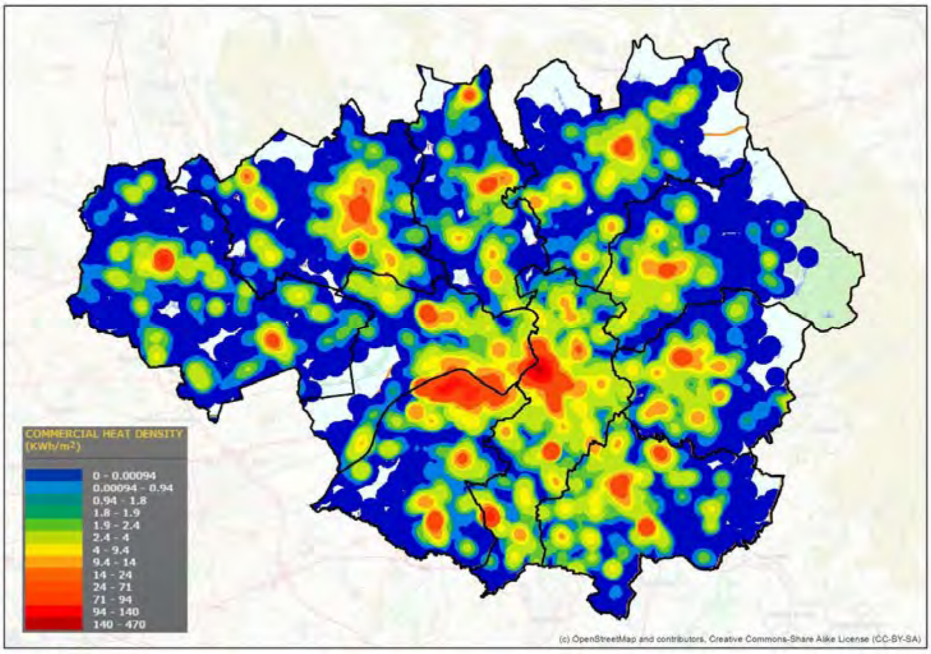

Figure 4-21 Heat density map: Commercial

The commercial heat demand is aligned with the density of city and town centres. Manchester city centre and Trafford Park have the largest area of heat density, with the main areas having a heat density of around 100kWh/m². Manchester city centre has a region of very high demand where the heat density is over 140kWh/m².

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This aligns with areas where heat networks may be appropriate as the heat density is a big driver in the technical and financial case for distributed heat delivery.

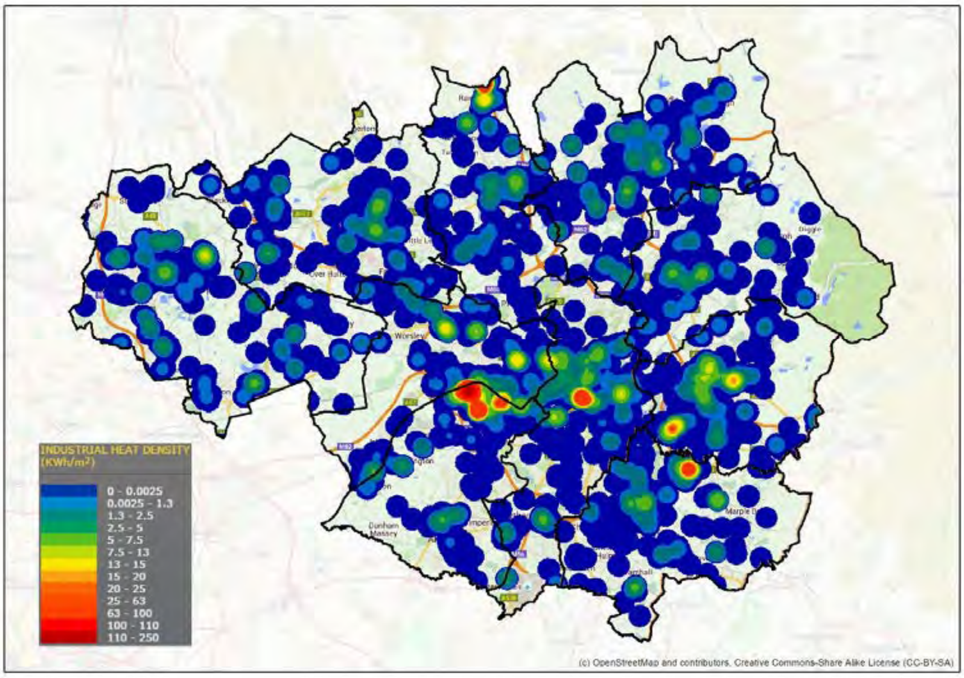

Figure 4-22 Heat demand density: Industrial

The industrial heat density map shows that there are a small number of areas of high energy use. Although the industrial usage is spread across the entire region it is mainly focused in the areas with industrial parks. The DECC heat map is based on benchmarking from floor areas. This may not capture the actual energy use by any building or industrial process, and so should be reviewed in combination with more detailed master planning and feasibility studies that engage with the local stakeholders to understand the local detail.

4.3.2 Cooling demand

Cooling demand is difficult to estimate as the available benchmarks do not cover cooling as a specific energy demand. It is included in the electrical usage. There is more information available for new build office and commercial buildings but this data is not extensive enough to provide meaningful context or useful mapped data.

Cooling demand tends to be aligned with retail and offices as these are the sectors which will have summer demand for climate control. The requirement for day time cooling in the North West is considerably lower than that in the south of the UK, especially in London.

The national comprehensive assessment of the potential for combined heat and power and district heating and cooling in the UK provides regional estimates for cooling demand (DECC, 2016). There is a total estimated cooling consumption of 2 TWh per year for the North West region.

The introduction of cooling demand methodologies into the building regulation energy requirements will be more important as temperatures increase and city centre densities get higher. Greater London have developed a methodology to benchmark new build residential buildings for cooling demand (AECOM, 2015).

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4.3.3 Process heat demand

Process heat demand and potential for waste heat supply is a very complex area of energy planning. The Heat Network Delivery Unit (HNDU) studies carried out to date for GM have not investigated in depth potential customers for process heat. There is work currently underway in Trafford Park and Bolton to engage with potential customers and understand their real requirements and processes. Process heat is not possible to benchmark, as the individual activities involved in process heat production could be significantly different in their heat profile.

4.3.4 Summary

- GM has a large heat demand with industrial and commercial demands focussed in a number of specific areas.
- Commercial demand is highest in the city centres of Manchester and Salford. Industrial demand is highest in Trafford.
- Process heat and cooling demands are very difficult to benchmark and require specific studies.

4.4 Current Energy Supply

This section describes the energy systems that support the energy demands of Greater Manchester. It includes the local sources and generation systems.

4.4.1 Grid Electricity

Britain's electricity transmission network transmits high-voltage electricity from where it is produced to where it is needed throughout the country.

The system is made up of high voltage electricity wires that extend across Britain and nearby offshore waters. Transmission is carried out at a number of voltages; 400kV, 275kV and 132kV.

It is owned and maintained by regional transmission companies, while the system as a whole is operated by a single System Operator (SO). This role is performed by National Grid Electricity Transmission plc (NGET) - it is responsible for ensuring the stable and secure operation of the whole transmission system.

Electricity distribution networks carry electricity from the high voltage transmission grid to industrial, commercial and domestic users.

There are 14 licensed distribution network operators (DNOs) in Britain and each is responsible for a regional distribution services area. The 14 DNOs are owned by six different groups. Electricity North West Limited (ENW) is responsible for the area covered this

Figure 4-23 North West Electricity Distribution area (ENW)

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report. Greater Manchester is covered by the regions North and South Manchester.

Electricity supplied from the transmission system is generated from a number of sources, the main generating technologies being coal, gas, and nuclear. Figure 4-24 Historical UK electricity fuel mix shows how the energy mix to produce the UKs electricity has changed since 1990 (DECC, 2016). Oil has reduced in significance, with gas becoming a major proportion of the mix. Coal has generally been reducing in proportion although use of coal saw a spike during the years 2012-2013. In May 2016 electricity generation for coal hit historic lows several times since the first coal-fired generator opened in London in 1882, with no electricity from coal for more than 12 hours (The Guardian, n.d.).

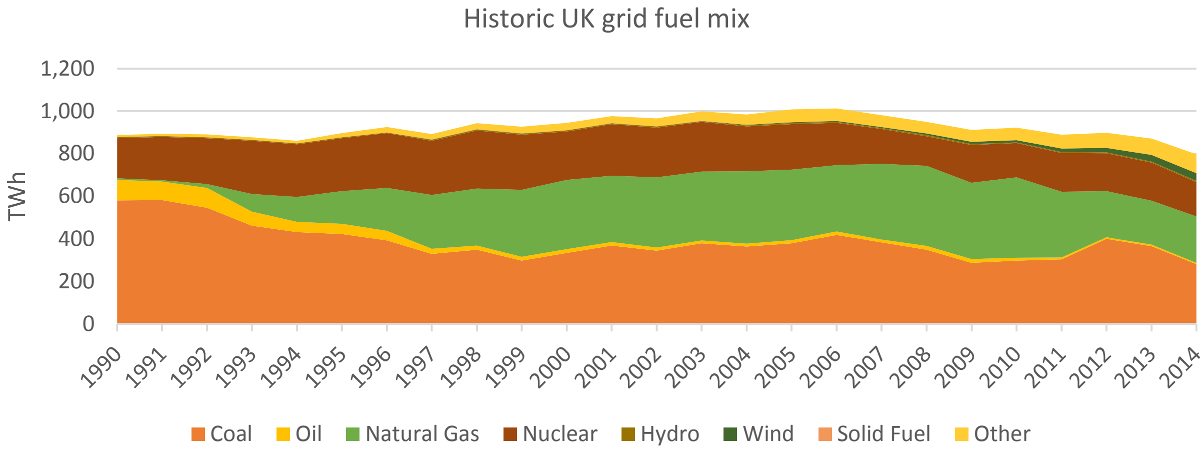

Figure 4-24 Historical UK electricity fuel mix

Transmission to GM

Greater Manchester is served by a number of High Voltage lines connected to 32 substations for distribution. Most of the transmission network is carried on high voltage overhead wires using pylons, small sections consist of buried cable. The distribution system is mostly served from the 132kV substations.

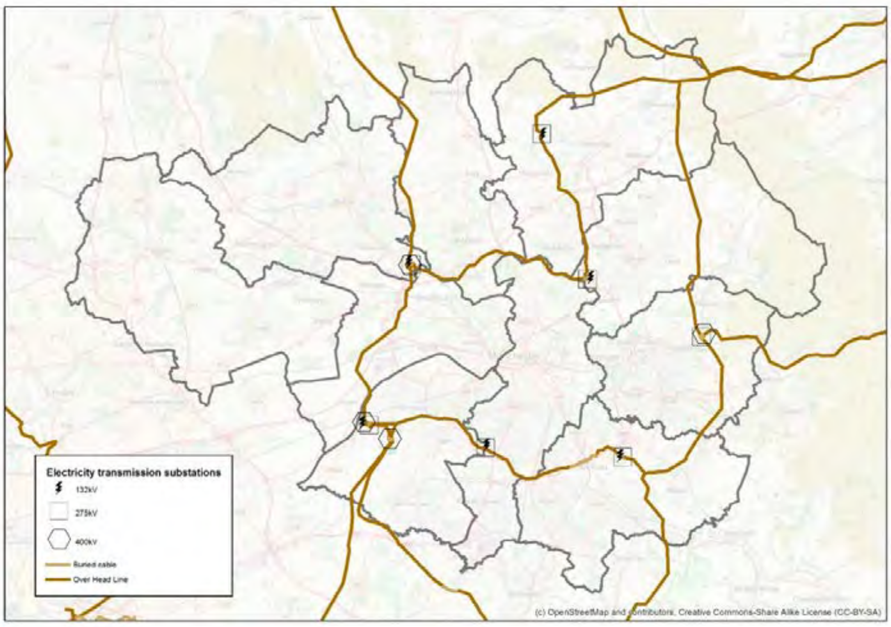

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Figure 4-25 Electricity Distribution network (ENW 2016)

Distribution within GM

There are 137 33kV substations feeding 11,205 distribution sub stations across the region. Figure 4-28 shows where these substations are most densely situated. They are clustered in mainly built up areas.

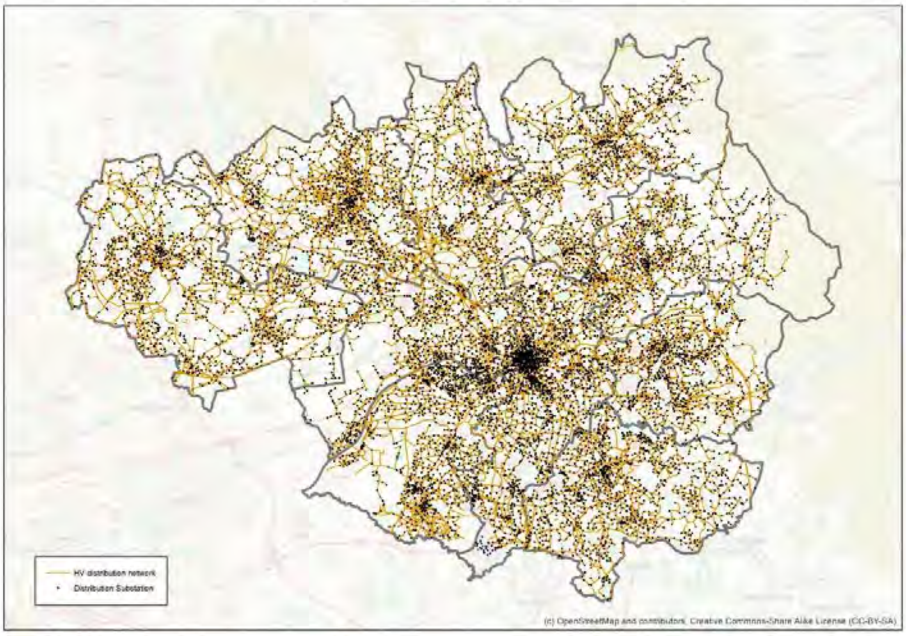

Figure 4-26 Electricity Distribution network substations (ENW2016)

The capacity of a substation is an indication of how much development and increased load could be handled without infrastructure upgrade. All new developments have to be assessed for network capacity, but upgrades to existing buildings (e.g. heating systems) have to be modelled and major shifts in technology can cause some issues. For example, installation of residential PV has caused problems with capacity in some parts of the country, as installed peak generation outstrips the capability of the local grid to distribution the energy.

The figures following show the capacity of the LV (local) and HV (distribution) substations. Substations are designed with a capacity of 80 %, which allows some capacity margin for unexpected peaks.

Figure 4-27 shows that the average local LV substation capacity is variable, there are no areas of particular concern, with no areas having an average of over 60 % capacity. This is important in understanding potential constraints to development or connection of renewable generation. As these are averages within the MSOA, the individual sub stations may be more or less under capacity.

The picture is slightly different for the HV distribution substation network. Figure 4-28 shows that there are a number of substations that are working at or above the 80 % design capacity. Electricity North West have a long term development strategy (LTDS) (Electricity North West, n.d.) which deals with reinforcement and upgrading the regional distribution infrastructure. A number of these substations are noted as being in line for equipment replacement or upgrade.

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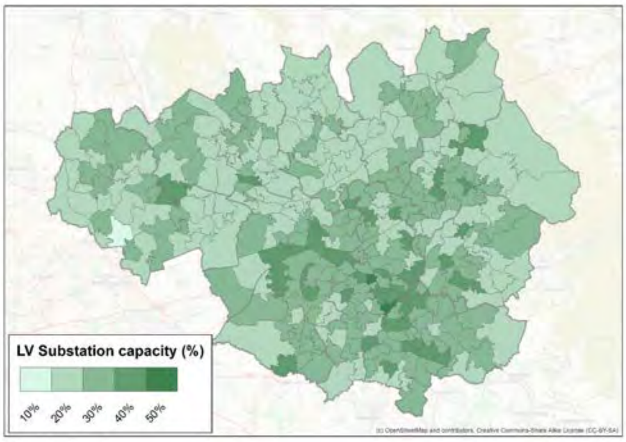

Figure 4-27 Average local Sub capacity (%)

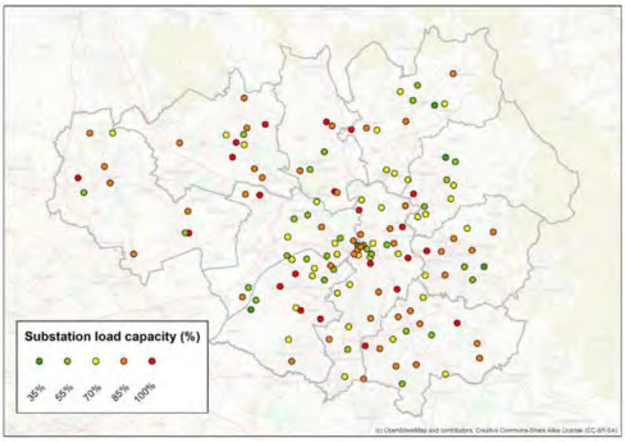

Figure 4-28 Distribution 33kV and 132kV load capacity

Connected Generation

There is currently no traditional (fossil fuel) connected generation in the GM region although that situation will change during 2016.

Carrington Power plant (due to be fully commissioned summer 2016).

Carrington Power received planning permission in 2008 for the construction of the plant at the former Carrington coal-fired power station site. Carrington Power will generate more than three times the amount of electricity than the former coal plant but will occupy only half the land. (Ramboll, 2014). The 880MW power plant will enter commercial operation in 2016 following the three-year construction period and will generate enough electricity to supply the needs of around a million homes. The station is being built using the latest natural gas combined cycle technology (CCGT). It will be one of the most efficient power stations in the UK once finished.

Renewables in GM provided 292GWh of electricity in 2014 (DECC, 2016). The Carrington plant is predicted to provide around 3,300GWh of electricity. This is over 11 times the current renewables generation.

4.4.2 Fossil Fuels

Gas

Britain's gas transmission network, the National Transmission System (NTS), is the high pressure gas network which transports gas from the entry terminals to gas distribution networks, or directly to power stations and other large industrial users. It is owned and operated by National Grid Gas plc (NGG).

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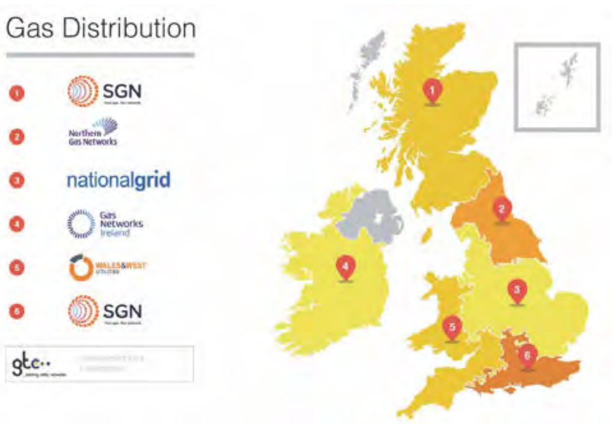

Figure 4-29 Gas Distribution areas *(ENA with permission)*

There are eight gas distribution networks (GDNs), each of which covers a separate geographical region of Great Britain. These are operated by 6 companies[54].

In addition, there are a number of smaller networks owned and operated by Independent Gas Transporters (IGTs). These are located within the areas covered by the GDNs.

Since GDNs are natural monopolies they are regulated to protect consumers from potential abuse of monopoly power.

The distribution of gas in the study area is carried out by National Grid Gas Networks. The UK gas pipeline network is extensive and covers most of the areas of the UK.

Figure 4-30 UK Gas Distribution routes *(National Grid with permission)*

On the 16th February 2016 National Grid launched a stakeholder consultation regarding the proposed sale of a majority stake in their distribution business. This may change the operator for the Manchester region depending on the outcome from both the consultation and any agreements made as part of a handover process.

Gas Distribution Network

Gas distribution is carried out a gradually reducing pressures, from the transmission network to the final consumer.

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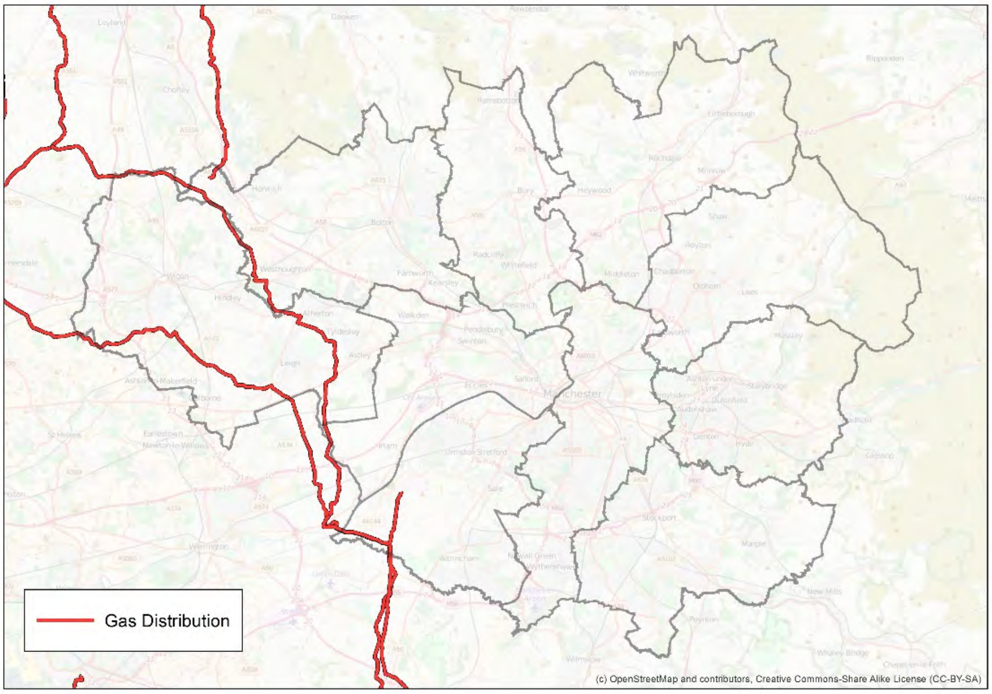

Figure 4-31 Gas Transmission network (National Grid 2016)

Gas Connections

5 % of all postcode units in the Greater Manchester region have been identified as having never had a gas connection (XOServe, 2013). Many of the large areas include regions of green space and agricultural land. Some of the postcode areas in the centre of towns will have electric only heating systems in residential areas, such as economy 7 storage heaters.

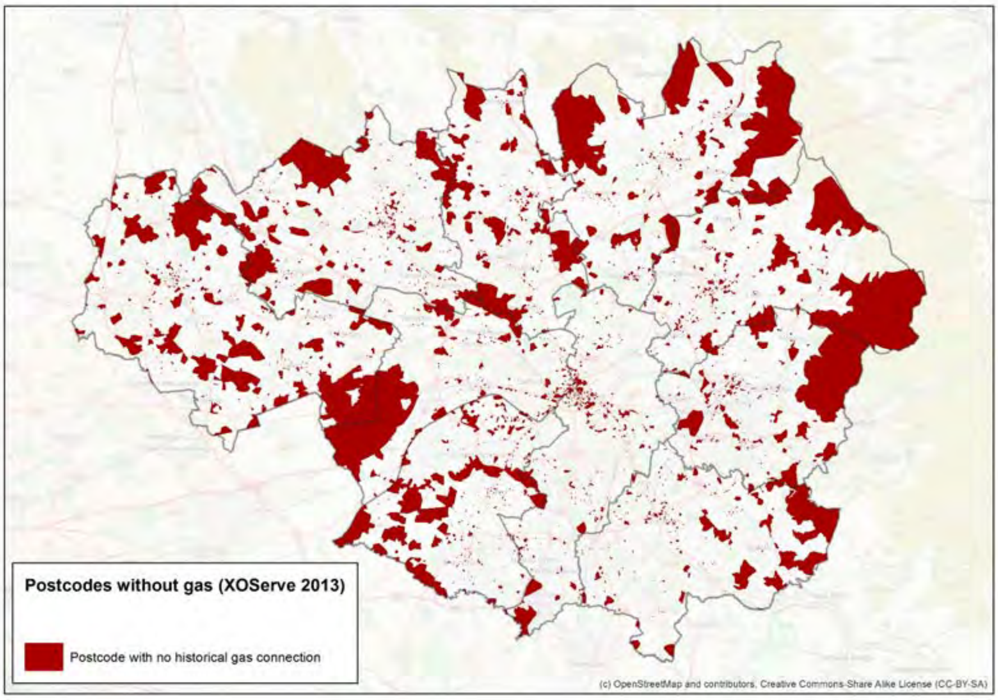

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Figure 4-32 Postcode with no historical gas connection

Gas production

Shale Gas

Scientists from the British Geological Survey (BGS) have estimated that the total volume of gas in the Bowland-Hodder shale in northern England is some 1,300 trillion cubic feet (central estimate).

The British Geological Society's Bowland Shale Gas study is the first in the UK to provide investors, operators and regulators with an indication of where to target future exploratory drilling. It is not possible to estimate how much shale gas and oil the UK can produce until there has been some exploration and testing (GOV.UK, n.d.).

The Greater Manchester region is in Bowland Shale Prospective Area and as such will be the subject of ongoing exploration and investigation (OGA, 2016). Whilst shale gas exportation is being supported by the UK Government, the deliverability of any shale gas resource has a significant planning risk in terms of securing necessary consents and approvals.

Coal Bed Methane

Coalbed methane (CBM or coal-bed methane), coalbed gas, coal seam gas (CSG), or coal-mine methane (CMM) is a form of natural gas extracted from coal beds. In recent decades it has become an important source of energy in United States, Canada, Australia, and other countries.

Gas is bound within coal by a process known as adsorption, where the gas molecules adhere to the surfaces within the coal. As pressure is reduced, gas is released from the coal surfaces, diffuses through the coal matrix and flows through the fracture system of the coal. Coalbed methane production can be subdivided into three categories: coal mine methane (CMM), abandoned mine methane (AMM) and coalbed methane (CBM) produced via boreholes from virgin coal seams. **(DECC, 2013)**.

There is potential within the Cheshire basin, and within the Greater Manchester region for CBM.

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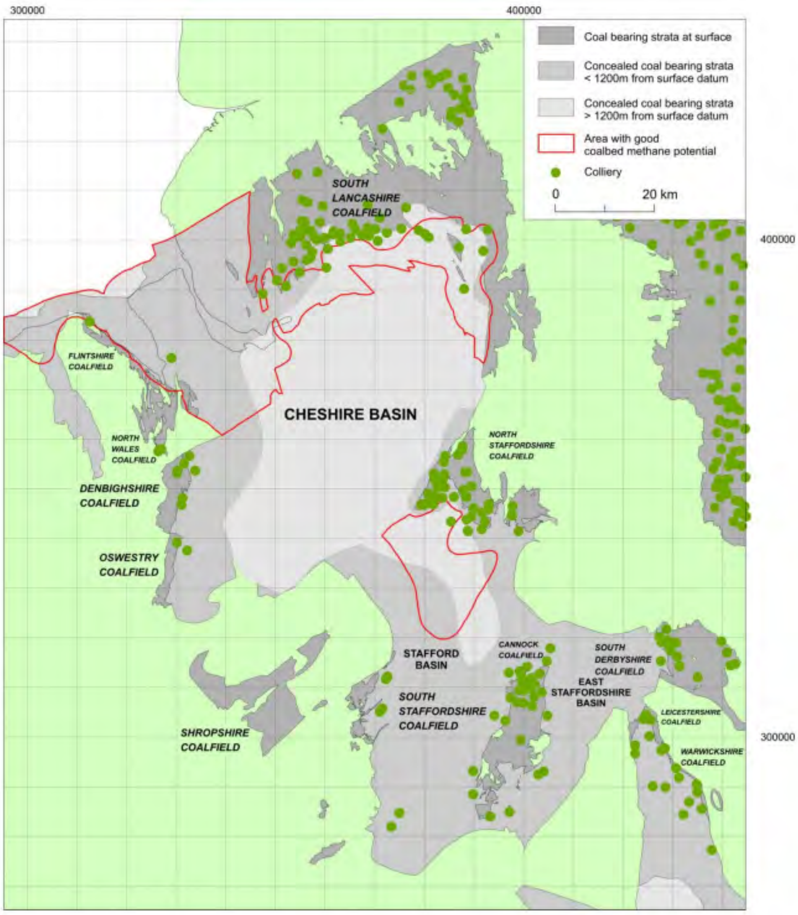

Figure 4-33 Potential for coalbed methane in the North West (DECC, 2013)

Currently Island Gas Ltd have been granted planning permission to continue to explore within Trafford, next to the Davyhulme Waste water treatment works (81446/RENEWAL/2013)

Exploration Licences

In August 2015, the Oil and gas Authority (OGA) announced its intention to offer licences covering 27 blocks. These blocks did not require further environmental assessment (OGA, 2016) under the Conservation of Habitats and Species Regulations 2010 (the Habitats Regulations). At this time, the OGA launched a consultation relating to a further 132 blocks that were subjected to further detailed assessment in accordance with the Habitats Regulations, and a public consultation on that assessment was carried out.

Figure 4-3434 shows the most recent (14th) round of exploration licence areas issues by DECC and the OGA. Also noted are current operating wells. These areas could have new wells producing gas or oil within 5 years.

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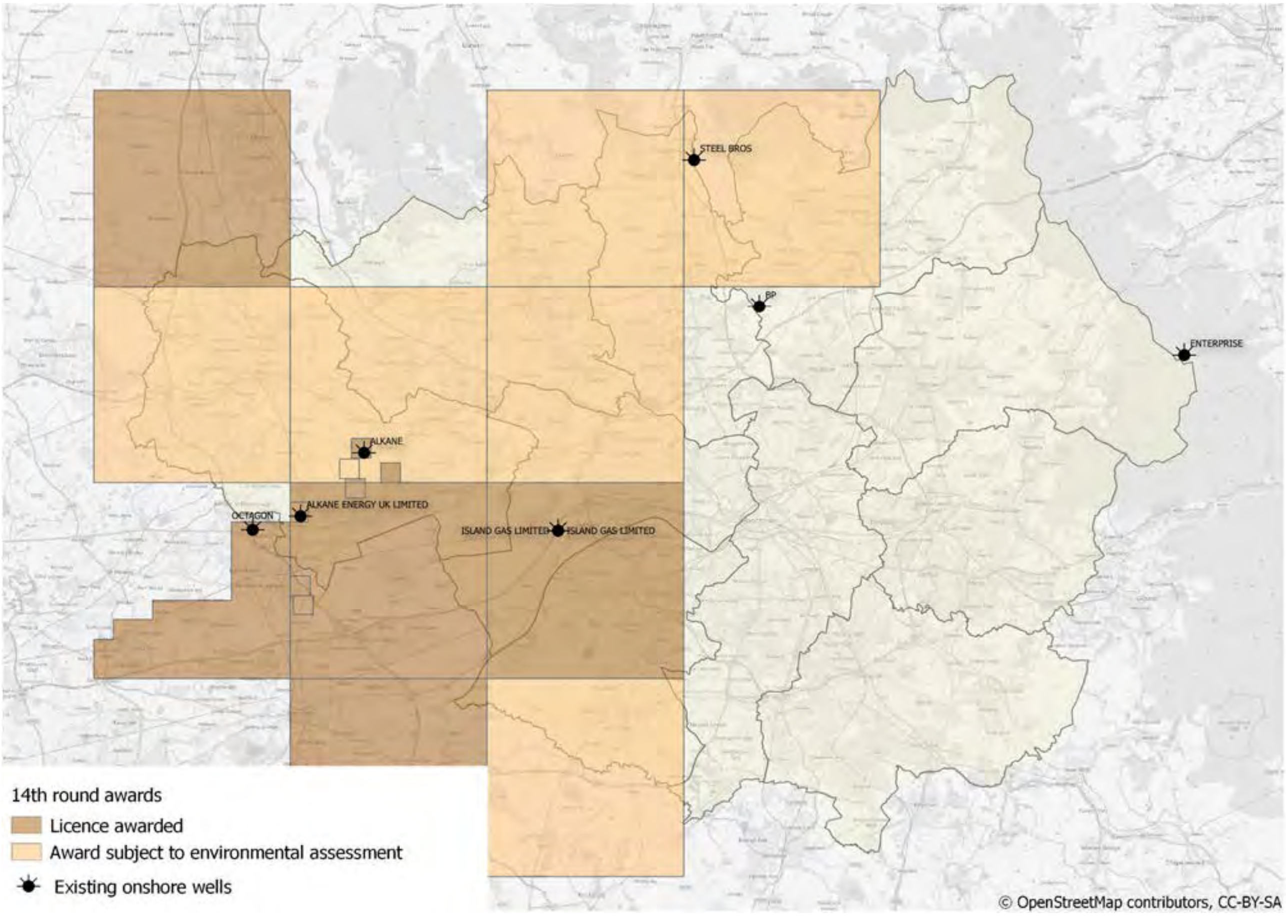

Figure 4-34 Onshore wells and licence areas

It is difficult to predict output from any wells, either oil or gas, as currently there is a no available data from any of the wells within the Greater Manchester region due to confidentially clauses in the issued licences.

4.4.3 Renewable and Low Carbon Energy Sources

Greater Manchester has a number of renewable and low carbon sources of energy, at a range of scales.

North West renewables 2003-2014

Regional installation of renewables since 2010 has seen some major changes, mainly due to the ramp up of wind installation. Figure 4.35 shows this trend. Due to the policy environment this acceleration may taper off as onshore wind finds it difficult to get sites approved and the most advantageous sites are utilised. Solar PV is a very small but growing part of the total capacity.

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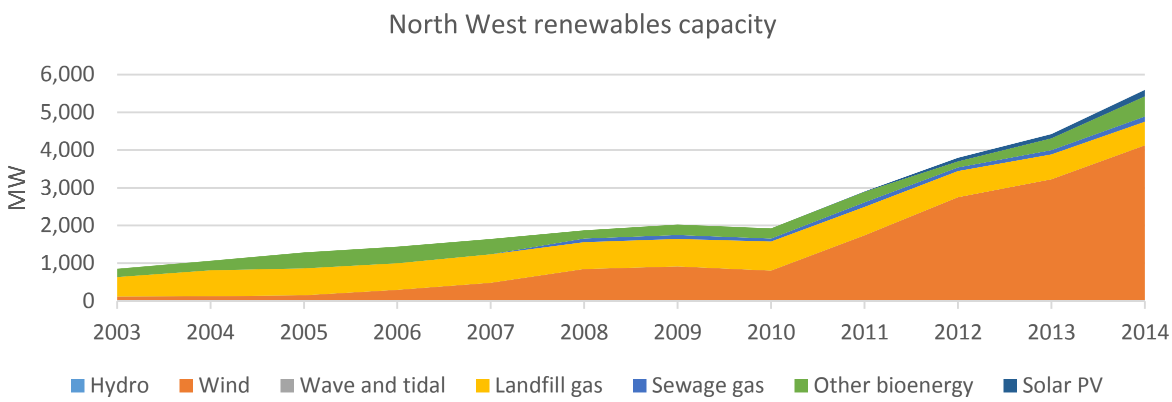

Figure 4-35 North West renewables installed capacity 2003-2014 (DECC, 2016)

GM Renewable Generation

In 2014 renewable generation within GM provided for 292GWh of energy (DECC, 2016). This is less than 1 % of GM total energy consumption and 2.5 % of electricity consumption.

Figure 4-36 shows the proportion of renewable generated by source. The largest contributor to GM is electricity form landfill gas, followed by sewage gas. Solar PV provides around 18 % of the total annual renewable generation.

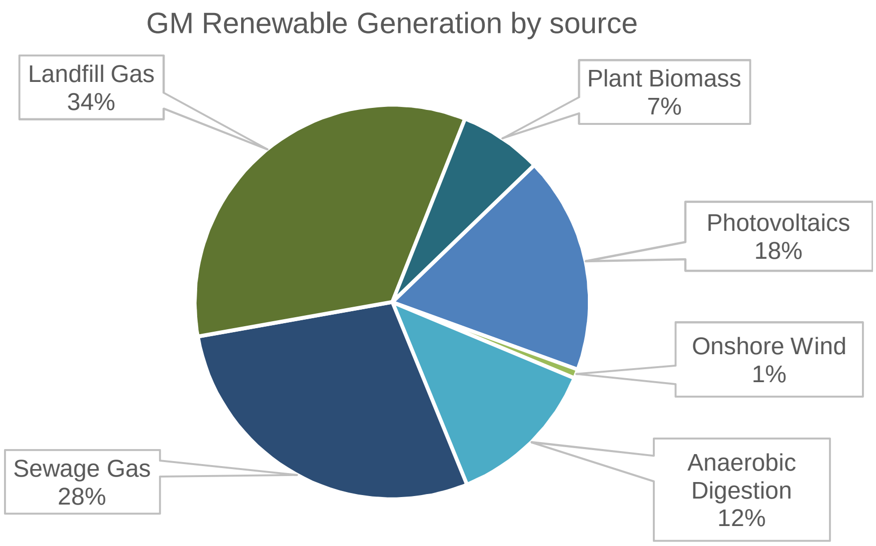

Figure 4-36 GM renewable generation by source

Figure 4-37 4.37 shows the generation of renewable electricity for each district for 2014. Landfill gas provides the largest proportion of overall electricity generation in Bury and Oldham. The sewage gas generation plant in Trafford provides largest proportion of electricity there. Photovoltaics (PV) provide the next highest generation figures in most districts. The exceptions are Salford and Trafford where Anaerobic Digestion (AD) provides a substantial amount. In the Trafford district AD provides around 72 % of the total generation for the district. In total sewage gas, landfill gas and AD provide a 74 % of the renewable generation.

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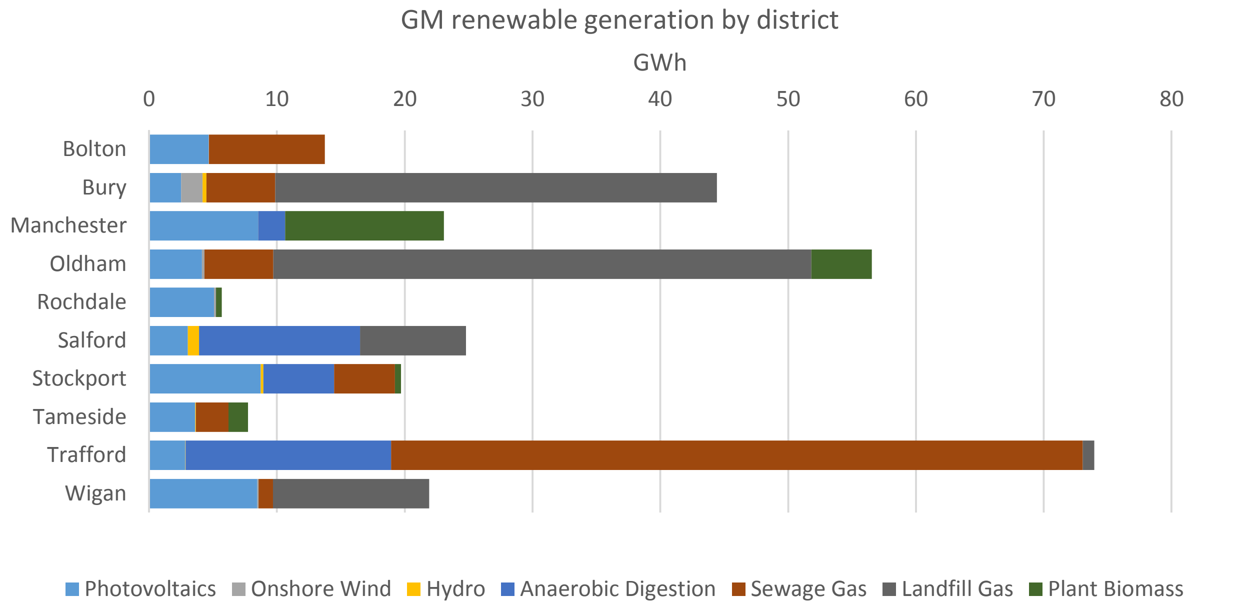

Figure 4-37 GM Renewable Electricity Generation 2014 (DECC, 2016)

Large Renewables

Large scale renewable capacity that has been through the planning system is registered in DECC's Renewable Energy Planning Database (REPD) (DECC, 2016). A number of sewage treatment works / water companies in the UK are upgrading sewage sludge into biomethane and injecting this into the gas distribution system. There are a number of landfill gas sites in GM which are producing renewable electricity into the grid. Tameside is the only district that doesn't have any renewable capacity registered in the REPD. Both sewage gas and gas from landfill may have growth potential in GM but are capped by the number of available sites.

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Figure 4-38 REPD sites

HV connected renewable generation sites

Figure 4-39 gives the HV connected renewable generation in the region. The majority of capacity is solar and biogas production. The locations are well spread out around the region with every district having some renewable generation.

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Figure 4-39 HV connected generation (DECC, 2016)

Table 4-1 Renewable generation capacity

Technology	Capacity (kW)
Hydro	3,575
Landfill gas, sewage gas, biogas (not CHP)	33,216
Mini CHP (<1MW)	1,240
Onshore wind	1,449
Other generation	15,394
Photovoltaic	65,047
Small CHP (> = 1MW, < 5MW)	5,500
Grand Total	**125,421**

Renewables Obligation (RO)

The Renewables Obligation (RO) is one of the main support mechanisms for larger renewable electricity projects in the UK. Smaller scale generation is mainly supported through the Feed-In Tariff (FITs). (DECC, 2016)

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The RO came into effect in 2002. It places an obligation on UK electricity suppliers to source an increasing proportion of the electricity they supply from renewable sources.

Renewables Obligation Certificates (ROCs)

ROCs are green certificates issued to operators of accredited renewable generating stations for the eligible renewable electricity they generate. Operators can trade ROCs with other parties. ROCs are ultimately used by suppliers to demonstrate that they have met their obligation.

Feed in Tariff (FIT)

The Feed-in Tariffs (FIT) scheme is a government programme designed to promote the uptake of a range of small-scale renewable and low-carbon electricity generation technologies. It is available through licensed electricity suppliers.

The scheme requires some suppliers to make tariff payments on both generation and export of renewable and low carbon electricity. Generation and export tariff rates are index-linked which means that they will increase or decrease with inflation.

FIT installed Capacity

Figure 4-40 Greater Manchester Installed FIT (electricity) capacity shows installed renewable energy capacity receiving FIT payments for the Greater Manchester region. Manchester has the highest installed capacity mainly due to the PV domestic installation numbers. In all districts domestic PV installation is the majority of installed capacity. Technologies other than PV do not provide significant capacity. The exception to this is Bury where 20 % of the total capacity is provided by non-domestic wind.

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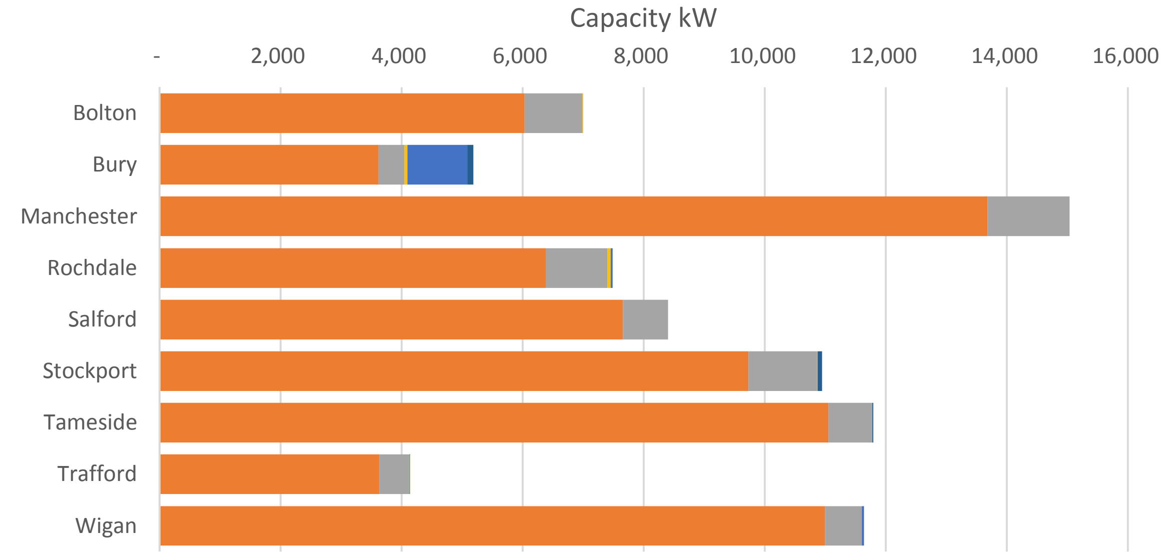

	Wigan	Trafford	Tameside	Stockport	Salford	Rochdale	Manchester	Bury	Bolton
PV Domestic	10,991	3,628	11,051	9,730	7,655	6,380	13,682	3,620	6,032
PV Non Domestic	608	509	725	1,137	747	1,020	1,350	427	958
Wind Domestic	-	-	-	5	-	53	-	47	6
Wind Non Domestic	37	-	-	-	-	33	-	990	-
Hydro Domestic	-	4	-	-	-	-	-	-	-
Hydro Non Domestic	-	-	15	74	-	-	-	100	-

Figure 4-40 Greater Manchester Installed FIT (electricity) capacity (DECC, 2016)

Domestic FIT installations

Figure 4-41 shows that when normalised by numbers of households, the amount of generation capacity installed varies considerably across the districts. Tameside (115W) has almost 3 times the capacity per household installed than Trafford (38W). All except Tameside are below the average installation per household for England (90W). This is indicative of the lesser solar potential and therefore lower financial returns from installations that are further north. When comparing with regional North West installations, there is a better fit. Tameside, Stockport and Wigan all have capacity levels above the regional average. Rochdale and Salford match the regional figure, whereas the other districts are below average by varying amounts. Trafford is around 50 % of the regional installation figure.

In total GM provides 31 % of the total installed FIT capacity in the North West region (279,000kW).

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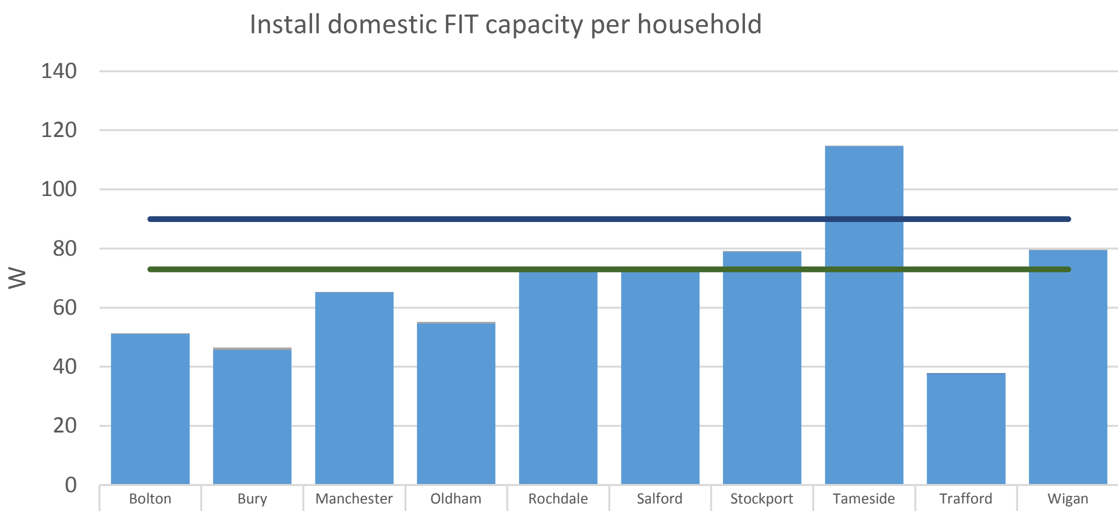

	Bolton	Bury	Manchester	Oldham	Rochdale	Salford	Stockport	Tameside	Trafford	Wigan
mCHP Domestic	0	0	0	0	0	0	0	0	0	0
AD Domestic	0	0	0	0	0	0	0	0	0	0
Hydro Domestic	0	0	0	0	0	0	0	0	0	0
Wind Domestic	0	1	0	1	1	0	0	0	0	0
PV Domestic	51	46	65	55	72	72	79	115	38	79
England	90	90	90	90	90	90	90	90	90	90
North West	73	73	73	73	73	73	73	73	73	73

Figure 4-41 Installed Domestic FIT capacity per household

Non Domestic FIT installations

Figure 4-42 shows the non-domestic FIT installation capacity normalised per 1,000m² floor area. The national (England) figure is 1.7W/m². The regional North West figure is 0.7W/m². In Bury, where a significant amount of wind generation has been installed, alongside some Hydropower the capacity exceeds the regional average. In all other districts the installed capacity is much lower. Trafford has the least with installed capacity of 0.1W/1,000m². Only looking at solar PV, Stockport and Oldham have installation capacity close to the regional average. All other districts are considerably lower.

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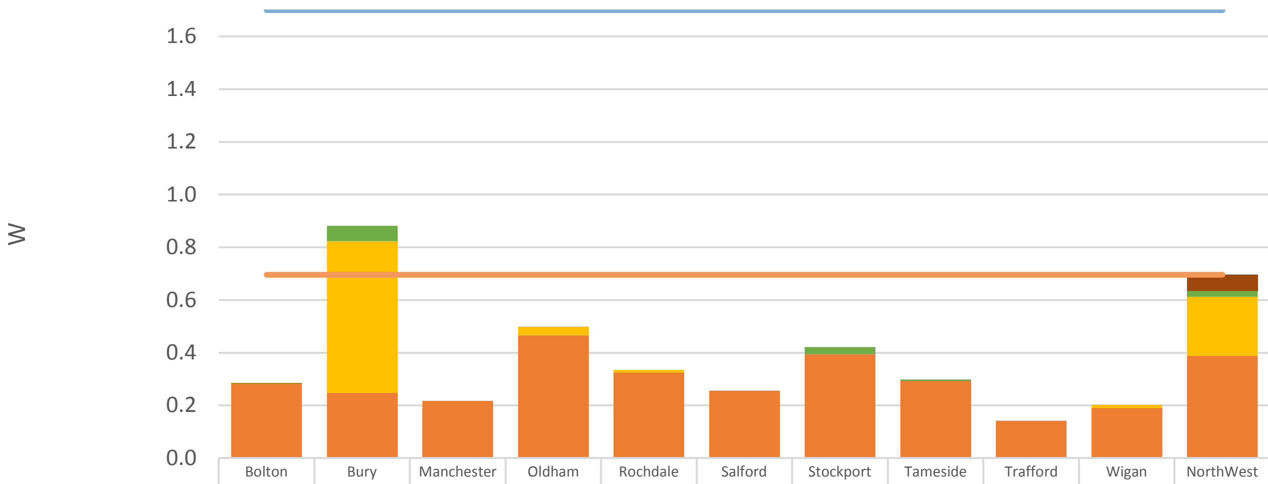

	Bolton	Bury	Manchester	Oldham	Rochdale	Salford	Stockport	Tameside	Trafford	Wigan	NorthWest
mCHP Non Domestic	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
AD Non Domestic	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Hydro Non Domestic	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wind Non Domestic	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
PV Non Domestic	0.3	0.2	0.2	0.5	0.3	0.3	0.4	0.3	0.1	0.2	0.4
England	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
North West	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7

Figure 4-42 Non Domestic FIT capacity per 1000m² floor space

Solar PV

Solar Photovoltaics (PV) make up the largest proportion of small scale installed renewable capacity. The national picture Figure 4-433 shows the effect of government policy on the installation numbers, and capacity. The sudden jumps are aligned with changes to the FIT Tariff. When tariffs change, there tends to be a last minute rush to get installs commissioned and registered under a higher FIT rate.

The largest proportion of installations are currently larger stand-alone systems e.g. solar farms. Figure 4-433 shows that there has been a gradual increase in residential scale solar systems (<4kw) over the last four years. PV installations under 5MW have grown steadily with commercial and large scale stand-alone systems increasing in large steps around the times of the major changes to fiscal support (FIT payment tariff digression) or policy changes. Currently large systems (5MW+) make up over 50 % of the deployed capacity of solar PV in the UK. Very small domestic scale (sub 4kW) provides a sizable proportion of the rest.

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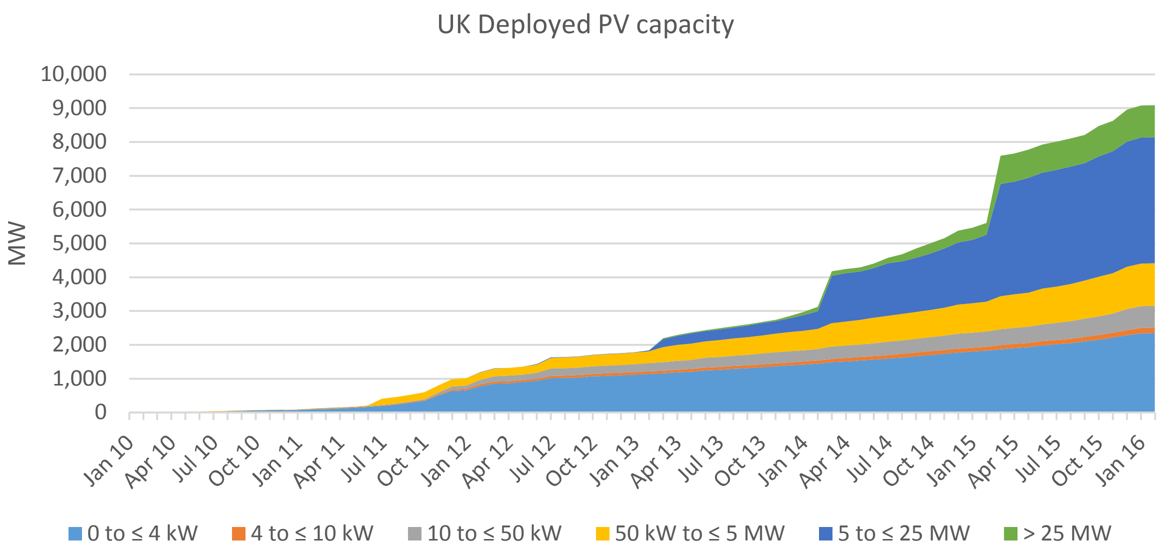

Figure 4-43 UK PV deployed capacity (DECC, 2016)

Wind

There are a number of wind turbines in the Greater Manchester area mainly located in the Scout Moor wind farm which spans the Rochdale/ Rossendale boundary. It has a total nameplate electrical generation capacity of 65 MW, providing 154,000 MWh per year from 26 Nordex N80 wind turbines. There is currently a planning application to expand the wind farm by adding another 14 turbines (United Utilities, n.d.). The electrical generation from this wind farm is not attributed to Rochdale in the national statistics.

Crook Hill wind farm (34.7MW) started operation towards the end of 2015 and will provide 94,608 MWh per year from 11 turbines. 7 turbines are in Rochdale, the other 4 are in Calderdale. A few individual small wind turbines are registered in the Renewable UK's Wind Energy Database (UKWED). This records projects with capacities of over 100kW, and so does not include micro turbines (RenewableUK, n.d.).

Table 4-2 Wind capacities

Wind Project	Location	Turbines	Project Capacity (MW)
Beet Farm	Broad Lane, Burnedge, Rochdale	1	0.1
Sillinghurst Farm	Castle Hill Road, Bury	1	0.25
Stand Lees Farm	Ashworth Road, Heywood	1	0.8
Wind Hill Farm	Ashworth Road, Heywood	1	0.5
Scout Moor Wind Farm	Scout Moor	26 (+16)	65 (+38.6)
Crook Hill Wind Farm	Crook Hill, Rochdale	11	35

All the wind generation in the GM region is to the North of the region, mainly in Rochdale and Bury. The size of Scout Moor wind farm dwarfs the other sites. If the 16 new turbines are approved, subject to outcome of public inquiry, the site will be the largest in England with a capacity of over 100MW.

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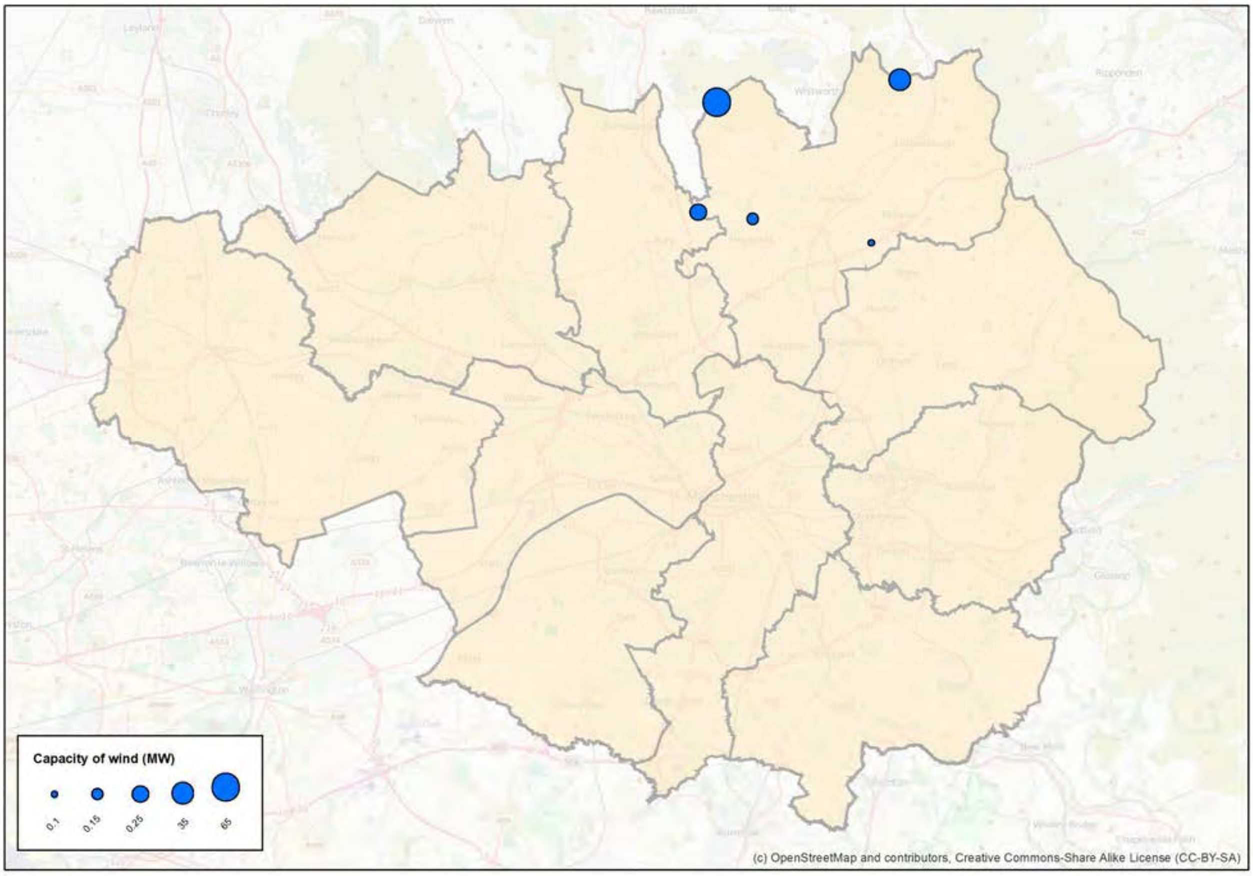

Figure 4-44 Location of GM wind turbines

Renewable Heat Incentive

The Renewable Heat Incentive (RHI) is a payment system for the generation of heat from renewable energy sources introduced in the United Kingdom on 28 November 2011.

The RHI operates in a similar manner to the Feed-in Tariff system, and was introduced through the same legislation - the Energy Act 2008. In the first phase of the RHI incentive payments were paid to owners who install renewable heat generation equipment in non-domestic buildings: Commercial RHI. The RHI was extended to domestic buildings on 9 April 2014. Whilst the Feed-in Tariff is paid by electricity retailers and funded from electricity bills the RHI is paid by central government from general taxation.

Domestic RHI

Take up of the domestic RHI has been very low and due to the requirement to provide anonymous statistics, district level installed capacity figures are not available directly (DECC, 2016). The number of accreditations is available per district. Using the North West Region figures for installation capacity by type and average size, it can be inferred which technologies have been installed and at what capacity in the GM districts. Figure 4-46 shows the amount of generation (kW) by technology type in each district. The totals are very low compared to similar data for the FIT and the number of households, with Wigan having the largest total installed capacity. Figure 4-45 shows that this is achieved by 166 accredited systems for the whole of Wigan. Salford only has 6 RHI accreditations in the 2 years since the scheme started.

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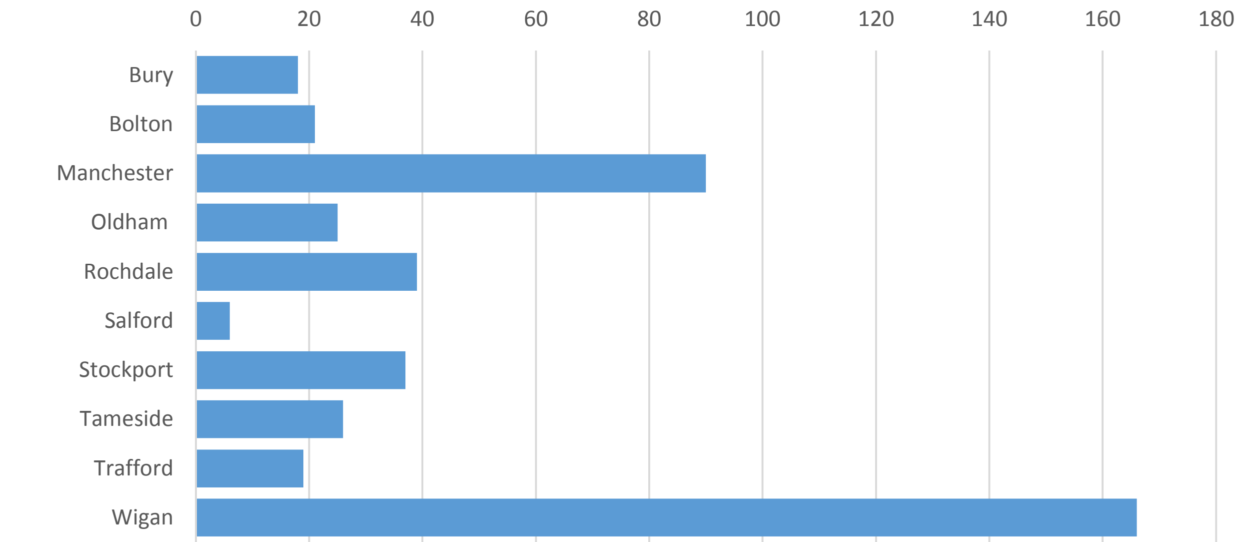
Biomass uptake is very difficult to measure but the DECC wood fuel use survey (DECC, 2016) found that nationally around 5 % of households in the North West use some kind of wood fuel, including for aesthetic purposes. The implementation of the RHI has increased the visibility of biomass installations although the RHI only recognises biomass that meets certain criteria and meets all the heating demands of the property.



	Wigan	Trafford	Tameside	Stockport	Salford	Rochdale	Oldham	Manchester	Bolton	Bury
accredited installations	166	19	26	37	6	39	25	90	21	18

Figure 4-45 Number of accredited domestic RHI applications

Regional (North West) statistics (4.3) gives the proportions for accreditations by technology. Air source heat pumps and biomass are the main technologies for installation making up 70 % of the total number of accreditations. Table 4.3 shows the average installation size for each technology nationally along with the regional (North West) accreditation numbers.

Table 4-3 North West Domestic RHI accreditations (April 2012-March 2016)

Technology	Accreditations	Proportion	Average Installation Size (GB)
Air source heat pump	1121	38 %	10kW
Ground source heat pump	485	17 %	12kW
Biomass	948	32 %	26kW
Solar thermal	367	13 %	12kW

Using Table 4-3 and Figure 4-45 an extrapolation can be carried out for the districts as seen in Figure 4-46 Domestic RHI accredited capacity. These numbers should be treated with caution and are only included for completeness.

Figure 4-46 Domestic RHI accredited capacity shows that Wigan has the largest amount of renewable heat capacity installed at domestic level. This is probably due to the partnership between GMCA and Japan's New Energy Development Organisation (NEDO) that is installing heat pumps in up to 600 homes across the Greater Manchester area. (GMCA, 2016). This project is piloting smart grid connected air source heat

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pumps initially in Wigan and may account for the disparity between districts. The Regional installation figures do not relate to what is happening at a local level, showing a high proportion of biomass installation. The vast majority of the domestic RHI in urban areas is anticipated to be air source heat pumps.

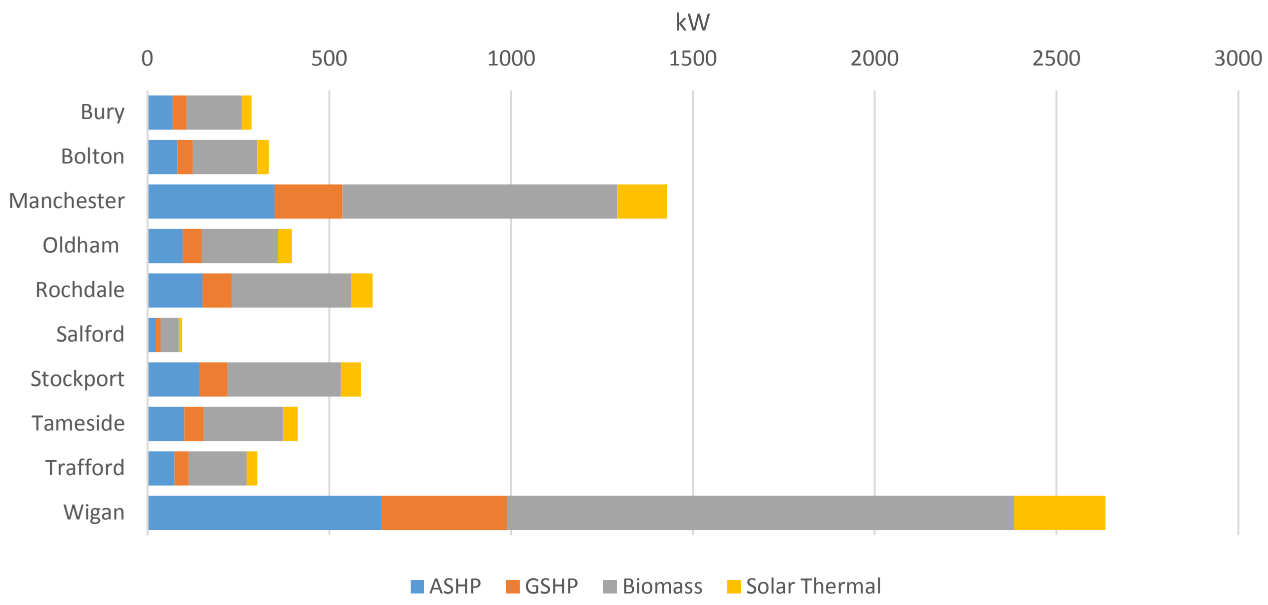

Figure 4-46 Domestic RHI accredited capacity

Non-Domestic RHI

DECC official statistics show that up to Feb 2016 the North West had 214 MW of accredited non-domestic capacity claiming the Renewable Heat Incentive (RHI). This is 7 % of the total GC installed capacity.

Non domestic RHI installations have lower numbers than domestic installations. The majority of all applications have been for biomass boilers, with small scale (<200kW) having the most applications and the highest capacity installed.

The small-scale biomass installations for the North West may not directly relate to the situation within the Greater Manchester region as small scale biomass has likely been installed in rural farms and businesses in the less populated areas of the North West. Unfortunately, it is not possible to understand the situation in the Greater Manchester area, as the released RHI figure do not have the resolution due to the requirement for anonymisation.

Table 4-4 North West Non Domestic RHI installations March 2016

Technology	Full applications	Accredited installations	Capacity of full applications	Capacity of accredited installations

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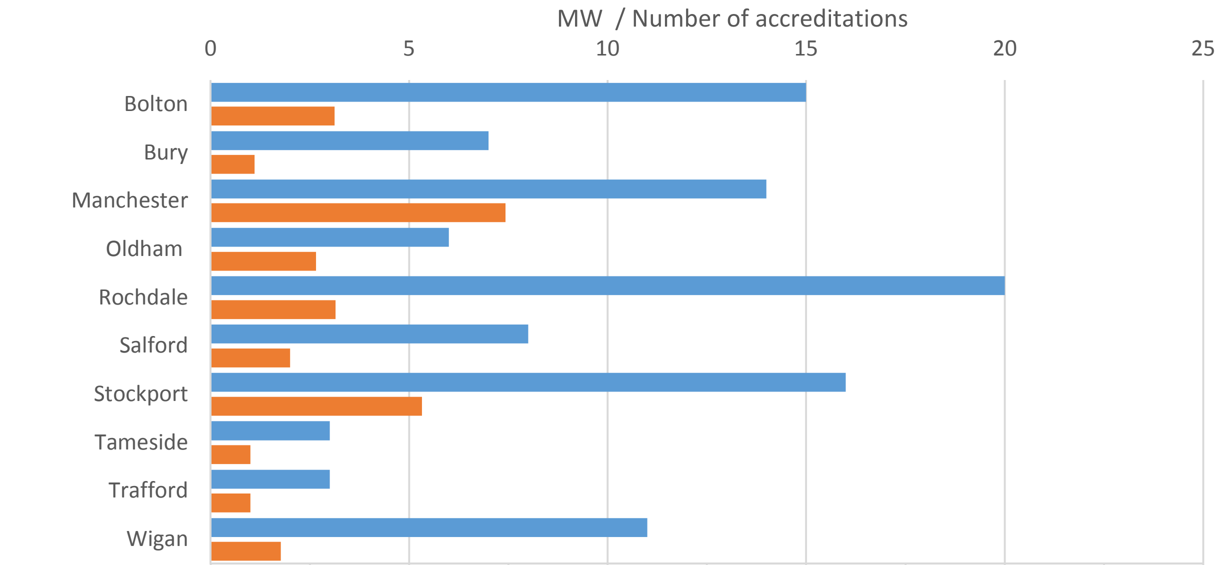
	Number	Number	MW	MW
Small biomass boiler (<200 kW)	929	842	163	139
Medium biomass boiler (200-1000 kW)	389	353	68	58
Large biomass boiler (>1000 kW)	113	103	20	17
Solar thermal (<200 kW)	2	2	0	0
Small water or ground source heat pumps (< 100 kW)	6	5	1	1
Large water or ground source heat pumps (>100 kW)	16	14	3	2
Air Source Heat Pumps	1	1	0	0
CHP	0	0	0	0
Deep Geothermal	0	0	0	0
Biogas	13	12	2	2
Total	**1470**	**1333**	**257**	**220**



	Wigan	Trafford	Tameside	Stockport	Salford	Rochdale	Oldham	Manchester	Bury	Bolton
Number of Accreditations	11	3	3	16	8	20	6	14	7	15
MW	1.8	1.0	1.0	5.3	2.0	3.1	2.7	7.4	1.1	3.1

Figure 4-47 non domestic - number of RHI accreditations and capacity by district

Networked Heating and Cooling, and Combined Heat and Power

Nationally, combined heat and power (CHP), and heat networks have been receiving much attention recently with policy and government funding encouraging interest through the Heat Networks Delivery Unit (HNDU).

Combined Heat and Power

Combined heat and power (CHP) generation allows heat, in the form of hot water, and electricity to be produced from a single unit. CHPs are usually run on gas but there are models that run on biomass or biogas. The ability to generate electricity locally means that transmission and distribution losses from the

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national grid supply can be avoided. This combined with the use of the waste heat can make CHP a very attractive technology, especially from a low carbon perspective.

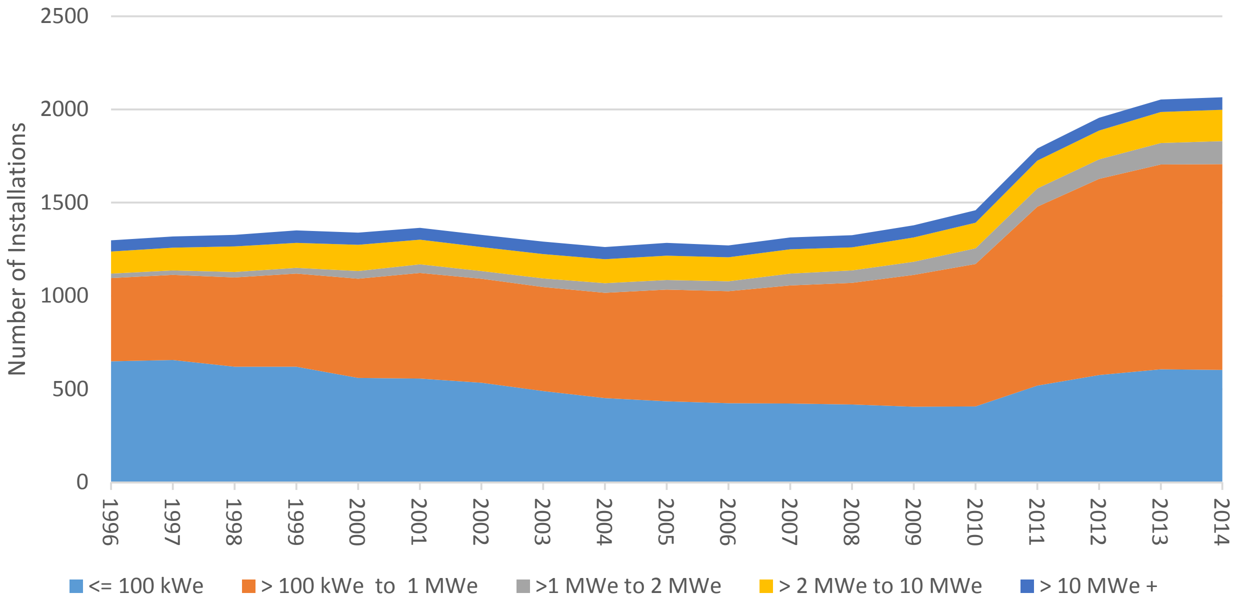

Figure 4-48 Number of CHP installations nationally (DECC, 2016)

The number of CHP installations has been increasing since 2010, after being relatively static for the previous 15 years. This is in part due to the incentives offered by the UK government including the climate change levy and carbon price support tax exemption, as well as enhanced capital allowances. The main category of increase is the 100kWe to 1MWe range. The total capacity of CHP installation has not increased significantly in the last 5 years. The main capacity comes from a small quantity of large installations. There appears to be a flattening off of the number of installations, suggesting a slowdown in install rates.

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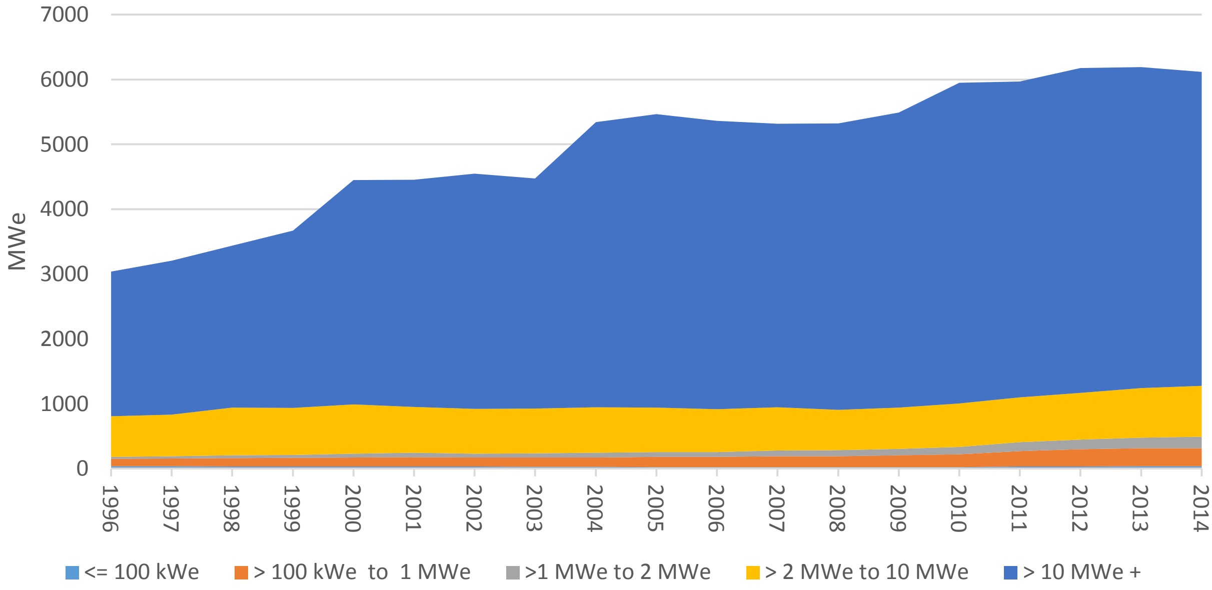

Figure 4-49 Capacity of CHP installations

Heat Networks

A district heat network is the distribution of thermal energy in the form of steam, hot water or chilled liquids from a central source of production through a network to multiple buildings or sites for the use of space heating or process heating or hot water.

Heat networks exist in Greater Manchester at Manchester Metropolitan University's Birley Fields campus, at MediaCityUK and in the St Mary's district of Oldham, while a Manchester city centre Civic Quarter network is in procurement for a delivery partner. Figure 4-500 shows the locations of identified existing heat networks and also CHPs that are identified on DECCs CHP register (DECC, 2016). There may be more CHPs that are not registered, but they are not easily identifiable within the scope of this study.

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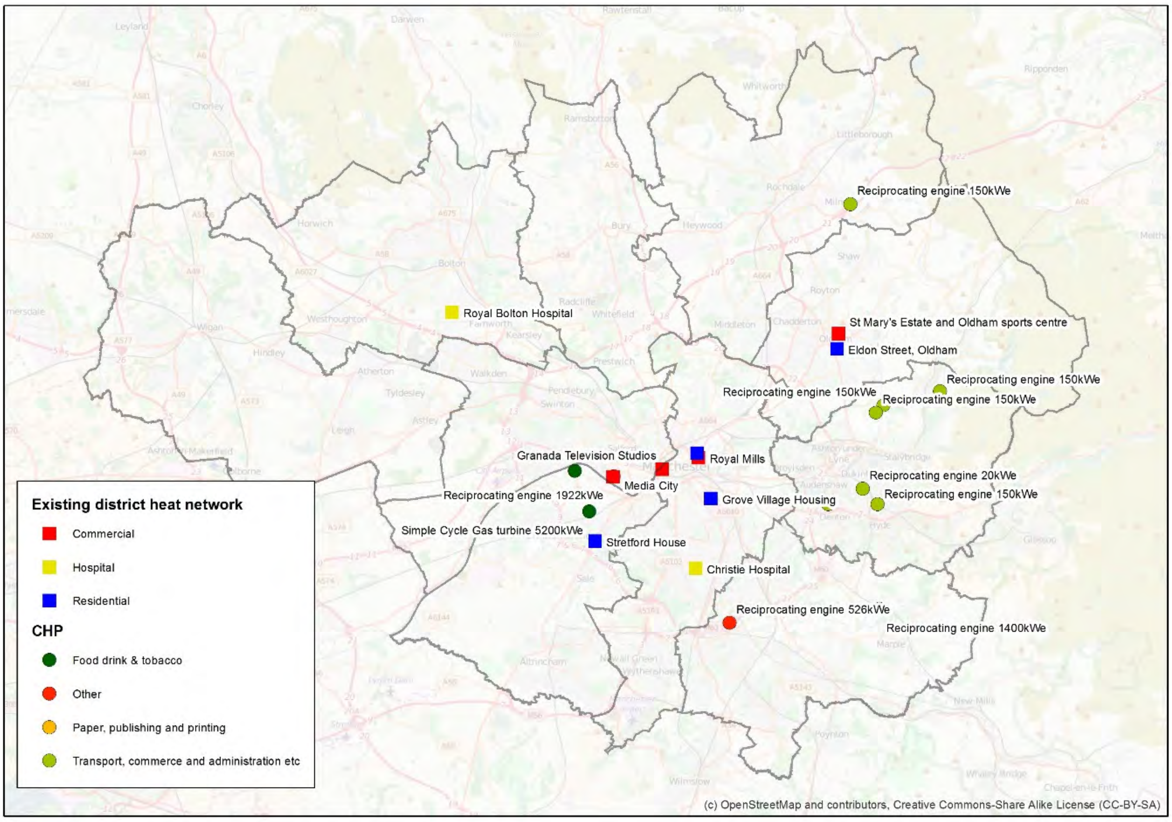
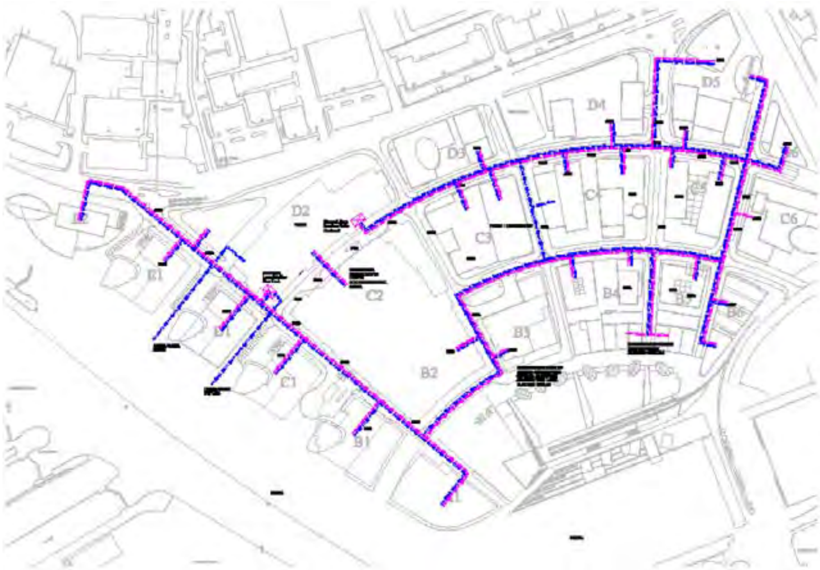


Figure 4-50 Existing heat networks and CHP

MediaCityUK

MediaCityUK is the first development in the world to become a BREEAM approved sustainable community and achieved the highest environmental saving rating in the world through the use of a highly efficient low carbon site based tri-generation system for the local generation of heat, cooling and electricity which will save approximately 20,000 tonnes of CO_2 per annum.



The site is the home for BBCs northern centre, others moving to the site include the University of Salford which is set to create a Higher Education Centre forming an extension of the University's main campus to accommodate over 700 students and staff.

The district heating network comprises of over two thousand metres of pre-insulated underground pipe with a 40MW tri-generation system simultaneously producing heat, cooling and power through a centralised Energy Centre whereby two 9MW natural gas fired boilers provide the majority of the heat, a 2MW Combined Heat and Power (CHP) engine generates heat and electricity simultaneously whilst an absorption chiller creates chilled water from the recovered waste heat

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which circulates in a water jacket around the CHP engine. The simultaneous generation of energy coupled with the use of recovered energy means that the system operates with very high efficiency compared to traditional forms of energy generation.

The energy centre is designed in a modular fashion, to be installed in two phases as the MediaCityUK site develops to its full potential size. Vital Energi have recently handed over the first completed phase of the installation which includes two 9MW gas boilers, a 2MW CHP engine and a 1.5MW absorption chiller which will provide cooling to the BBC film studios (VitalEnergy, n.d.).

The scheme is current exploring the potential to move to the next phase of connections and infrastructure.

St Marys, Oldham

The St. Marys District Heat network in Oldham currently provides heat and hot water to around 1,400 homes and Oldham leisure centre. The former coal fired district heat network is now gas-fired and is managed by First Choice Homes Oldham. Heat meters have been introduced.

The gas plant was designed for more than 1,700 dwellings as well as the leisure centre. It consists of 3 boilers: a dual fuel, gas and gas-oil fired boiler, and 4 pass boilers which heat the primary air from the flue. The gas-oil boiler was installed as a back-up but it has never been used.

Each boiler is rated at 5.5MW and thermal efficiency is above 83 %. A typical summer load would be about 2.5MW, peaking to 6MW in the winter months, therefore the existing network has significant unused capacity.

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Water Abstraction

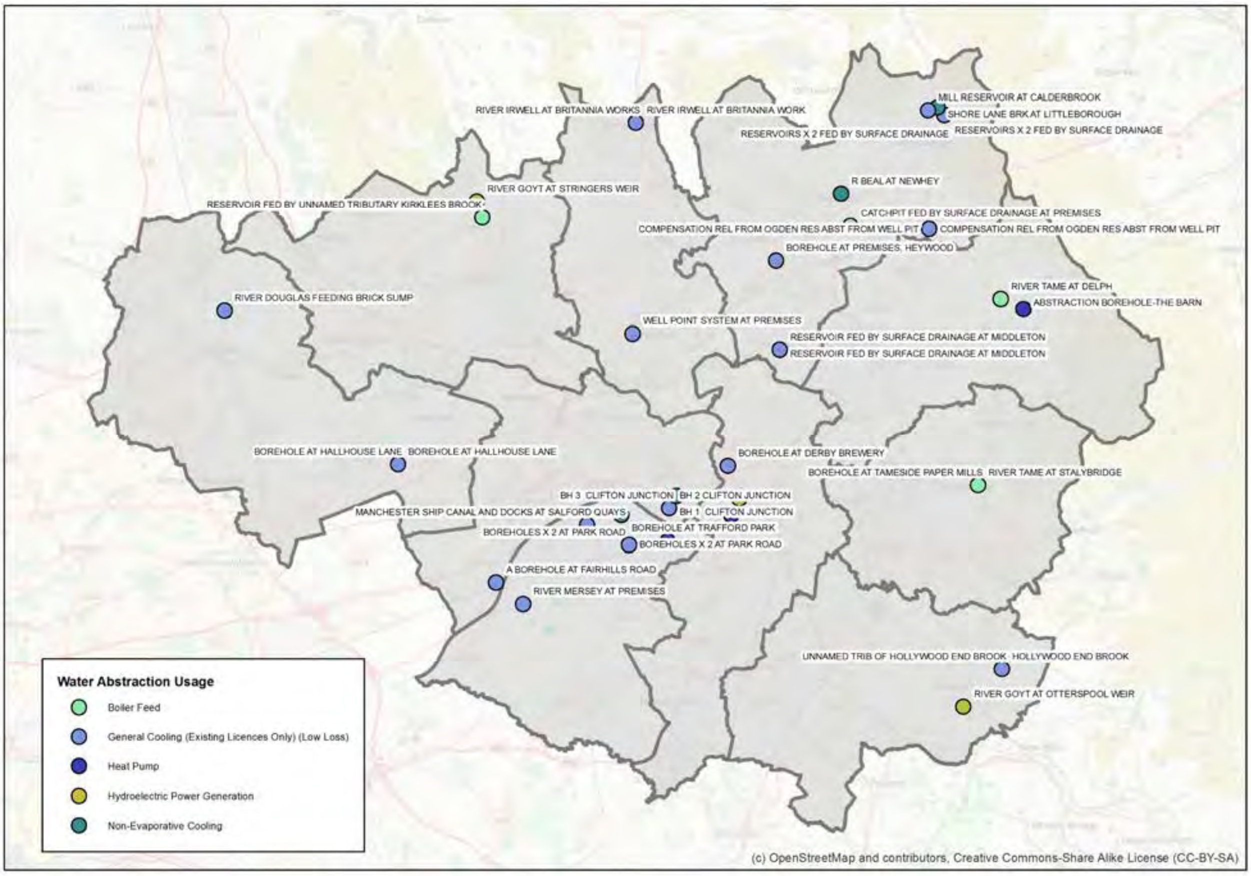

Figure 4-51 Water abstraction locations (EA, 2016)

Water is used for a number of purposes in the energy sector. For each of these usages an abstraction licence is required from the environment agency. The main usage is for cooling of boiler feeds, or industrial processes. In many cases it would be replacing or augmenting electrical cooling. There are a number of energy centres that use abstracted water for uses connected with energy production. Trafford city centre and Manchester Metropolitan University both use ground water for heat pump heat extraction.

Energy from Waste (EfW)

The Bolton Incinerator was constructed in 1971. The incinerator burns up to 20 tonnes of household waste per hour (85,000 t/yr) and can generate up to 11 MW of electricity. The plant is operated by Viridor. The Bolton Incinerator is the only household waste incinerator in Greater Manchester.

A 20MW biomass plant at Barton attained final Planning permission on 16th May 2013, with a variation application submitted in September 2015 and approved in February 2016 (ref 86514/VAR/15). The plant will burn around 90 % biomass made up of 70-75 % "waste wood", some of which is potentially from civic municipal facilities, and 15-25 % from other plant-derived biomass, such as managed forestry residues, energy crops, agricultural residues and solid recovered fuel.

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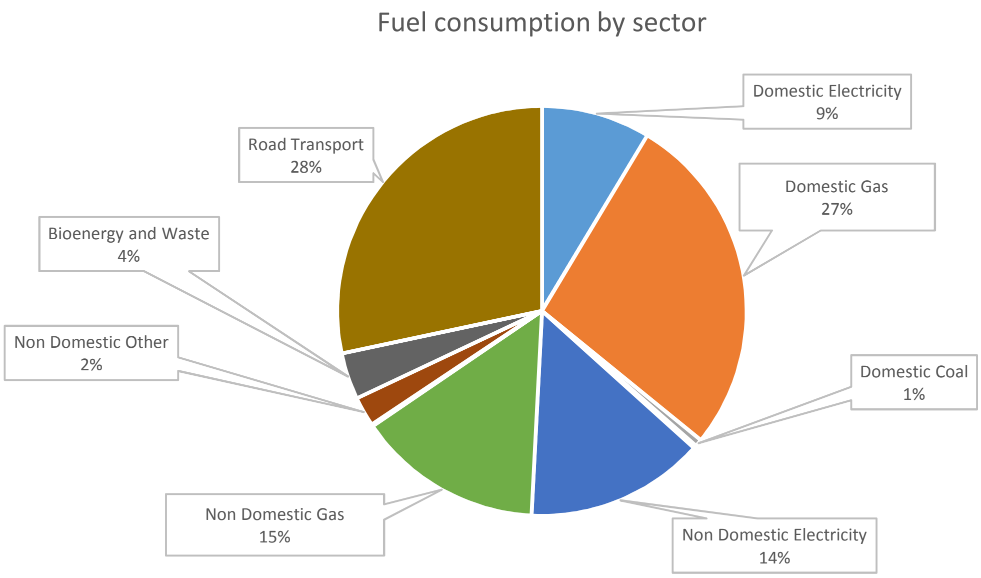
4.4.4 Summary

- Greater Manchester has a wide range of energy supplies. Electricity is distributed from 137 33kV substations feeding 11,205 distribution sub stations.
- Gas is available across almost all of the region. Renewables generated 292GWh of electricity. There are opportunities for oil and gas exploration.
- There are a number of heat networks with the GM region, providing heat to households and businesses.

4.5 Current Fuel Consumption

Fuel consumption statistics are taken from DECCs fuel consumption data collections (DECC, 2016). Floor areas for non-domestic normalisation are taken from data published by the Valuation Office Agency (VOA, 2012)

The total fuel consumption including transport is 51.6TWh. The fuel consumption across Greater Manchester is split between domestic, non-domestic and transport sectors, with a number of fuels contributing to the final total. Excluding transport, the figure is 37TWh. Bioenergy and waste includes gas from biogas at sewage works and waste incinerated in energy form waste plants.



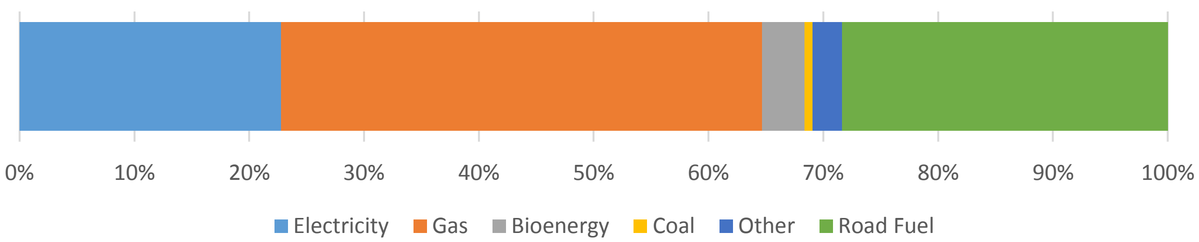


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Figure 4-52 Fuel consumption by fuel type

Domestic and non-domestic energy consumption in GM accounts for 37 % and 35 % respectively. Road transport accounts for 28 %.

The most significant fuel consumed in GM is gas. This accounts for around 42 % of total energy usage, with domestic gas usage being slightly larger than non-domestic usage.

When looking at energy consumption by district, Figure 47, it is clear that Manchester has the highest energy consumption with a total of 8.8 TWh. This accounts for 17 % of the total usage across the Greater Manchester region. Manchester has the highest usage, followed by Trafford. Coal accounts for around 3 % of Wigan's total fuel usage.

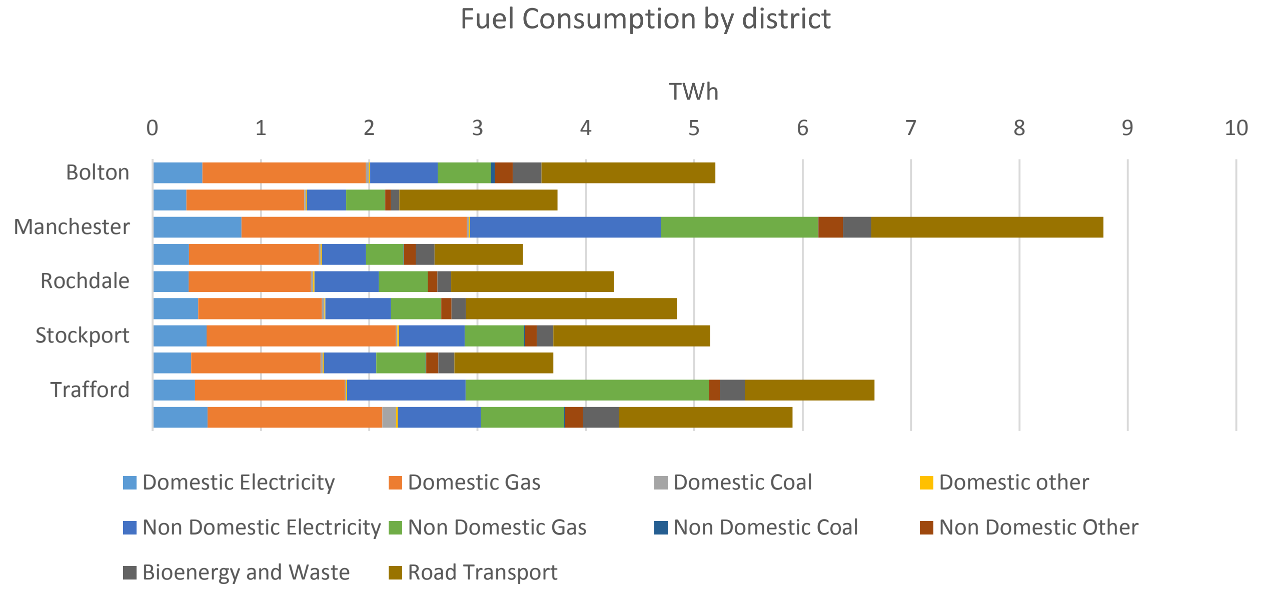

Figure 4-53 Fuel Consumption by district

4.5.1 Domestic Fuel Consumption

The major demand in domestic consumption is gas for heating and cooking. Electrical demand is fairly consistent across the Local Authorities, at around 4000 kWh per household. This is in line with National Averages. The gas consumption varies by 400 kWh; this is a variation of 20 %.

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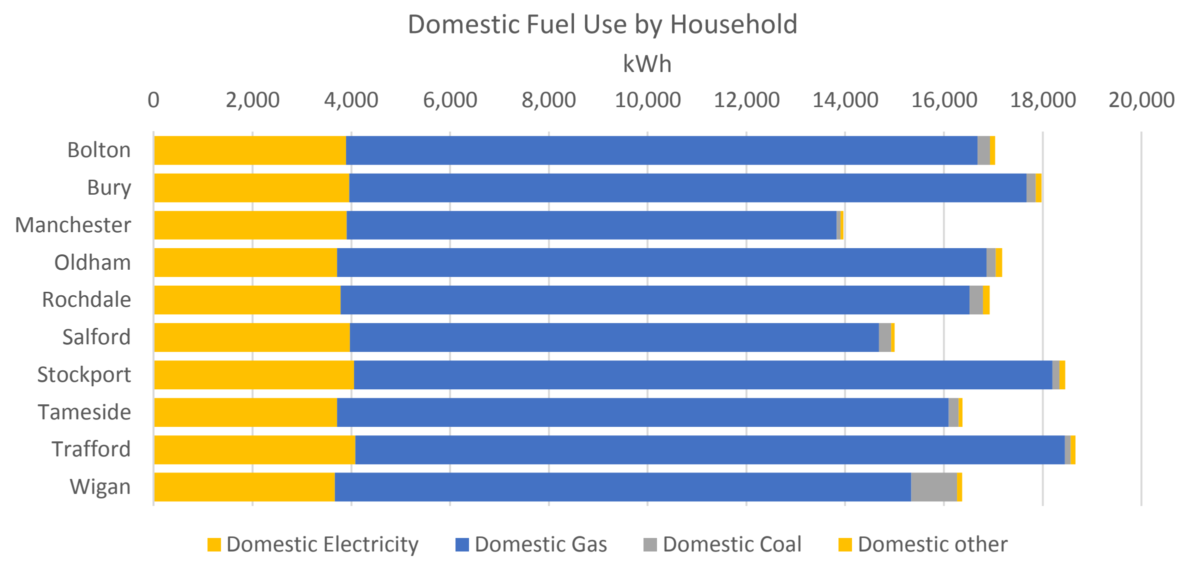

Figure 4-54 Domestic household fuel use by district

Gas mainly covers the requirement for heating and hot water and is directly related to the energy efficiency of residential property. Wigan has a larger requirement for coal for domestic heating.

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Domestic Electricity by Household

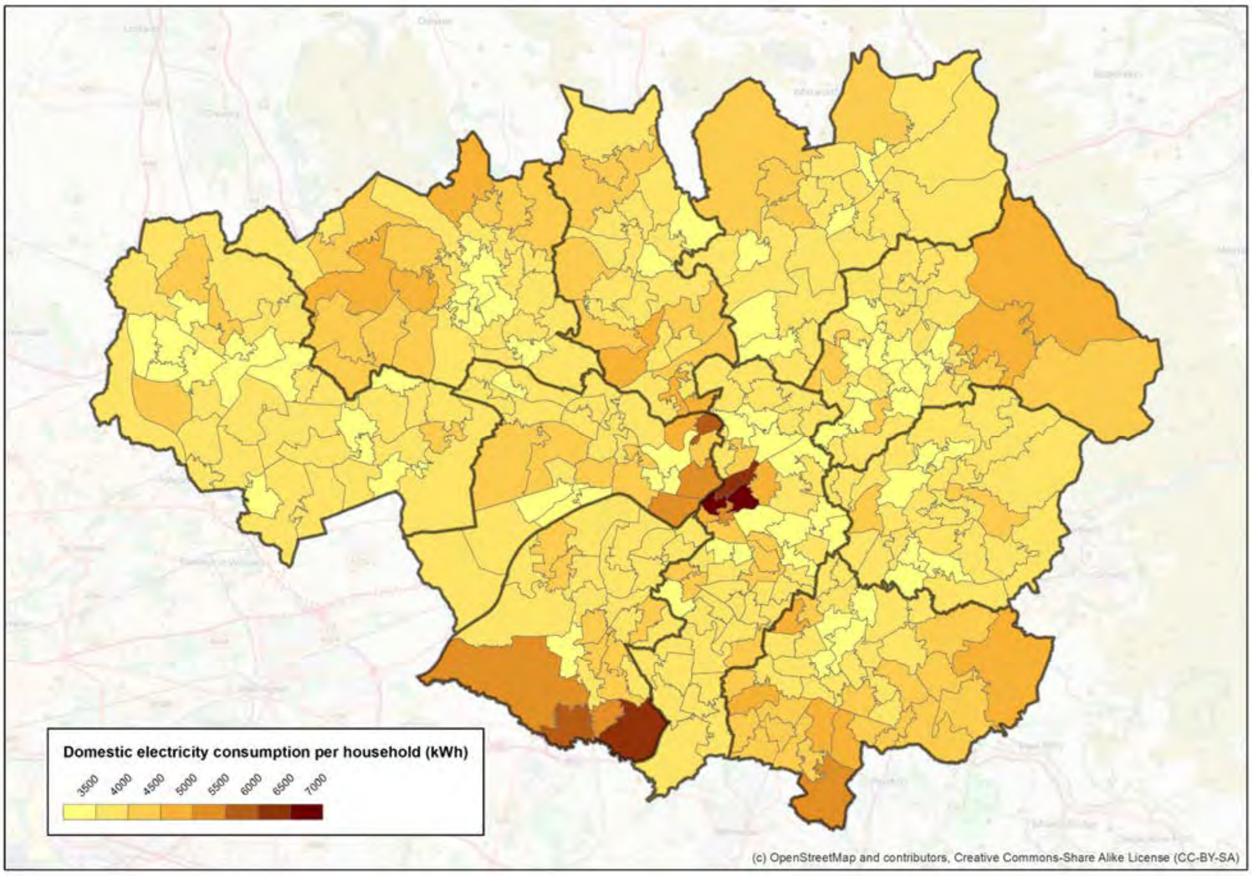

Figure 4-55 Domestic electricity consumption by household

Electricity consumption per household is fairly consistent across the region at around 4-5000kWh for the recorded year (2014). There are a few stand out areas, mainly in the centre of Manchester city and to the south of Trafford. High usage is normally due to a high proportion of dwellings with electric heating. This would be true for the city centre. High usage levels in the south west of the region near the airport are harder to explain. Domestic gas consumption is also high in this area.

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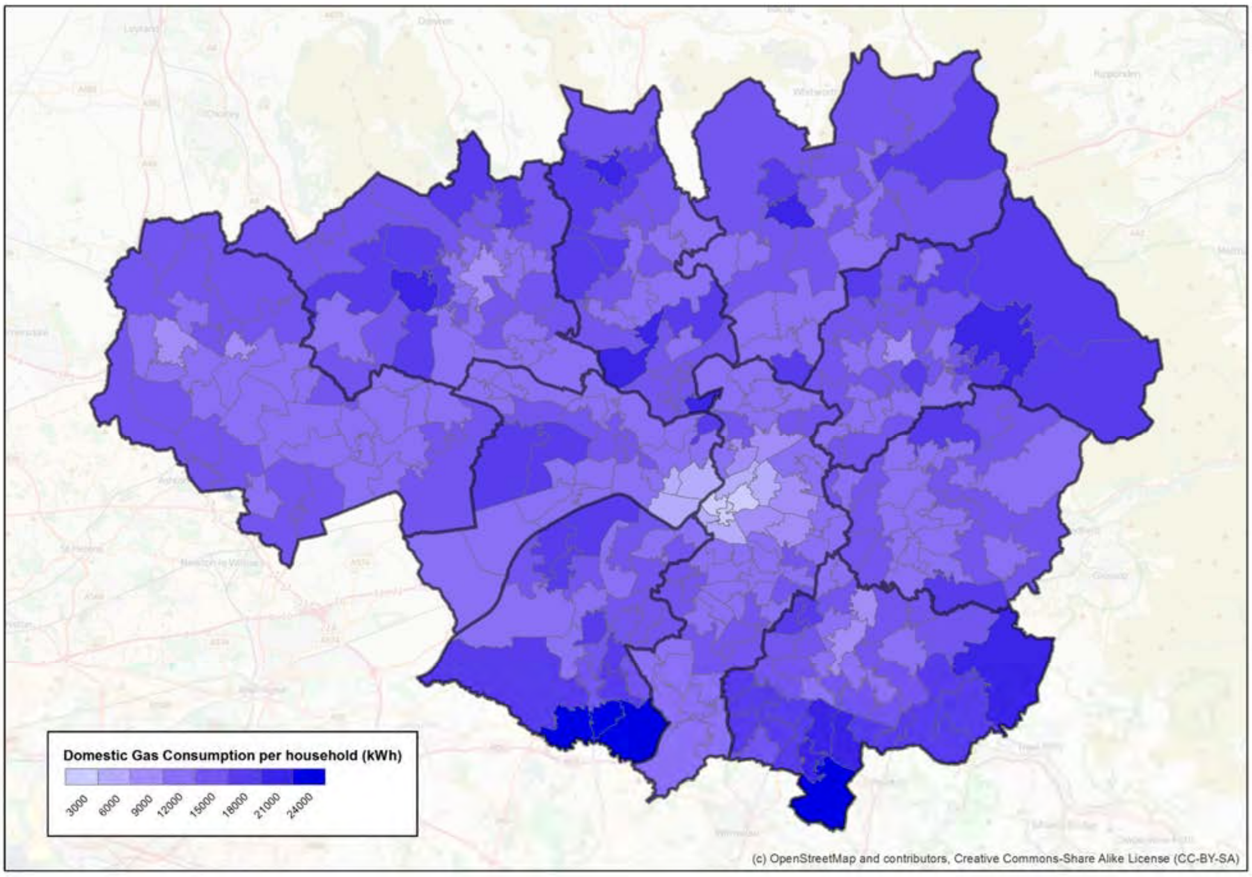

Figure 4-56 Domestic Gas Consumption per household

Gas is the most popular fuel for domestic heating. The areas of low gas consumption in the city centre of Manchester and Salford correlates with the higher electricity usage in Figure 4-55 Domestic electricity consumption by household. This suggests that these areas have electrically heated homes. This also corresponds with the highest density of new build properties. The other areas with large gas usage correspond with areas built in the post war period when energy efficiency was not a driving force for dwellings. The area around the airport has large electricity use and high gas usage on a normalised per household basis.

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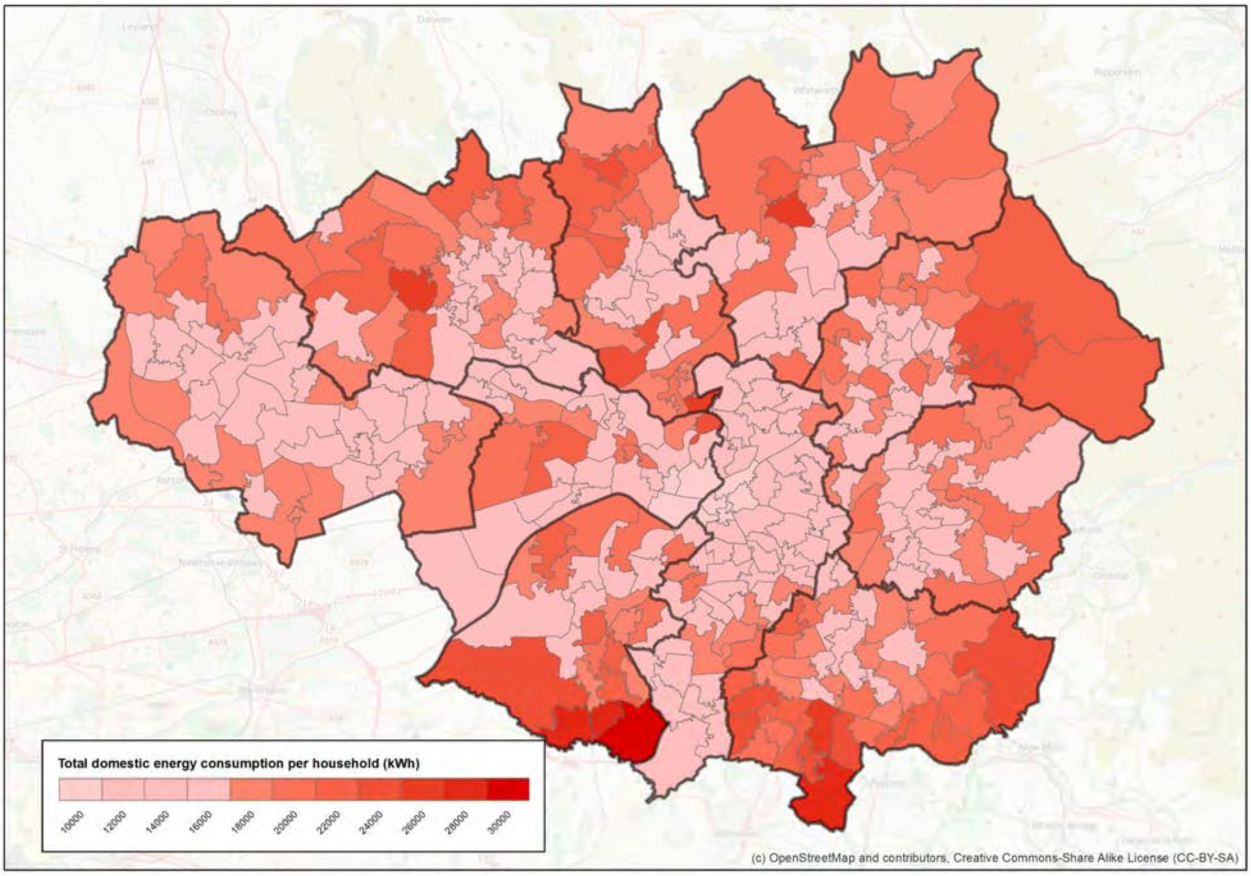

Figure 4-57 Total domestic energy consumption

A better idea of the high energy use areas can be found in Figure 4-577 which shows the total energy use (electricity and gas). The average domestic consumption in the UK is around 15,000 kWh per year. There are a number of areas in GM that are significantly higher consumers per household of total energy. The airport corridor is a particular hotspot.

Fuel for Domestic Heating

The majority of heating is carried out using gas, with a small amount using electric heating and some coal use. Coal use is most marked in Wigan where 8 % of domestic heating is provided through coal. Electrical heating is a very small proportion of the total demand. Manchester has the highest use of domestic heating through electricity with 3 % of heating demand met electrically (DECC, 2016).

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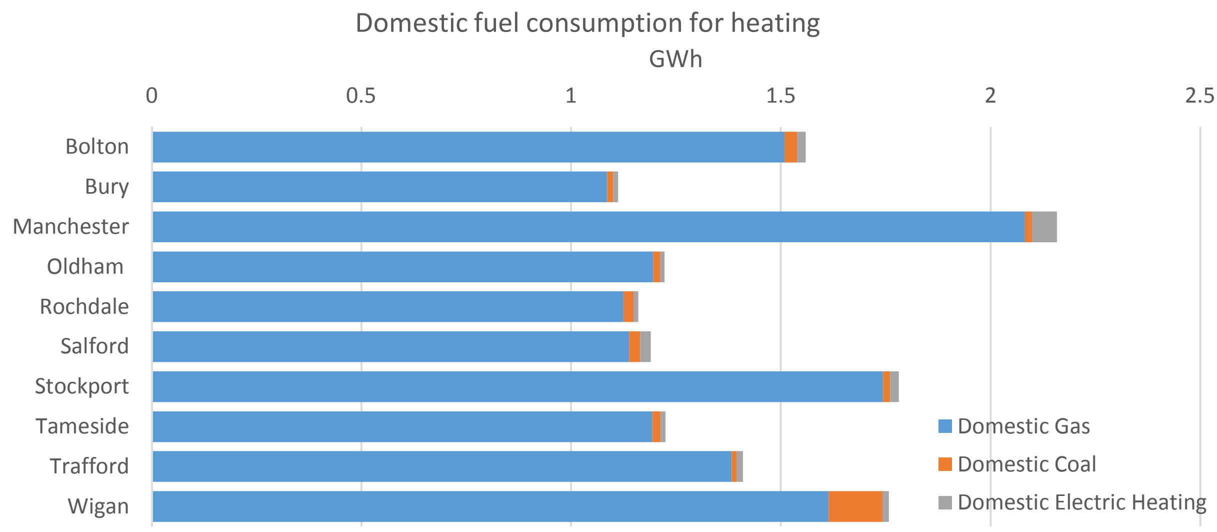

Figure 4-58 Domestic fuel consumption used for heating

Where electricity is used for heating and hot water there will be a split between direct electric heating, storage heaters and heat pumps. As the number of registered heat pumps is very small (in the hundreds) most electric heating will be direct. Where electricity is used to provide hot water it is usual to take advantage of cheaper overnight rates through Economy 7 tariffs.

Figure 4-588 and Figure 4-59 (DECC, 2016) show the how the proportion of Economy 7 meters are distributed across the districts. The highest rates of Economy 7 meters are in Manchester and Salford, at around 11 % of meters each. This is explainable through the higher density of apartments in these districts which are more likely to use electric heating.

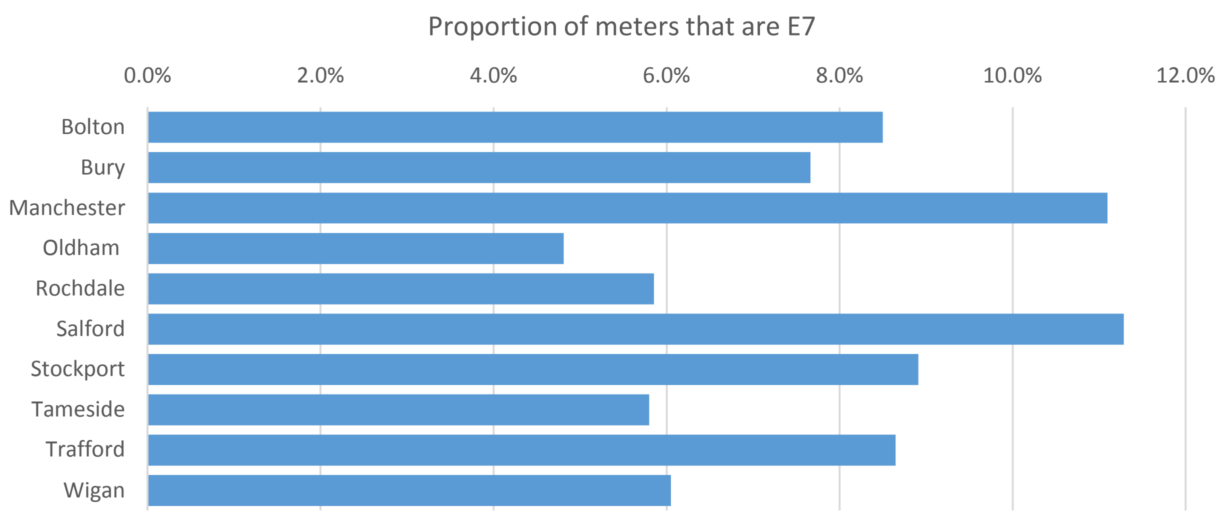

Figure 4-59 Proportion of domestic economy 7 meters

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4.5.2 Non-domestic

Non-domestic fuel usage is highest per m² floor space in Trafford. Bury is the next highest. The Trafford figure is boosted by coal usage. Trafford is a highly industrial area which uses coal in industrial processes. Heavy industrial processes will use more energy more intensively and this may be the main difference between the districts.

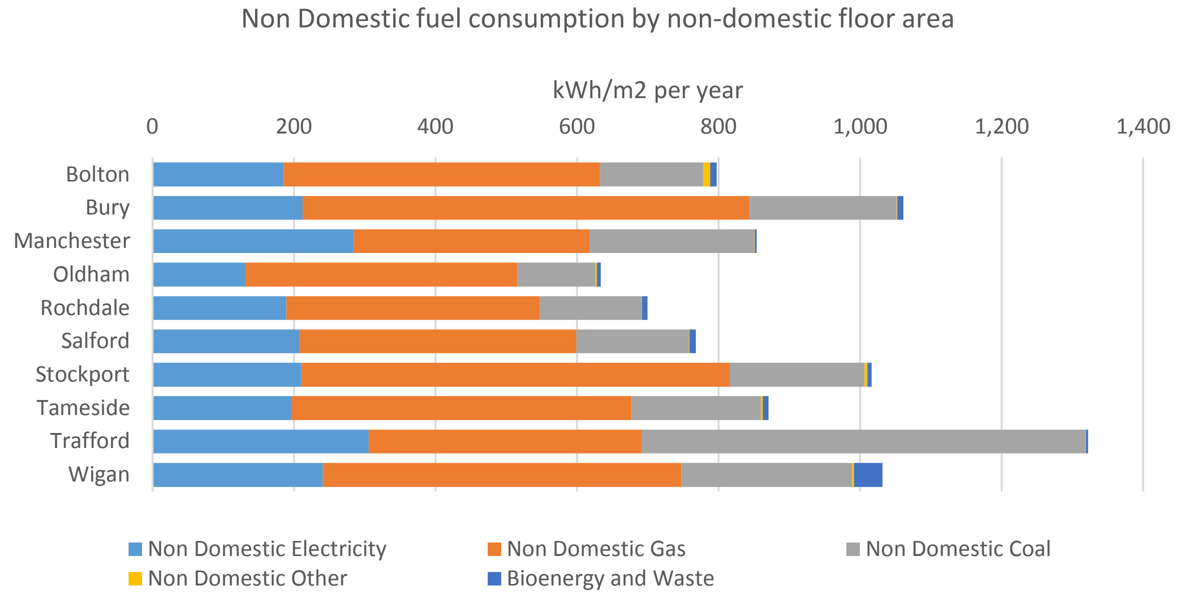

Figure 4-60 Non domestic fuel consumption by floor area (m²)

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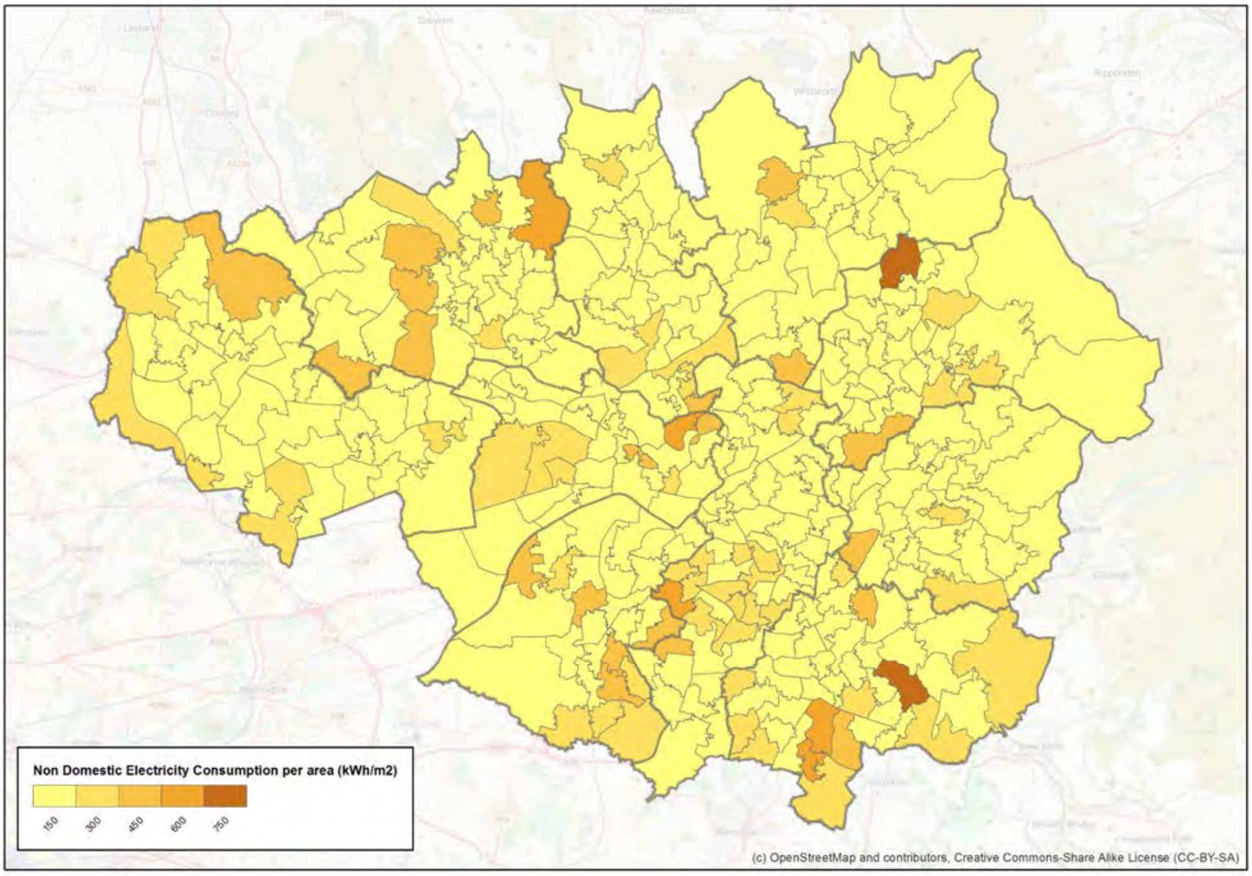

Figure 4-61 Non-domestic electricity consumption by floor area per year (MSOA)

The non-domestic electricity consumption is fairly consistent and in line with standard benchmarks for non-domestic buildings such as CIBSE TM46 and Guide F. There are areas with high per m² usage figures. These are focussed around particular sites and processes and as such it is difficult to draw any conclusions from this data.

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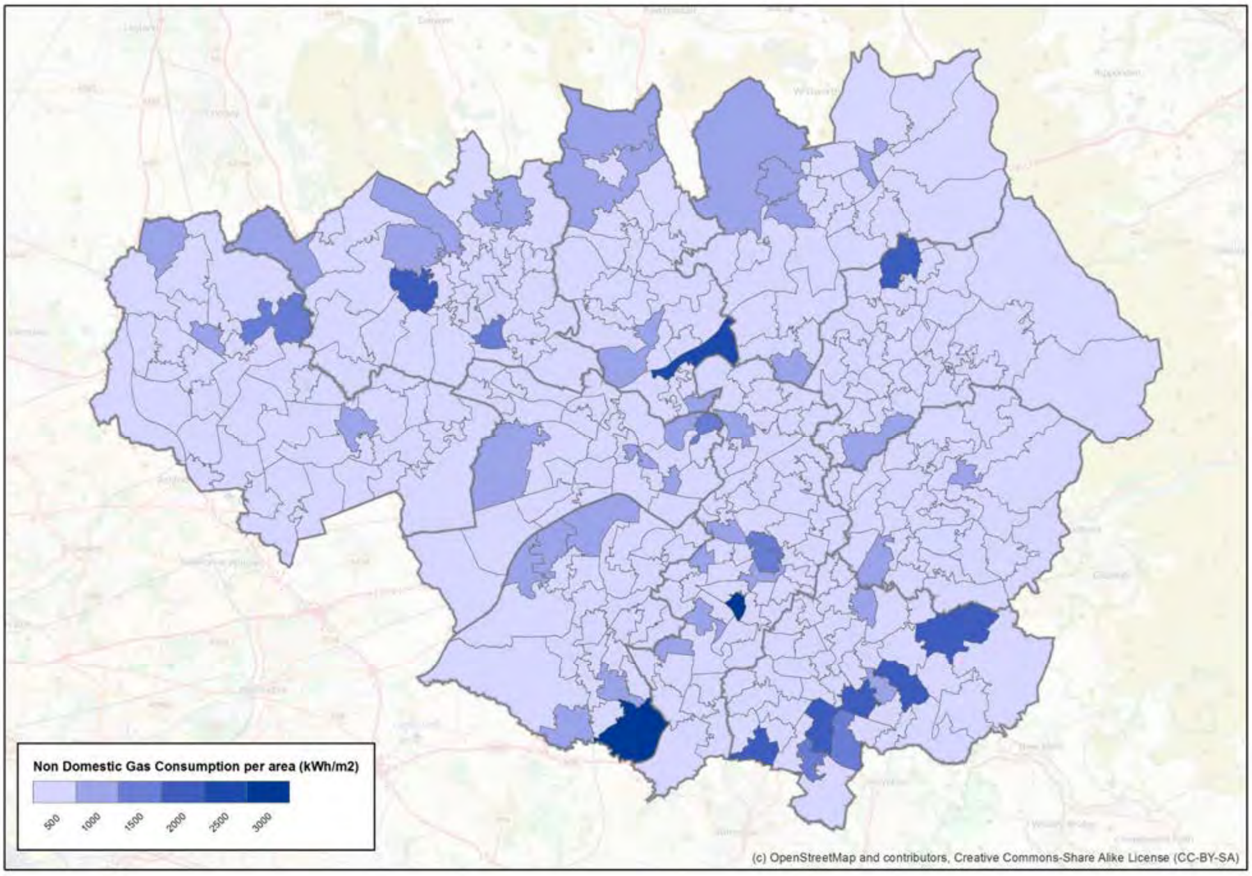

Figure 4-62 Non-domestic gas consumption by floor area per year

Non-domestic gas consumption per floor area is fairly consistent. The areas of higher usage are due to areas of heavier industry and specific processes or businesses.

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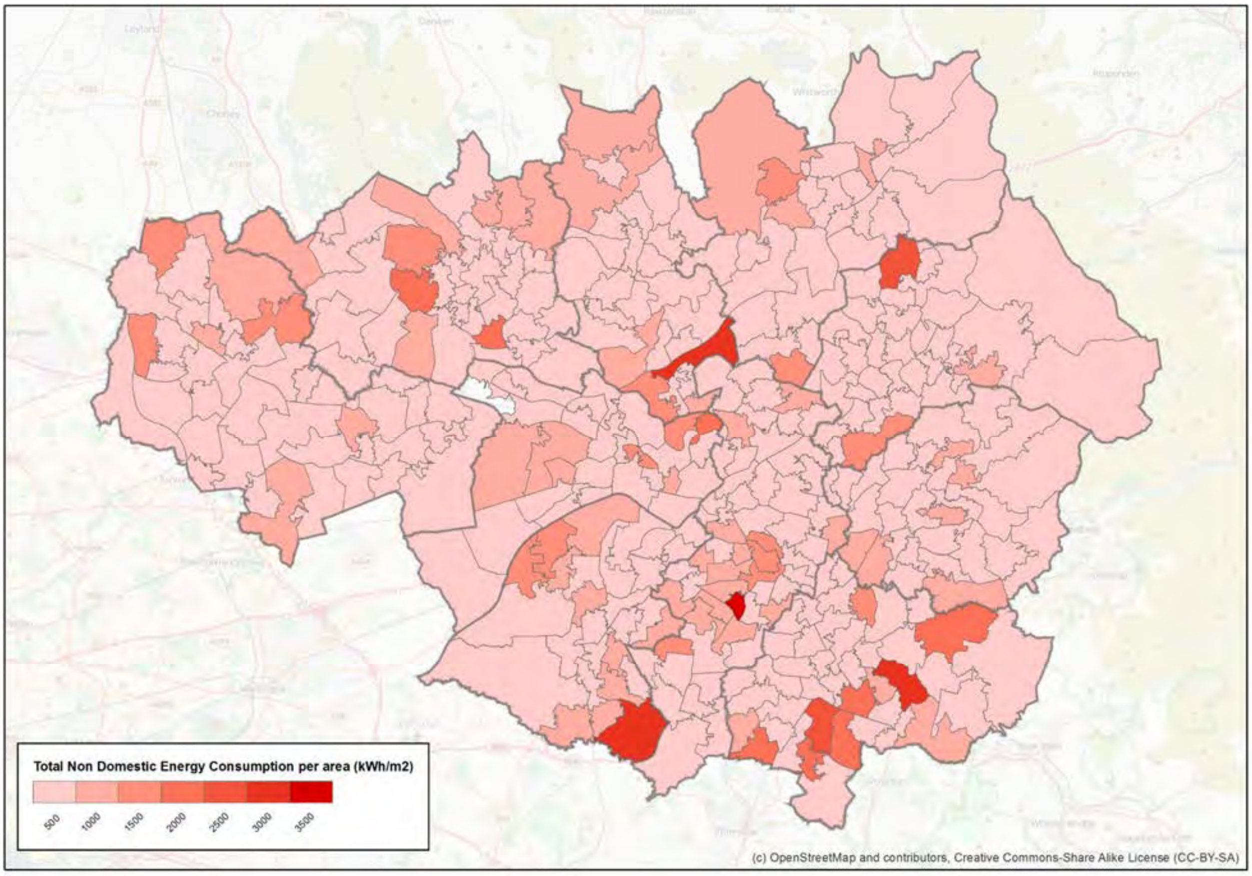

Figure 4-63 Total non-domestic energy consumption by floor area

The total energy use by floor area is dominated by gas usage. The high total energy usage areas are clustered around the south east of the region in Tameside and Stockport's industrial areas.

4.5.3 Power for vehicles

Electric vehicles (EVs) and Plug-in hybrid electric vehicles (PHEV) account for a negligible amount of the total vehicles in the greater Manchester region. Data on power consumption on EVs and PHEVs charged at home not readily available. This may change if there is a large uptake in EVs and PHEVs that are charged on domestic properties.

Pure electric and hybrid vehicles currently do not play a large role in the energy system. The department for Transport report that less than half of a percent of new car purchased in 2015 were pure electric ultra-low emission vehicles (ULEV). Hybrids accounted for 2.4 % (Department for Transport, 2016).

The national picture for EVs shows an acceleration in take-up of electric vehicles since 2010. Cars now make up the largest proportion of ultralow carbon vehicles licenced in the UK.

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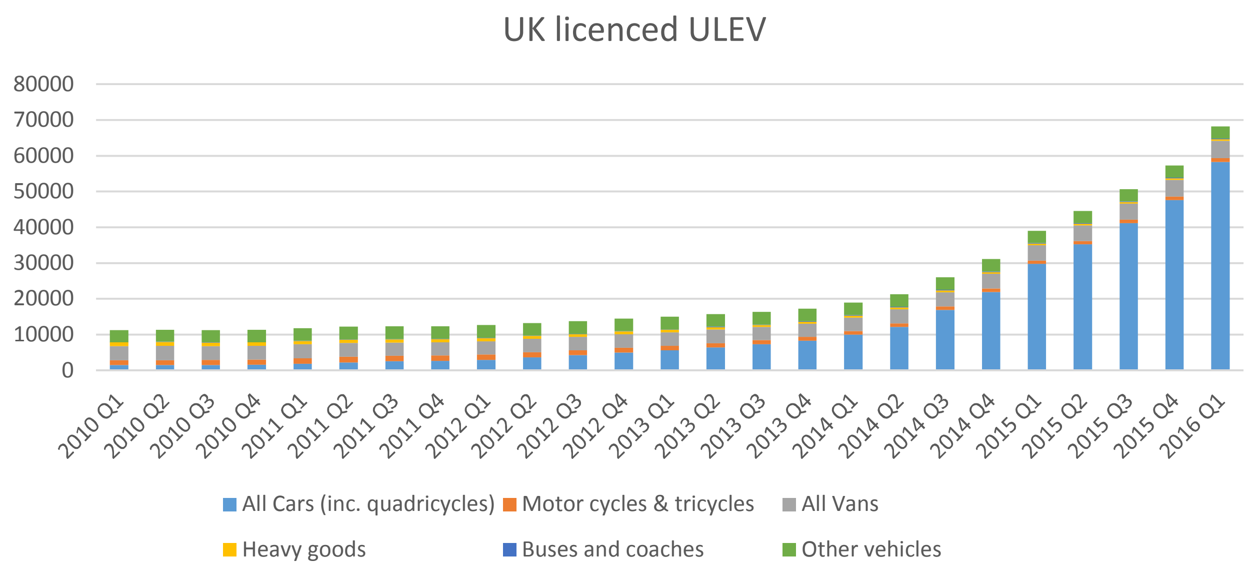

Figure 4-64 UK Total licenced ultra-low carbon vehicles (ULEV)

All districts have seen a similar increase in the number of licenced vehicles. These follow the national trends. Figure 4.65 shows that Bury appears to have the largest number of licensed ULEV in 2016 Q1 with a total of 254 ultra-low emission vehicles. Put in context, Bury has 109,300 registered vehicles as of 2015. Electric vehicles comprise less than 0.5 % of the total registered vehicles.

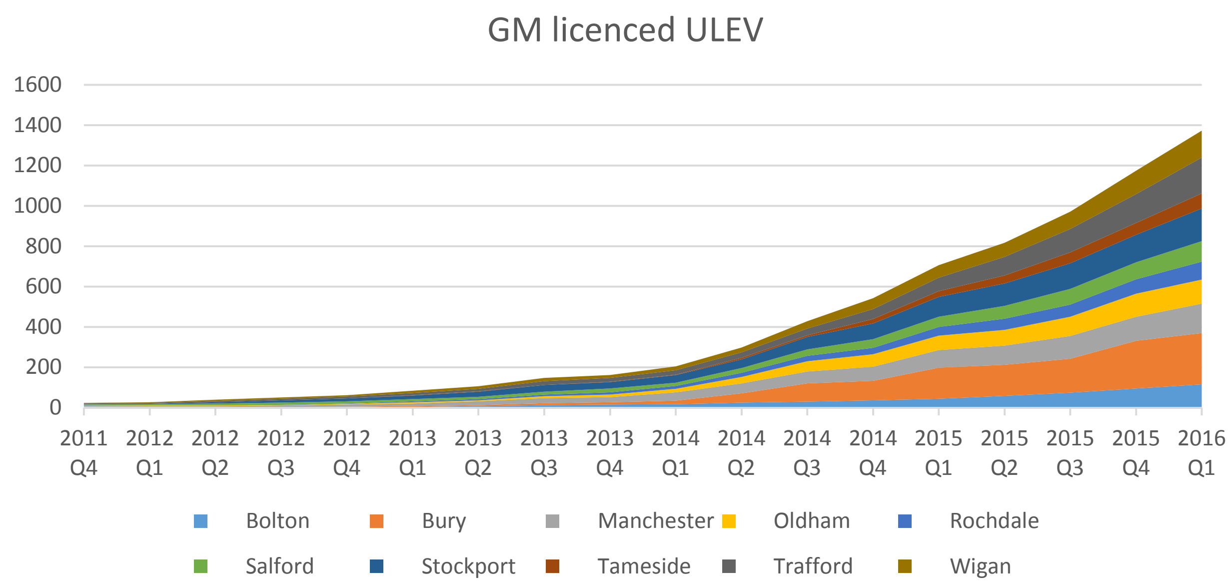

Figure 4-65 GM cumulative licenced ULEV by district

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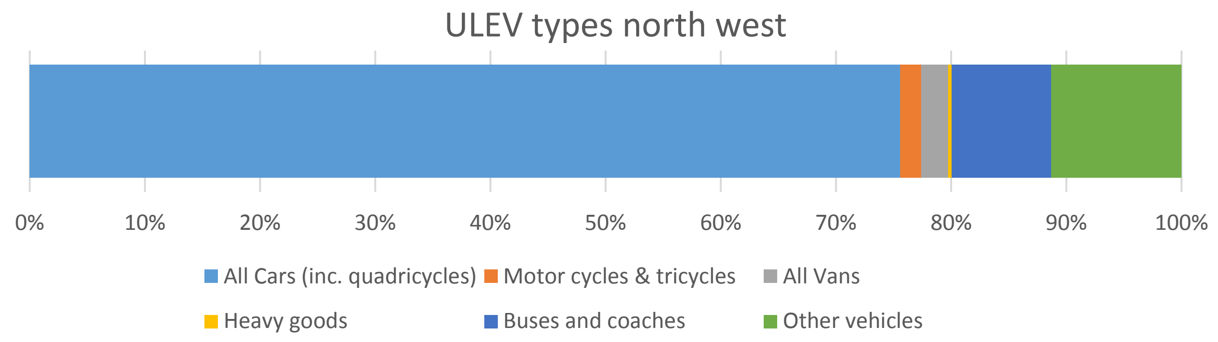

Figure 4-66 Licence ULEV types (North West)

Most of the ULEVs in the North West region are cars although buses and other (which includes diggers, lift trucks, rollers, ambulances, Hackney Carriages, three wheelers, tricycles and agricultural vehicles) comprise around 10 % each.

Charging infrastructure

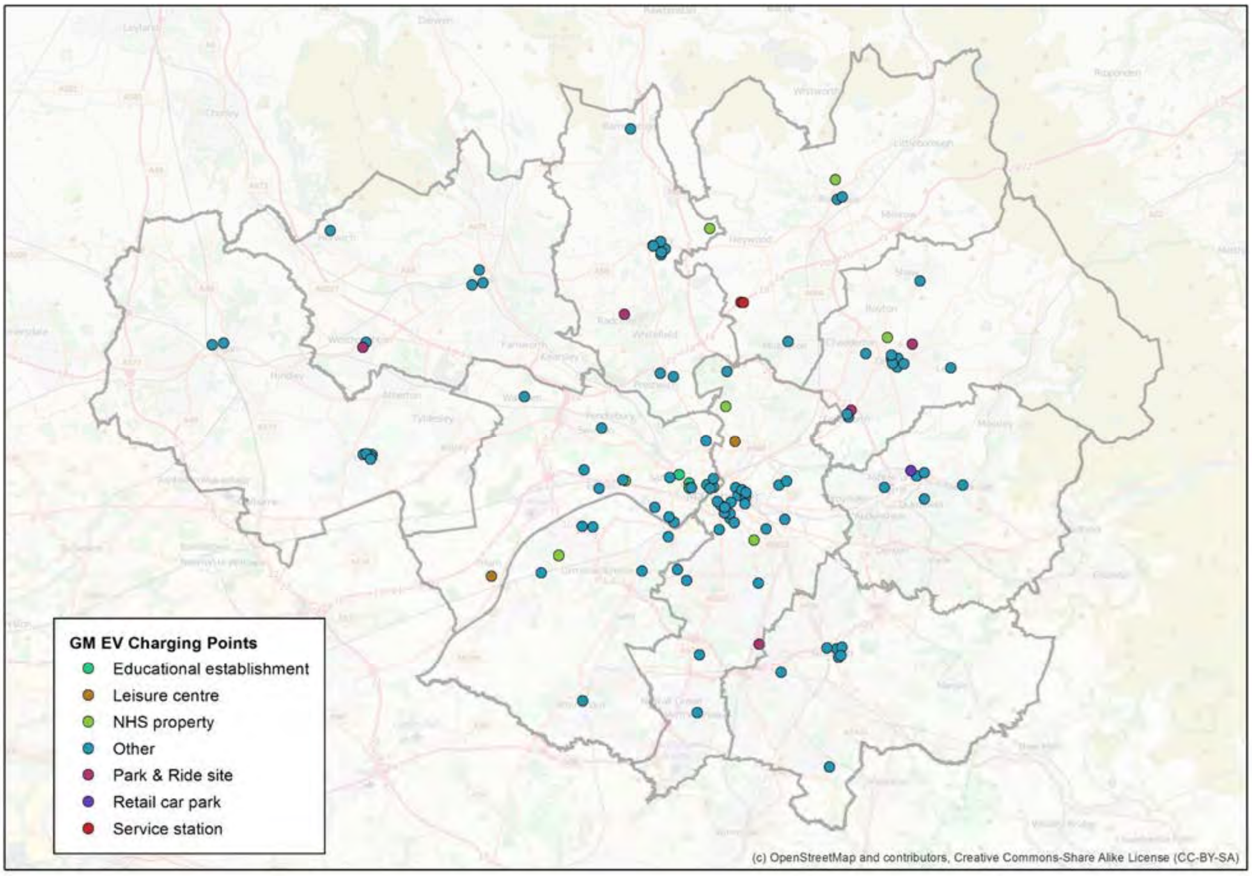

Figure 4-67 EV charging points

There are a number of public EV charging points across Manchester, mainly in the built up areas. The GMEV charging network has 1162 members at last count and in April 2016 provided 34,000 kWh to electric vehicles charging at public points.

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4.5.4 Summary

- Greater Manchester is a significant energy consumer and there is a wide variation in energy use between the different districts.
- Gas is the principle fuel used for space and water heating and is the predominant fuel within GM making up 42 % of total energy consumption.
- Coal and oil still play a key part of the energy mix in some districts and around 5 % of homes in GM remain off- gas, often with poor thermal efficiency and high levels of fuel poverty.
- Electricity makes up 23 % of GM's total energy consumption.

4.6 Carbon Emissions

As set out in the policy section the UK government has made a commitment to reducing greenhouse gas emissions by 80 % from a 1990 baseline by 2050. The GMCA has adopted a local carbon target to deliver a 48 % reduction equivalent to 11 million tonnes of CO2 by 2020 against a 1990 baseline.

Greater Manchester was responsible for 13.6 $MtCO_2e$ of carbon emissions in 2014 (DECC, 2016). This is 3.6 % of the UK total. This equates to 5.0ktCO2 per capita. This is 21 % lower than the UK national average of 6.3ktCO2 per capita. It should be noted, however, that national figures are heavily influenced by heavy industrial emissions from processes such as steelmaking which are not present in GM. This can be seen, to some degree, in the relative emissions of the different districts within GM (below). Trafford has much higher emissions per capita due to higher industrial emissions.

Sub-national data on energy use and emissions has only been collected since 2005; the latest figures (for 2013) were published in July 2015. Data presented in the GMCCS Implementation Plan is for 2010. Since then, data from 2010 has been revised and as such some of the data below does not exactly match that set out in some of the latest GM reports and strategies, such as the GM Implementation Plan and CCS. As data is not available before 2005, GM's environmental strategy team undertook its own analysis to produce a 1990 baseline for GM. This analysis suggested that emissions in 1990 were 21.1MtCO2e.

As illustrated in Figure 4-68 GM carbon emissions 2005-2014, carbon emissions have been generally reducing over time with a 35.8 % decrease between 1990 and 2014. Since 2005, emissions have reduced 26 %.

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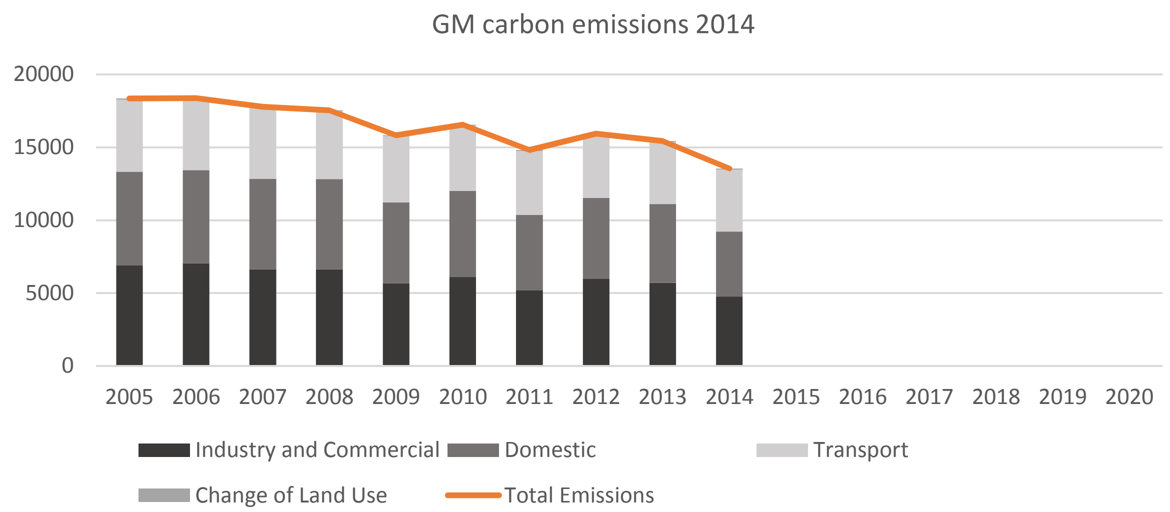

Figure 4-68 GM carbon emissions 2005-2014

In 2014, GM emitted just over 13.5 $MtCO_2$ equating to 3.6 % of all UK emissions. As illustrated in Table 5 GM Carbon Emissions 2005-2014, carbon emissions have been generally reducing over time with a 36 % decrease between 1990 and 2014 and a 26 % decrease from 2005.

Each sector is following the reduction trend although as Figure 4-69 shows the industrial and commercial sector had a greater reduction since 2005 (31 %) than domestic (31 %) and transport (14 %). The transport sector is much less variable as it doesn't respond to factor like cold winters whereas the other sectors do. The emissions from change of land use are insignificant in comparison to the other sectors.

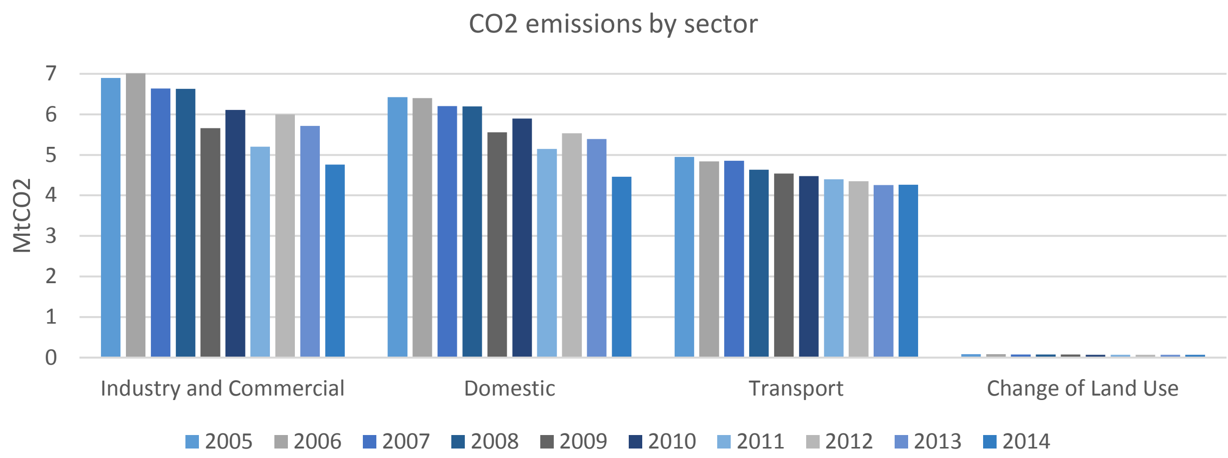

Figure 4-69 GM CO_2 emissions by sector

Annual variations are caused by a number of factors, the most important being winter temperatures, as this drives heating demand. For example, there was an 8.1 % increase between 2011 and 2012. This increase is consistent with the rest of the country where 92 % of local authorities experienced a rise equivalent to a 5.0 % increase across the country. The main drivers of the increase in UK emissions in 2012 were an increase in residential gas use due to 2012 being a colder year than 2011, and increased use of coal for electricity generation. The figures for 2013 show a continuation of the general downward trend.

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To put local actions in context the national electricity grid has reduced carbon emission associated with power generation by 4 % a year on average since 2009. Since 2005 power sector emissions have reduced by around 33 %.

The total carbon emissions for 2014 (the latest figures available at time of writing) are shown in Figure 4-700. These show that the highest emitter is the Manchester local authority. There is a wide variation between local authorities in absolute emissions. There are slight variations in the proportions of emissions from each sector within each local authority.

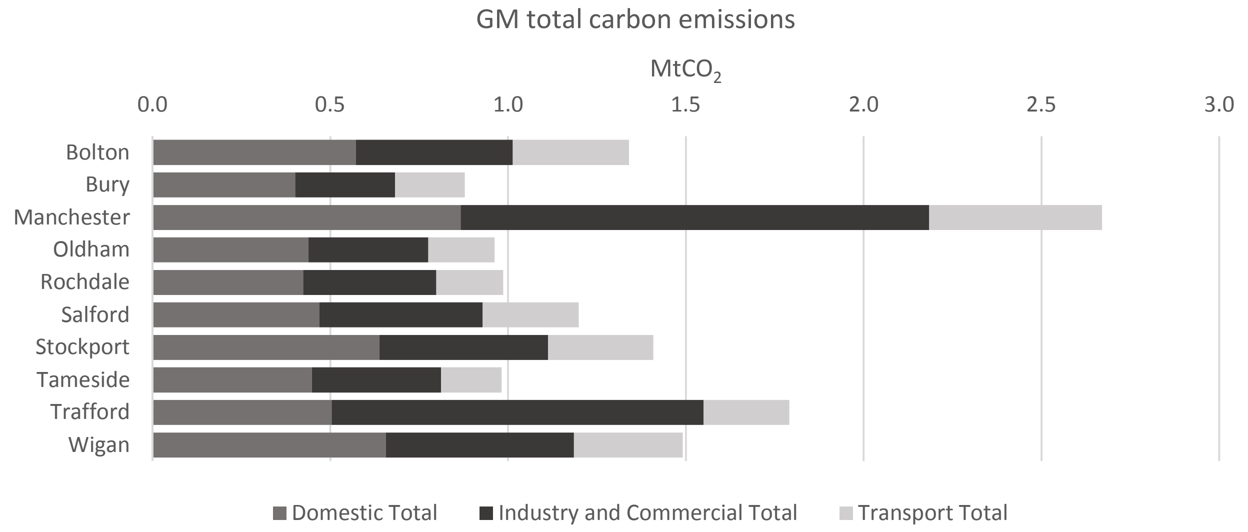

Figure 4-70 Total Carbon emissions 2013

Figure 4-711 demonstrates that Trafford has a larger proportion of industrial and commercial emissions than the other districts (55 %). Manchester also has a high proportion of commercial emissions (46 %). Most districts have around 40 % residential with Trafford lower at 27 % and Manchester next lowest at 31 %.

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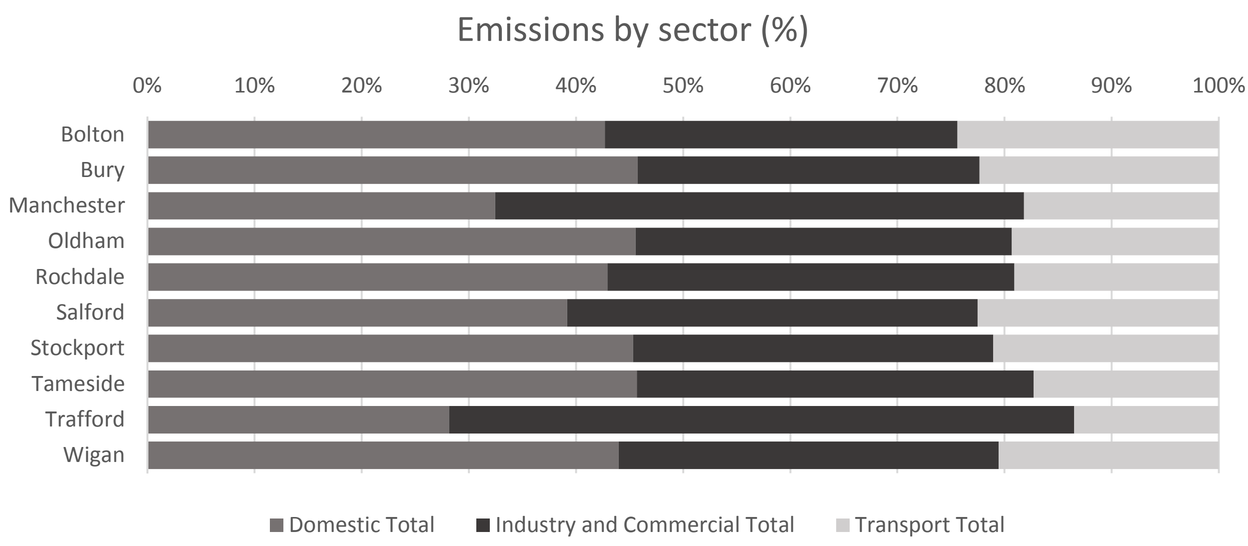

Figure 4-71 Proportion of carbon emissions by sector

On a per capita basis, Trafford is the only local Authority above the national average and is considerably higher than the other districts. This reflects the different mix of industrial/commercial and residential in the Trafford district. The average for England is 5.7tCO²e/year

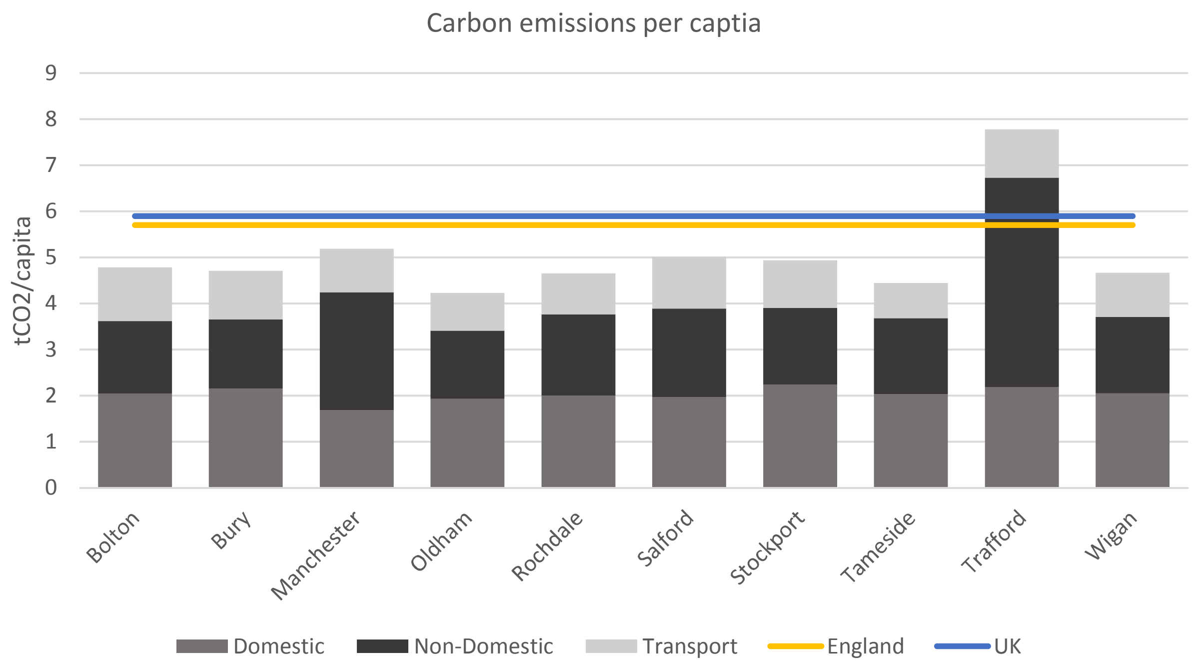

Figure 4-72 Carbon Emissions per capita

4.6.1 Domestic Carbon Emissions

Domestic carbon emissions vary by 20 % at a household level, with the proportions reasonably similar for electricity and heating use. Wigan is a standout in other fuels, this is due to a larger usage of coal for

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heating than the other local authorities. Manchester is more efficient mainly due to the higher density of apartments and new build residential properties.

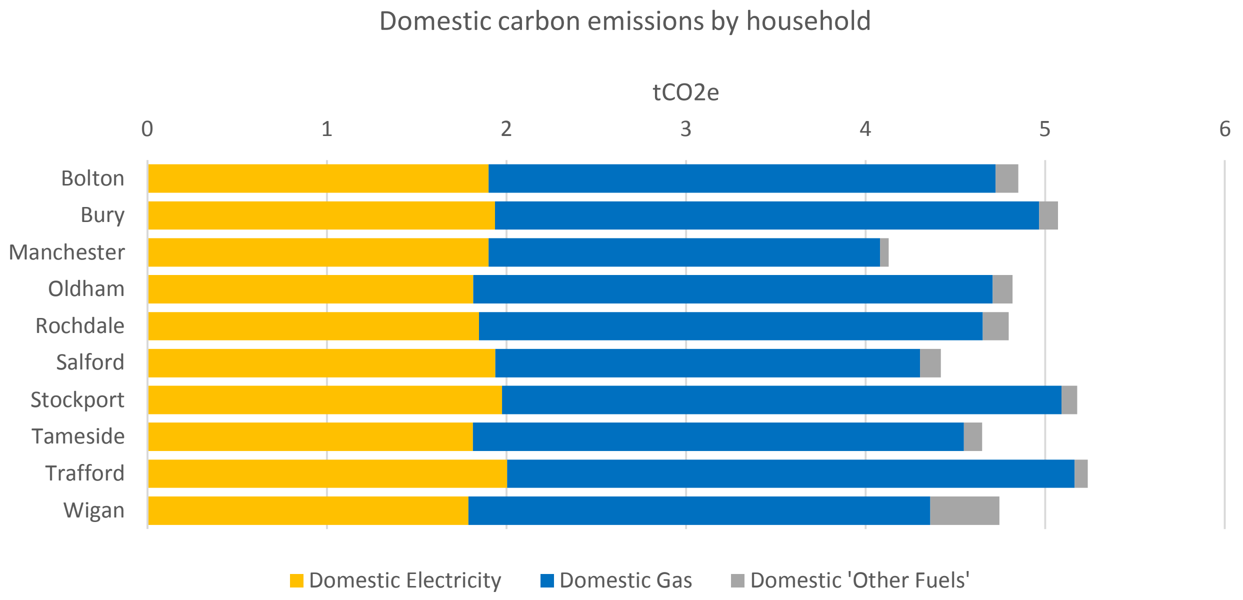

Figure 4-73 Domestic Carbon Emissions by Household

4.6.2 Non-Domestic Carbon Emissions

Sources of Non-domestic carbon emissions include industry and commercial businesses, agriculture and transport.

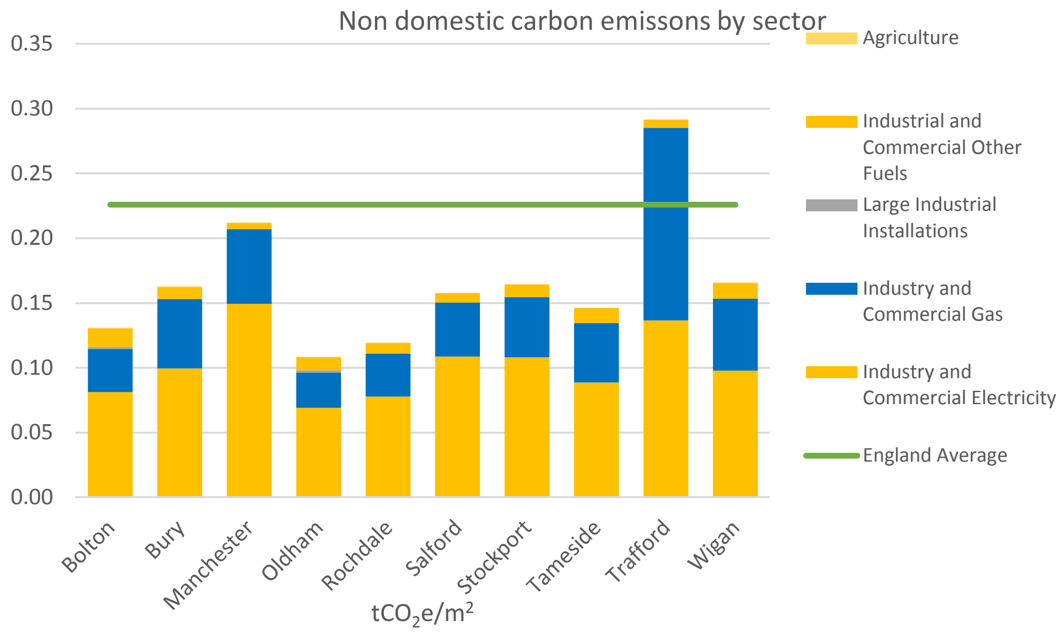

Figure 4-74 Non domestic, non-transport carbon emissions by footprint (m2)

All areas of Greater Manchester emit at below the average tCO_2e/m^2 for England (0.23 tonnes/m^2) except for Trafford which is considerably higher at 0.29t/m^2. Oldham has the lowest emitted CO_2 per m^2 of non-domestic area at 0.11t/m^2. Non-domestic electricity is the largest proportion of the carbon emissions.

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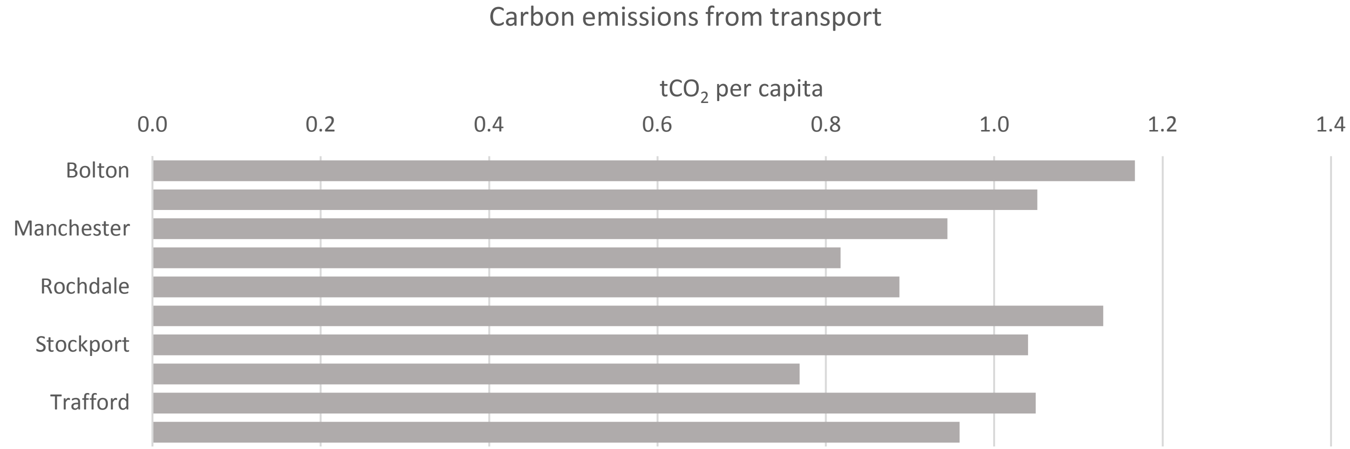

Figure 4-75 Carbon emissions from transport per capita

Figure 4-75 Carbon emissions from transport per capita shows that the emissions from transport vary across the districts with Tameside lowest at 0.8 tonnes CO_2e per capita and Bolton the highest at 1.2 tonnes CO_2e per capita.

4.6.3 Summary

- Current energy consumption in GM results in total carbon emissions of 13.5MtCO2/yr (2014).
- The GMCA has committed to achieving emissions reductions of at least 80 % by 2050 and has adopted a carbon target to deliver a 48 % reduction by 2020 against a 1990 baseline and 41 % by 2020 from 2005 levels.
- Achieving GM's long term decarbonisation ambitions will require significant changes to what types of energy are used as well as how, and when, they are used.
- Future energy sources must be secure, affordable and sustainable for GM to continue to grow. This will require action at both a local and a national scale and business as usual will not be sufficient to meet the targets that have been set.

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5 Low Carbon and Renewable Energy

5.1 Introduction

This chapter describes some technologies which might make up parts of a future, low carbon energy system. In some instances, an attempt is made to estimate the technical potential of particular technologies. It is highly unlikely that any of these potentials will be economically feasible at the level of the technical potential estimates. Indeed, some technologies, such as batteries for energy storage and solar PV, are years away from being competitive when considered from a technology agnostic perspective.

Government subsidies may be available for deployment of some low carbon technologies. These are generally paid for through a levy on energy bills, or through general taxation. Since GM has above average GDP per capita it is likely to be a net loser if these technologies are deployed across the whole of the UK.

Whilst this report sets out some technology options it will be important to identify specific opportunities by conducting energy planning at a local scale within individual districts. This will require an understanding of the existing local buildings and energy networks as well as any local priorities and constraints which might influence future pathways. This knowledge will allow development of cost effective energy strategies for individual districts to support a cost effective transition that is built upon local stakeholder requirements.

5.1.1 Energy Generation

The energy system is undergoing a transformation with more distributed generated being added to the grid each year. This is mainly in the form of solar and wind capacity. There are a number of other potential technologies in various stages of development that could provide low carbon generation. Alongside those technologies mentioned in section 5.2, there are two areas of particular interest that could provide significant contributions to decarbonising energy generation. Both of these might be relevant, at some scale, in meeting GM's future energy needs.

Small Modular Nuclear Reactors (SMR)

Large existing nuclear reactors are best suited for baseload electricity generation. Small modular nuclear reactors could fulfil a different role. Units of 50-300MWe could complement large nuclear generation. Due to their smaller size and modular approach they offer more flexibility and could deliver low carbon electricity and heat into cities via hot water pipelines with a length up to 30km. (ETI, 2015). SMRs are currently only at the feasibility study stage of development and are unlikely to be able to make a significant contribution before the late 2030s.

Carbon Capture and storage (CCS)

Burning fossil fuels releases carbon dioxide. Carbon capture involves preventing the carbon dioxide from entering the atmosphere after it has been made in power plants or industrial processes. Once the carbon dioxide has been captured it is transported by container or pipeline to a secure storage site. These sites are usually located in specific types of rock several kilometres below the surface.

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Carbon capture and storage could be an integral part of the UKs approach to carbon reduction. By capturing carbon emissions form fossil fuels before they enter the atmosphere it is possible to use fuels previously thought to be too dirty such as coal in a low carbon energy system.

The development of CCS is considered a priority of the UK government although currently the financial support available for demonstration projects has been withdrawn and it is anticipated that the commercialisation of CCS will require large government investment in the future.

CSS is still at a small scale demonstration phase globally and the economic and technical viability has still to be demonstrated on a large scale. Evidence suggests successful use of CCS could achieve significant savings in the long term and reduce reliance on wind and nuclear to decrease the costs and risks of decarbonising the UK economy.

5.1.2 Supply Systems

Once energy has been generated it is necessary to deliver it to the end user. There are a number of technologies, both mature and nascent that could have an impact on the energy supply system.

Hydrogen

Unlike other fuels combusting hydrogen produces only water meaning no carbon dioxide or other wastes are produced at the point of combustion. There are a number of challenges to its use and we are unlikely to be able to produce it in large enough quantities for it to make up a significant part of the energy generation system alone. The main challenge is producing hydrogen in high volumes and at reasonable cost from a low carbon energy source or process.

Generating hydrogen from electrolysis of water requires large amounts of clean electricity if the hydrogen is to have low embedded carbon. Otherwise hydrogen must be produced from fossil fuels. Production through steam methane reforming is the most common method but is energy intensive and will require the addition of Carbon Capture and Storage to produce low carbon Hydrogen. Once hydrogen has been produced it must be compressed or liquefied for transportation. This has an additional energy cost. At point of use hydrogen must then be converted back to either electricity or heat. The multiple energy transformations in the hydrogen value change (from the energy input at one end of the system, through conversion to hydrogen, compression, transmission and conversion to heat or electricity at the other end of the system) are likely to result in low end to end efficiency and high associated costs.

Hydrogen can be mixed with existing combustible gases, such as methane, butane and propane as found in traditional natural gas supply and can be burned in normal boilers with some modifications. Using hydrogen to power fuel cells can produce electricity with no greenhouse gas pollutants at point of use although overall emissions will depend on how the hydrogen is produced.

Hydrogen could provide a flexible source for power generation. Hydrogen can be produced from fossil fuels using CCS and then stored in salt caverns to be burnt in gas turbines for electricity generation. This could provide a cost effective, low carbon way of meeting peak electricity demand (ETI, 2015)

The H21 Leeds City Gate project is part of the ongoing studies of how hydrogen could be used in a reconfigured gas distribution network. The project redesigned the gas network for Leeds to establish a high pressure (17 bar) outer city ring main transporting methane (CH_4) from strategically placed Steam Methane Reforming (SMR) plants with carbon capture and storage for distribution into the below 7 bar network.

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Another study on hydrogen potential is: "*Scenarios for deployment of hydrogen in meeting carbon budgets", E4tech for CCC.* This found that Hydrogen may be a viable alternative to large-scale retrofit of heat pumps and district heating but there are a number of challenges. These are: the requirement for hydrogen production to include carbon capture and sequestration; the need to build a new hydrogen transmission network; and cost analysis suggests that the total cost per household of heating with hydrogen is less than for ASHPs but more than electric storage or district heating

5.1.3 Storage

Energy storage is important in enabling provision of reliable and cheap energy supplies. The UK energy system stores significant quantities of energy in the gas network and associated storage assets (ETI, 2015). The largest gas store in the UK is the Rough storage facility in the North Sea that has a capacity of 35TWh (National Grid, 2016). This provides inter-seasonal storage with other, smaller storage facilities meeting medium term storage demands. The fact that gas in the transmission and distribution networks is compressed also provides considerable additional short term storage to meet periods of peak demand during individual days. At these times the rate at which gas is consumed from networks is higher than the rate at which it is fed into the networks. Pressure in the networks is allowed to reduce in order to ensure that demand is met.

With decreasing use of gas, it is likely that there will be a significant requirement for storage of the alternative, low carbon energy sources.

The UK also stores significant amounts of energy using pumped-hydro schemes where electricity is stored by pumping water up hill and then releasing it through turbines to produce electricity at times of high demand.

Hydrogen

As discussed above, hydrogen can be produced at time of low demand and stored for use when demand is high (ETI, 2015).

Battery Storage

Many low carbon electricity generation technologies, such as wind and solar, are intermittent in terms of the power that they generate. With increasing use of these technologies to provide low carbon electricity it is likely that there will be times when electricity production exceeds consumption. In these situations, it will either be necessary to turn off some generation capacity or to store the excess electricity produced for use when demand is high.

Batteries may provide a partial solution to enable storage of locally produced electricity within GM. However, battery storage is currently expensive and bulky if large amounts of energy are to be stored.

Thermal Storage

Many new, low carbon, heat technologies such as air source heat pumps, work at a lower output power than conventional gas boilers. This can require the use of heat storage in order to meet peak demand for heat on cold days. Heat can be readily and cheaply stored as hot water. This could be at a network level for heat networks, or at a building level for individual heating systems.

Heat networks with thermal storage can decouple the timing of production from that of consumption. Using a thermal store at an energy centre can allow the efficient operation of Combined Heat and Power

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irrespective of heat demand. Heat from the store can then balance the daily variations on heat demand, minimizing the need for heat only boilers (Greater London Authority, 2013).

There are numerous examples of heat storage in networks from small scale, such as at Bunhill in Islington with a capacity of 100m^{3}, to very large scale at Odense in Denmark with a capacity of 73,000m^{3} (JRC, 2012) It is likely that this type of thermal storage could make a valuable contribution to future heat networks within GM.

At a domestic scale re-installation of a hot water tank might be technically feasible, and the cheapest low carbon choice for heat provision to a particular building. However, it is unlikely to be an acceptable solution to many households who consider the space gained by previous removal of the hot water tank to be extremely valuable. These considerations could severely restrict both the scale of domestic heat storage which might be considered viable and the types of buildings into which it might be deployed.

In addition to storage of heat as hot water other potential solutions are available such as phase change materials. These store heat by converting the heat storage medium from one form to another – typically by changing it from a solid to a liquid as energy is stored and back into a solid as heat is extracted. These technologies may provide options for domestic heat storage that have more flexible installation options than hot water tanks so may provide opportunities for wider deployment. However, they are at an early stage of development and their potential to compete economically is unclear.

5.1.4 Energy Demand and Management

Smart Systems

Smart energy systems and markets could empower both consumers and suppliers in GM to manage energy supply and demand more cost effectively and support low carbon transition.

Intelligent devices could all form part of a smart energy system within GM including electric vehicles, smart appliances and industry processes to improve efficiency and decrease peak loads on the distribution network.

Low carbon heating solutions in GM will need to be consumer focused and appeal to households if they are to achieve their potential (ETI, 2015). Smart-user interfaces and intelligent heating controllers could deliver greater control for householders and/or energy services providers to better manage energy use in the home and incentivise energy use that improves balancing of demand and supply. (DECC, 2014)

The ability for devices to share data across different platforms is an important part of a smart energy system and to promote innovation, it is anticipated that businesses providing smart heating systems or home automation controls and related services and products will be able to access energy and tariff data from smart metering systems.

Electricity and gas retailers currently compete primarily on price, with terms of service, network size, generation capacity/mix and so on largely resulting from regulation not market forces. Indeed, the retailers' scope of service is only units of commodity metered which consumers cannot relate to the things they value; primarily cleanliness and a warm home, making up 80 % of energy use.

In future it may be better to think of the energy system as a constantly evolving supply chain where its primary driver is customer service. Whilst consumers currently purchase units of energy, what they actually want is the warmth, comfort and cleanliness provided by that energy. If consumers could make

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real choices around those energy services they would be much more likely to engage with the changes required to meet carbon reduction targets.

In order to achieve this three things are needed: first, consumers must be empowered with a rich data and control ecosystem they trust; second, this data and control must be enabled to stimulate rapid ongoing innovation in domestic energy services; and third, the supply chain must be reformed so its design and operation evolves around consumer services within a near-zero carbon constraint. No individual company, government department or local authority can achieve these three things alone.

As part of the change an ecosystem will need to be established within which the consumer is empowered with the data and control they need to be able to make choices. This is likely to be achieved by development of Home Energy Services Gateways which allow consumers to choose between options that will meet their individual needs and then ensure that those needs are met whilst integrating with a wider, intelligent energy system.

SSH is developing a Home Energy Services Platform to do this, enabling information creation and sharing in a manner that protects consumer and commercial interests, establishes value exchange between parties to align motivations and facilitates consumer navigation of this new paradigm. This Platform will initiate a shared language to describe levels of service and associated costs, as well as the analytics for service providers to design, price, target and deliver services. It covers the obvious, like how warm, which rooms, for how long and so on, but it also covers the less obvious, like weather effects on cost certainty, speed of heating up on-demand, cost of appliance replacement and so on. Commercially, this Platform will need to be set up so it can openly support multiple service providers and multiple devices from multiple vendors, while being set up so it is inherently unable to exploit its position to become a competitive threat to its participants. It will also need to mitigate cyber-security risks to energy system stability.

5.1.5 Retrofit of existing buildings

Over 60 % of the domestic buildings in GM have low thermal efficiency, with an EPC rating of D or lower. It is expected that around 90 % of these buildings will still be in use in 2050. Imrpoving their thermal performance could not only help to meet future carbon emissions targets but may also improve health and comfort, reduce fuel poverty, improve energy security and smooth the peaks of heating demand by using the building fabric effectively as a heat store (ETI, 2015).

Effective retrofit is likely to be best achieved when a pakage of measures is applied together. In the most poorly performing buildings this is likely to include insulation of both the walls and roof alongside fitting better performing windows and doors and other draught proofing. This is often highly expensive. An ETI study (ETI, 2015) found that an extensive retrofit could cost as much as £31,000 per building if performed at an industrial scale and provide a reduction of around 45 % in CO_2 emissions.

Consumer research conducted as part of the ETI's Smart Systems and Heat Programme found that owners might want to prepare buildings for low carbon heating if it was easy and also improved their properties There is an opportunity to prepare buildings for heat pumps by installing insulation or draft-proofing when they are renovated. Around a third of households are planning renovations at any time. Half consider improving energy efficiency when the work is done. 85 % claim they might spend on average 10 % more to incorporate energy efficiency if asked. There is enough time to integrate preparations as 75 % of renovations are planned and 70 % of plans take over a year to finalise. More will take this opportunity if they expect preparations to bring other, more immediate benefits as 90 % renovate to improve their

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property. Even the 10 % who renovate to enhance energy efficiency want to improve comfort more than reduce running costs. Conversely, people will avoid actions they perceive will make their property less valuable, for instance if insulation reduces space or obscures period features. They prefer to renovate when properties are empty, or phase work to reduce the disruption, even though this is less efficient than doing everything at once. This implies they might be more willing to prepare their home if it reduced the disruption of conducting other work, for instance by speeding it up.

5.1.6 Transport

It is likely that there will be increased electrification of transport in future with many households switching to either battery electric vehicles, or hybrid electric vehicles. In both cases it is expected that the majority of vehicle charging will take place at home (ETI, 2013). The majority of this is likely to occur in the evenings or overnight when most vehicles are parked. This coincides with the time of peak demand for heat when most people are at home.

When combined with a switch to electric heating in homes, the addition of electric vehicle charging could result in a considerable increase in the total power that will need to be delivered through the electricity network. It is likely that in many areas this will require some reinforcement of the electricity network although there are options to control vehicle charging remotely so that it does not occur at the evening peak but is delayed until demand is at its lowest overnight. This charging control could be linked to new outcome based energy services where consumers pay a provider to meet their energy requirements rather than simply purchasing energy.

5.2 Technical Potential

There is a significant technical potential to meet GMs current and future energy demand from low carbon and renewable energy sources. As outlined in section 3 the last decade has seen a significant increase in installed capacity of low carbon and renewable technologies providing both heat and power.

In order for the UK to meet its 2050 carbon targets there must be an acceleration in the reduction of carbon emissions from domestic buildings. The Committee on Climate Change has highlighted this as priority area (Commitee on Climate Change, 2016). The vast majority of carbon emissions in a domestic setting come from heating where less than 4 % of people in the UK have low carbon heating systems.

In discussing the technical potential, it must be taken into account that the economic feasibility is likely to be significantly lower than the technical potential. Other factors such as planning, policy and local concerns will also play a part in determining what is realistically feasible.

Up to **1,030 GWh/yr (9 %)** of GM's 2016 electricity consumption could technically be generated by renewable energy sources within GM, delivering annual CO2 reductions of **2.6 million tonnes (19 %)** from 2014 levels. Of those renewable energy technologies which are most mature solar PV and heat pumps (air source and ground source) have a significant technical growth potential. Wind can provide significant contribution to the total. As noted above, however, the economic feasibility of these technologies is likely to be significantly lower than the technical potential identified here.

In this section the potential contribution to the local energy supply through generation and use of carbon renewable energy technologies and control mechanisms is investigated.

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5.2.1 Solar PV

Solar Photovoltaics (Solar PV) are a low carbon, emission free technology that harnesses the sun's radiation into usable electricity. Solar panels are built out of semiconducting materials that produce electrons from the intensity and wavelength of the suns light (electromagnetic radiation). For best potential in the UK panels should be inclined at an angle of 30-40°. They should face south and not suffer from shading due to trees or other buildings.

The potential for solar PV deployment in GM was calculated using the DECC standard approach to assessing solar potential (DECC, 2010). This allows the potential in each district to be understood and strategies developed in planning that may encourage installation. This gives a good indication of the total potential available and its scale against the potential demands in 2035. Projected changes to stock are included up to 2035.

The technical potential capacity for solar in GM is estimated as 1090MW peak. This would provide an annual generation of 917 GWh. This corresponds to around 8 % of the current electricity consumption in GM. This is an increase of around 20 times from the current (2015) generation output of 51GWh from solar PV for the whole of GM. This drops to between 6 % or 7 % by 2035.

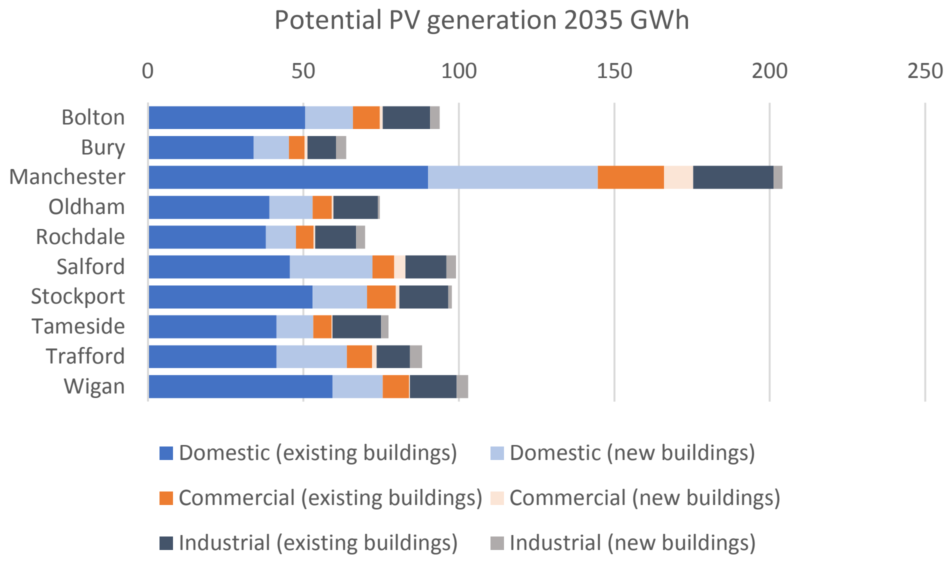

Figure 5-1 Potential Solar PV generation 2035

The greatest potential for solar PV is shown in Manchester, this is due to high numbers of households and commercial roof space in the district. Manchester also has the highest potential for PV from new stock. The existing housing stock and the existing industrial space provide the biggest opportunity for increasing solar PV capacity across the GM region.

At current cost levels solar PV is only economically viable with significant subsidy. This is currently paid in the form of a feed in tariff paid for by a levy on all electricity bills. It is unclear how long current subsidy levels will be maintained or at what point solar PV could become commercially viable without subsidy.

Large scale solar farms can have a significant impact on the local electricity network which often requires reinforcement. This can have a significant impact on project costs and can make projects uneconomic even with current subsidy levels.

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Clustering of individual domestic solar PV systems can cause similar problems for network operators. It is much more difficult, however, to plan for any reinforcement required due to a large number of small systems coming on to the network over time compared to one large system of the same total capacity. There is no obligation to inform the local network operator prior to installation if a new system has a peak power of less than 3.68kW. This makes network planning even harder. The implication is that any electricity network reinforcement required due to connection of domestic solar PV systems is likely to be too piecemeal and expensive with costs passed on to all local consumers.

Domestic solar PV systems are generally considered to be 'permitted development' and, as such, do not require planning permission.

5.2.2 Solar Thermal

Solar Water Heating (SWH) compromises of a solar panel that harnesses the suns radiation to heat a fluid. This is circulated through a coil to heat water in a storage tank. Demand for heating / hot water is higher during colder weather when solar power is less effective, hence SWH requires a backup boiler to provide additional heat on colder or cloudy days.

The potential for solar thermal is limited in the DECC methodology (DECC, 2010) to domestic properties only. Commercial and industrial use is difficult to quantify, as it will be dependent on the processes involved.

Solar thermal is around 4 times more efficient than solar PV and so a smaller installed capacity will provide a higher annual output per area.

The technical potential for solar thermal on domestic properties in GM is 600MW of heat. This could provide an annual heat generation of 2770 GWh equivalent to 5.4 % of total annual energy demand in GM (13 % of gas demand).

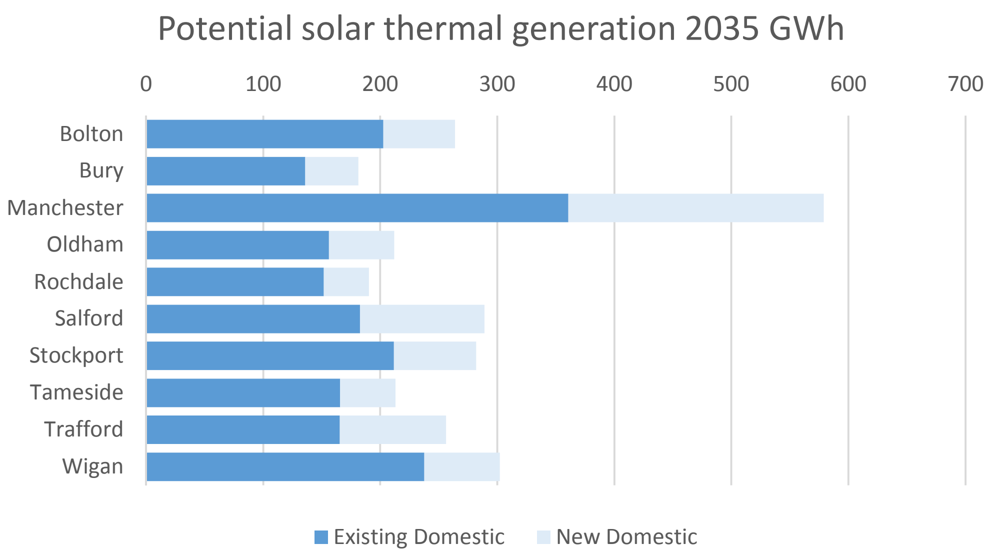

Figure 5-2 Potential solar thermal 2035

The greatest potential for solar thermal is shown in Manchester, this is due to high numbers of households. Manchester also has the highest potential from new stock. The existing housing stock provides the biggest

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opportunity for increasing solar thermal capacity across the GM region. In Manchester there is an opportunity to install on new stock.

The ability to harness solar thermal heat is limited as the main demand is for space heat in winter when solar thermal systems only generate very low quantities of heat. Potential solar thermal output may also be reduced due to the competition for roof space with solar PV, which is currently seen as an easier technology to integrate as excess generation can be exported to the grid. Where heat networks exist, it may be possible to export excess heat from solar thermal.

5.2.3 Hydropower

Hydropower harnesses the kinetic power of water flowing from one height to a lower reservoir to drive a turbine and generator to produce electricity. Pumped storage systems pump water into higher reservoirs at times of low electrical demand (and when electricity is cheaper during the night). When electricity demand, and electricity price are higher it generates electricity by releasing the water to the lower reservoir generating electricity via a turbine.

The GM decentralised energy study (URBED, AECOM and Quantum Strategy and Technology, 2010) identified the potential for hydro across the region but highlighted the requirement to do more detailed studies across all district to understand the full potential.

The most recent assessments include a study commissioned by Stockport MBC (Water Power Enterprise and H2OPE, 2008), which identified five potential sites with a combined capacity of 256kWe and a study commissioned by Groundwork Bury from the University of Lancaster (Lancashire University Engineering Department, 2008), which identified two potential sites with a combined capacity of 366kWe. In each case the potential, whilst small, could be linked to investment in discrete development sites within a close proximity.

Identification of further low head sites would require modelling of the sub-region's catchment areas, and a comprehensive survey of weirs and locks.

Assuming an 80 % uptime for the schemes, a potential **4.4 GWh** of electricity (0.04 % GM electricity demand) could be generated from the hydropower schemes which have already been identified.

Obtaining approval to install hydropower on existing water courses can be costly and time consuming due to the potential impact on the aquatic environment and the requirements of the Environment Agency.

5.2.4 Heat Pumps

There are two main type of heat pumps - ground source and air source. They convert thermal energy from the ground or air into usable heat by 'upgrading' it from a lower, to a higher temperature. Ground source heat pumps can be of two types – open loop or closed loop. Closed loop systems utilise the temperature in the ground to heat a working fluid, open loop system use ground water to provide the heat. In both cases the fluid absorbs heat from the ground. The heat is transferred in a heat exchanger to a refrigerant which boils and turns to a gas. This gas is then compressed by a compressor, which causes it to significantly increase in temperature. An additional heat exchanger then removes the heat from the refrigerant (turning it back to a liquid), to allow the heat to be transferred to the water in the building heating system.

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Air source heat pumps work in a similar way to ground source heat but absorb heat from the outside air rather than from below the ground.

The DECC renewable potential methodology (DECC, 2010) gives a potential maximum heat pump deployment of 50 % of all buildings both domestic and non-domestic. This includes new stock.

As part of the NEDO Smart Heat project (GMCA, 2016), 300 homes in GM have been fitted with air source heat pumps connected to a smart grid system to manage demand on the distribution network. The pilot project will see up to 600 heat pumps installed in Wigan, Bury and Manchester.

Ground Source Heat Pumps

There is some potential for ground source heat pumps in the Manchester region, work has been carried out to explore this technology.

The British Geological Survey (BGS) screening tool for open loop ground source heat pumps (British Geological Survey, 2016), shows that most of the Greater Manchester area is favourable for open loop GSHP pumps. Some areas (dark blue) do not have the appropriate geology to be favourable for open loop systems. This would mean that closed loop systems should be used.

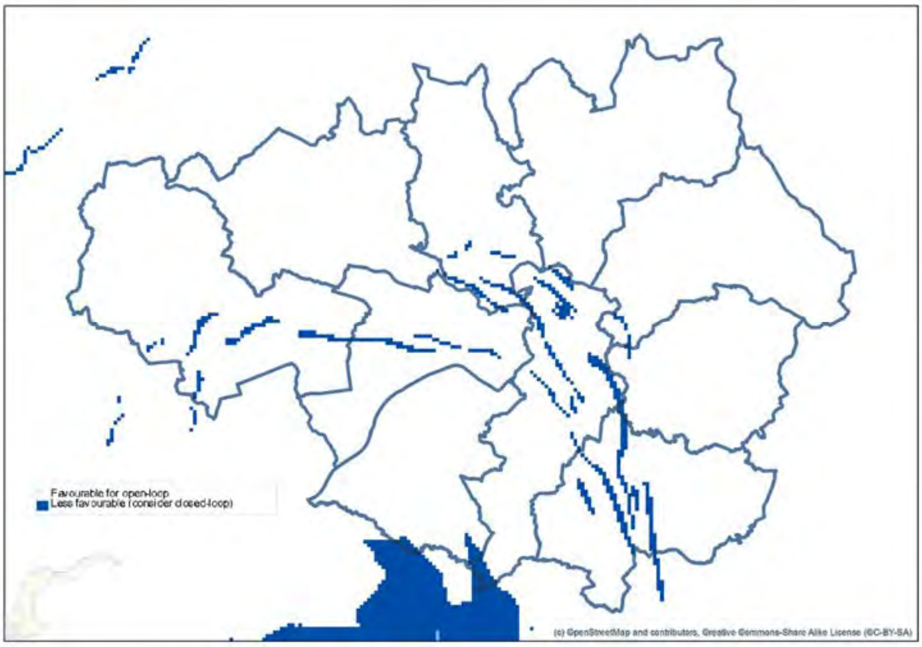

Figure 5-3 GSHP open loop screening tool

Air Source and ground source heat pumps

The DECC methodology gives total potential heat pump capacity of 8GW for GM.

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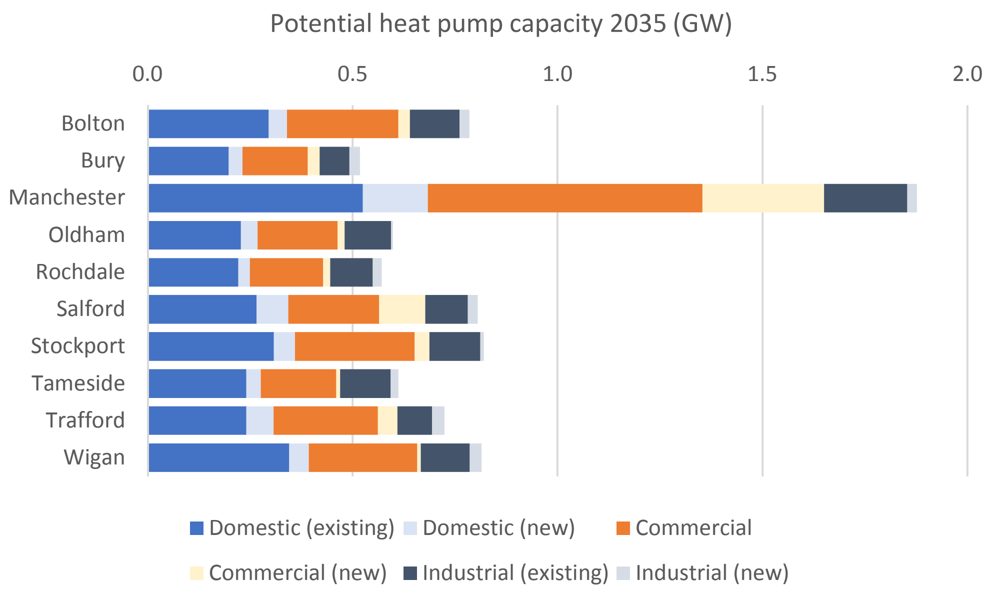

Figure 5-4 Potential Heat Pump Capacity GM 2035

If heat pumps provide heating to 50 % of all properties, then this could provide 10.7 TWh per year (2015 figures). These figure should be treated as a theoretical maximum. There are likely to be local constraints due to property type and building demand. Indeed, David Mackay (Mackay, 2008) suggests that we might be able to provide 12kWh/day per person from GSHP in the UK without freezing the ground but that demand is around 48kWh/day per person. This implies that only a quarter of people could have a GSHP. On this basis 50 % of all heating can be considered above the technical maximum.

Heat pumps can have a very high efficiency although this depends on the temperature of the source and the level of temperature increase that is required. As a result, the efficiency of air source heat pumps, in particular, can fall considerably on the coldest days when heat demand is at its highest. As part of improving the overall efficiency of heat pumps an output temperature that is lower than that from a conventional gas boiler is preferred. This has two implications:

1) Larger radiators may be required to operate at lower temperatures.
2) Heating systems take longer to heat up and so should be run for longer periods at a lower level than a gas boiler.

These implications have a knock on influence on consumer perceptions as consumers struggle to understand that a lower temperature heat source can achieve the same level of comfort as a gas boiler and are resistant to the expense and inconvenience of installing new radiators.

Domestic heat pumps can have a significant influence on local electricity networks for several reasons.

1) Deployed in large numbers they will increase demand at peak times leading to a requirement for network reinforcement.
2) They can put significant load onto networks when they start which can lead to problems achieving the regulated electricity quality levels.
3) Many air source heat pumps have a setting which runs the system late at night to avoid freezing on cold nights. Problems have been encountered when heat pumps are clustered on the network and

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all employ the same strategy and so start at the same time leading to both a very large load and a reduction in electricity quality.

Water Source Heat Pumps

The energy capacity in rivers and water bodies is significant. Water source heat pumps (WSHP) operate by taking the latent heat from water courses and boosting the temperature as described for ground source heat pumps.

The resultant hot water can be fed into local heat networks or single buildings, providing a low-carbon source of renewable heat to local areas. WSHPs can also be used for cooling.

There are a number of watercourses in the GM region that may be appropriate for WSHP. The primary two identified using the DECC heat mapping tool are the Manchester ship canal and the river Irwell. The tools suggest that these have a heat capacity of 13MW and 12MW respectively. This is additional to the potential identified for individual ground and air source heat pumps.

Where heat network viability is identified along the routes of these watercourses it would be sensible to ensure that the water source potential is realised. There are a number of smaller waterways and canals that could potentially provide smaller scale heat sources.

- **Ground Source** and **Air Source Heat Pumps** have the theoretical potential to contribute to **10.7 TWh/yr (50 %)** of current GM heat demand. Heat pumps could play a significant role in the decarbonisation of existing homes, particularly in the less built up areas of GM.
- Potential heat pump capacity in GM could increase electricity consumption annually by **30** %.

Hybrid Heat Pumps

Air source heat pumps generally provide hot water at lower temperatures than a gas boiler and can struggle to produce significant quantities of heat when outside temperatures are low and demand for heat is at its highest. This can be particularly problematic in older buildings with lower thermal efficiency. One way of overcoming this limitation is to pair the heat pump with a small gas boiler that can provide top-up heat when required. Whilst this will mean that the heat supplied to the building is not zero carbon it has several potential advantages.

1) It can ensure that the heating system meets consumer expectations in terms of performance.
2) It can meet a large proportion of heat demand using future supplies of low carbon electricity.
3) It allows flexibility to reduce electricity demand in times when demand is high without compromising heat delivery.

5.2.5 Wind

Wind power is the most established renewable energy technology, producing almost 10 % of the UK's energy. Wind is one of the simplest forms of energy generation, a large turbine is rotated by the wind to generate electricity.

Any wind farms built within Greater Manchester can be expected to feed energy into the National Grid. This means that, whilst they will contribute to reducing the carbon content of the electricity that is

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imported into Greater Manchester, their total output is unlikely to be allocated to GM in terms of carbon accounting. The overall influence on the carbon emissions of GM from any particular project will be small. The key role for GM in building wind farms will be centred around having the planning capacity to support projects.

While technical potential can be identified there are considerable challenges in getting new onshore wind projects through the planning system which is likely to be constrained by the current policy position (DCLG, 2015).

Many wind farms are offshore as the wind tends to be stronger out at sea, the further away from the coast the stronger the wind tends to get, however moving further away creates difficulties due to the depth of the seabed and the distance back to shore. Offshore wind cannot contribute directly to carbon savings in Greater Manchester but will be part of general electricity grid decarbonisation.

A recent series of studies carried out for GM (JBA Consulting, 2014) identified a number of potential sites for wind turbines across 6 of the districts in GM.

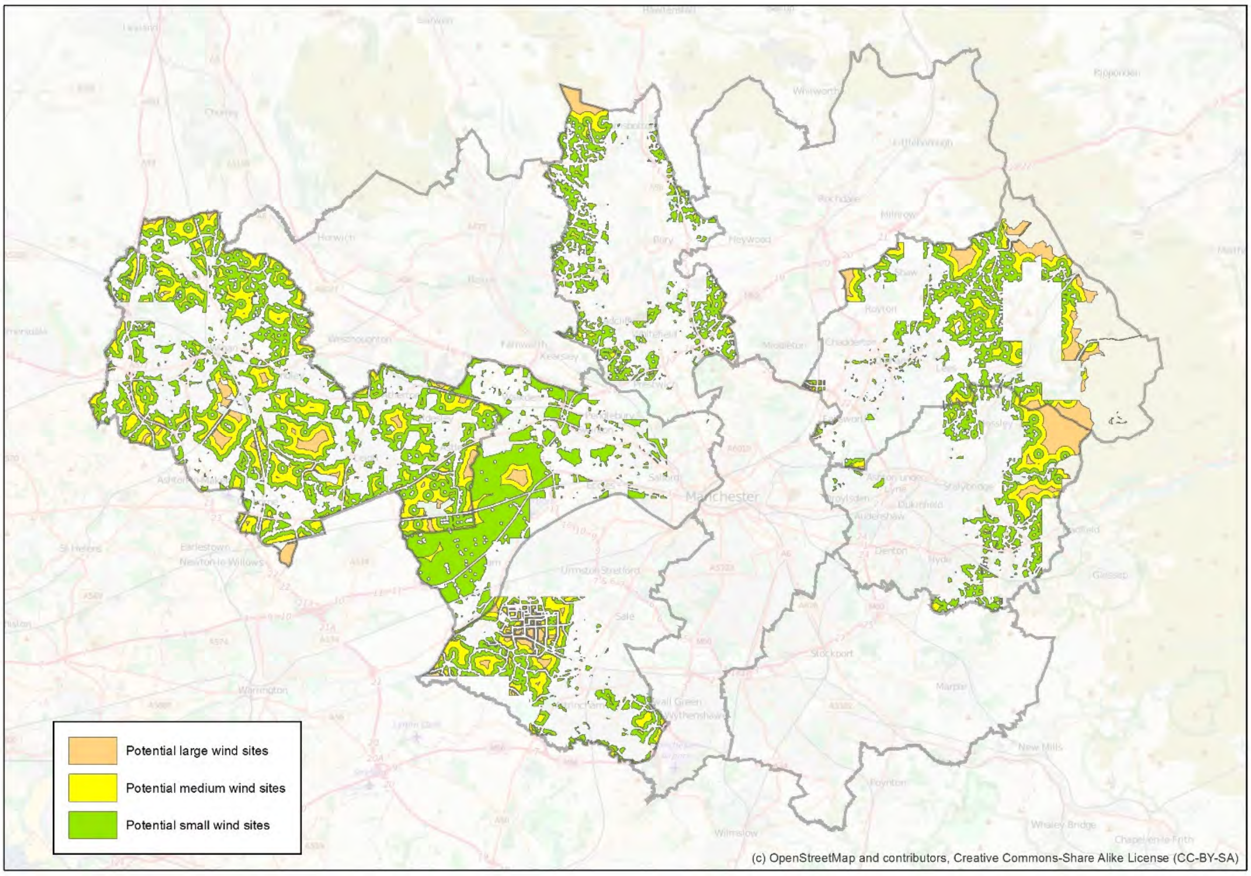

Figure 5-5 Potential wind deployment areas. Small = less than 50kW, Medium = up to 550kW, Large = up to 2MW.

Across the 6 districts a total of 60MW of potential wind resource has been identified (JBA Consulting, 2014). Using the output factor from existing wind in the GM area this could provide 141GWh per year. This is 1.1 % of the total 2015 electricity consumption in GM. There are large wind sites within Greater Manchester (Scout Moor), but the electricity and carbon savings are not attributed to GM but to neighbouring counties.

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District	Number of Potential wind turbines		
	Small	Medium (500kW)	Large (2MW)
Bury	16	2	0
Oldham	17	18	0
Salford	19	9	2
Tameside	22	2	5
Trafford	15	2	0
Wigan	80	20	5

Table 5-1 Potential wind turbines in GM

GM Wind power generation currently delivers **2.2GWh** and has the technical potential to increase and provide a further **141 GWh (1.1 %** of GM total electricity**)** focused principally in **Bury** and **Oldham**.

5.2.6 Bioenergy

As plants grow they absorb CO_2 from the atmosphere. This offers the opportunity for an energy source which has low carbon emissions. Many studies have indicated a prominent role for bioenergy in the future (ETI, 2015).

Biomass can be burnt in boilers to produce heat or in combined heat and power plants to produce heat and generate electricity. It can also be converted into gaseous and liquid fuels.

The high value of bioenergy lies both in its versatility to produce heat, power, gaseous and liquid fuel applications flexibly and cost effectively; and in its ability to make carbon budgets easier to meet by removing CO_2 from the atmosphere (so called 'negative emissions') when combined with Carbon Capture and Storage (CCS). CCS is used to permanently store the carbon that growing plants have absorbed from the atmosphere, when their biomass is used for energy. This is only practical in large scale plants connected to the pipelines and carbon required to store the CO_2.

The bioenergy sector is complex, yet immature, and the success of bioenergy's utilisation and growth will depend heavily on the route to deployment. Deployed properly, it has the potential to help secure energy supplies, mitigate climate change, and create significant green growth opportunities (ETI, 2015). Without access to flexible bioenergy, deeper emissions cuts will be needed in transport, with big implications for electricity and potentially hydrogen infrastructure needs (ETI, 2015).

Growing biomass in the UK could increase energy security and complement imports. However, UK land available for biomass production is finite so any large scale deployment of biomass will be dependent on imports. These are likely to have emissions associated with their production and transportation such that they may not be 'low carbon' over their entire life cycle. These factors combined with the versatility of biomass mean that future supplies are likely to be highly valued and so may not be economically viable to deploy at a large scale for domestic heating where cheaper options are likely to be available.

Biomass Heating

The AGMA decentralised energy study from 2010 found that there is potential for access to 10,217 tonnes of biomass per year within the GM boundary supplemented by access to a wider regional supply chain from which a proportion of an estimated 325,000 tonnes/annum could be contracted (URBED, AECOM and Quantum Strategy and Technology, 2010).

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At 3,500 kWh/tonne (30 % moisture content) this provides for potentially **1,173 GWh** of heat to be provided by biomass. This could account for around **5 %** of 2014 total gas demand.

5.2.7 Tidal

There are two main technologies appropriate for generating energy from the tides: tidal range and tidal stream. Tidal range (or head) driven technologies operate by delaying the flow of water between high-tide and low-tide to create a store of gravitational energy. They are most effective in environments where there is a significant inter-tidal range. Tidal stream driven technologies harness kinetic energy from the movement of water between high and low tide.

Due to the geographical makeup of the GM, tidal power is not considered to play any direct role in local generation, on a national scale it has potential to contribute to decarbonising the electricity grid network.

5.2.8 Deep Geothermal

Deep Geothermal energy harnesses the thermal energy that is stored deep underground in hot rocks. With advances in drilling techniques, a well can be drilled at very deep depths, water is pumped into this well, hot geothermal rocks heat the water turning it into steam / hot water which is extracted via a separate well for use in steam power plants to generate electricity or hot water to be used in district heat networks.

The potential for deep geothermal in the UK is outlined in the Busby report (Busby, 2013). Manchester is not in a region that is considered to have high potential for deep geothermal. The Permian sandstone resource is identified as being close to the south west of the Greater Manchester region but not at any more than 10 GJ/m². This is the level at which deep geothermal is considered viable. Figure 5-6 Deep Geothermal potential shows the main outputs from the Busby report showing the locations of good deep geothermal potential.

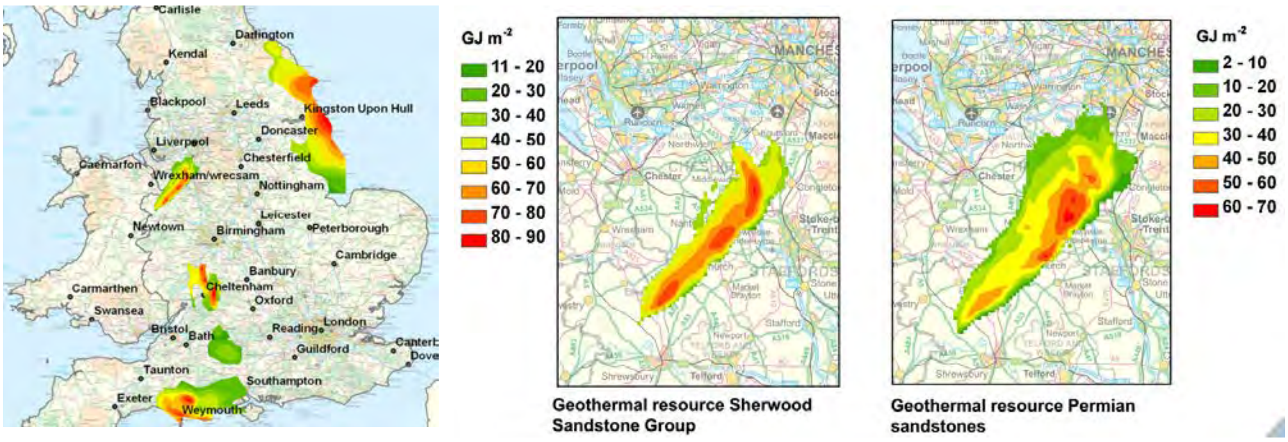

Figure 5-6 Deep Geothermal potential

Deep Geothermal plant in central Manchester

GT Energy commissioned a study in 2008, into the geothermal potential of the Cheshire Basin in Manchester. GT Energy proposed to develop a geothermal heat plant on Devonshire Street in Ardwick, Manchester. The proposed heat plant was to be located on a site on Devonshire Street with two deep wells to an approximate depth of 3,000m.

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The project was granted planning permission subject to conditions on 25th October 2013. The lack of progress since that date implies that the project was not viable for technical or commercial reasons in the current climate.

It seems unlikely that deep geothermal is a major potential source of heat within Greater Manchester.

5.2.9 Mine water

The use of mine water as a heating and cooling source to supply district heating is a relatively new concept. The technologies required– including well drilling, heat pumps and district heating - are tried and tested. Mine water heating and cooling projects utilise the 'standing' temperature change between shallow mine galleries and deep galleries, with a typical temperature increase of 3°C for every 100 metres increase in depth. Abstracted water can be raised to a higher temperature by a heat pump. Cooler water from nearer the surface can be used directly for cooling, or chilled by a heat pump. In this way the body of water can be charged with heat during the cooling season, which can then be drawn out during the heating season.

The GM region has a history of coal mining dating from the industrial revolution. All of these colliery sites are now closed. However, depending on their depth and extent they could have the potential to supply geothermally heated water. (URBED, AECOM and Quantum Strategy and Technology, 2010)

The Decentralised and zero carbon study compiled for AGMA in 2010 (URBED, AECOM and Quantum Strategy and Technology, 2010) provides the following estimates for colliery site thermal potential. These are high level estimates and so should be used with an understanding that further work is required to confirm the potential.

Colliery Size	Workforce	Sites	Thermal Potential (MWth)
Very Large	>2000	1	11.3
Large	1,350-2,000	3	28.4
	700-1,349	3	22.7
Medium	350-699	8	45.4
	125-349	18	68.0
Total		33	176

Table 5-2 Energy potential from old colliery works in GM

The total potential thermal energy from use of old colliery workings is 176 MWth/yr. This is less than 0.5 % of total current (2015) gas demand. Mine water heat extraction in GM has the technical potential to provide **176MWth/yr.**

Water in mine workings can be heavily contaminated. If the water is pumped to the surface in order to extract the heat this can cause considerable disposal problems. The contaminated water cannot be discharged to local drains or water courses without expensive decontamination. In these cases, a pipe must be inserted into the mine with a heat transfer fluid pumped down the mine and back up again in order to extract the heat. Where mine water is contaminated it may make projects technically or commercially unviable.

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5.2.10 Network Heating and Cooling

Heat networks use a series of insulated pipes to pump hot water to homes and buildings, which use heat exchangers to take heat for use locally. The heat source can be from a variety of sources including recovered waste heat of an industrial process, biomass or gas boilers, biomass or gas fired Combined heat and power (CHP), large scale ground and water source heat pumps, mine water or waste incineration.

Heat Networks have the potential to provide low carbon heat and replace a large number of traditional gas boiler systems.

In 2013 DECC identified that the North West had 95 small heat networks and, 20 medium and large heat networks. Small networks had an average of 35 dwellings while medium and large had an average number of dwellings of 190 and 1,035 respectively. (DECC, 2013)

Ramboll carried out a strategic heat network masterplan for GM that identified a number of future potential heat networks (Ramboll, 2014). The short to mid-term opportunities identified (2015-22) for heat networks in GM are shown in Figure 5-7.

Combining this with the currently identified areas for new build, it is possible to understand areas which may be viable to connect to a heat network. If a building is within 500m of a network connection is likely to be technically viable and could be commercially viable given the right incentives.

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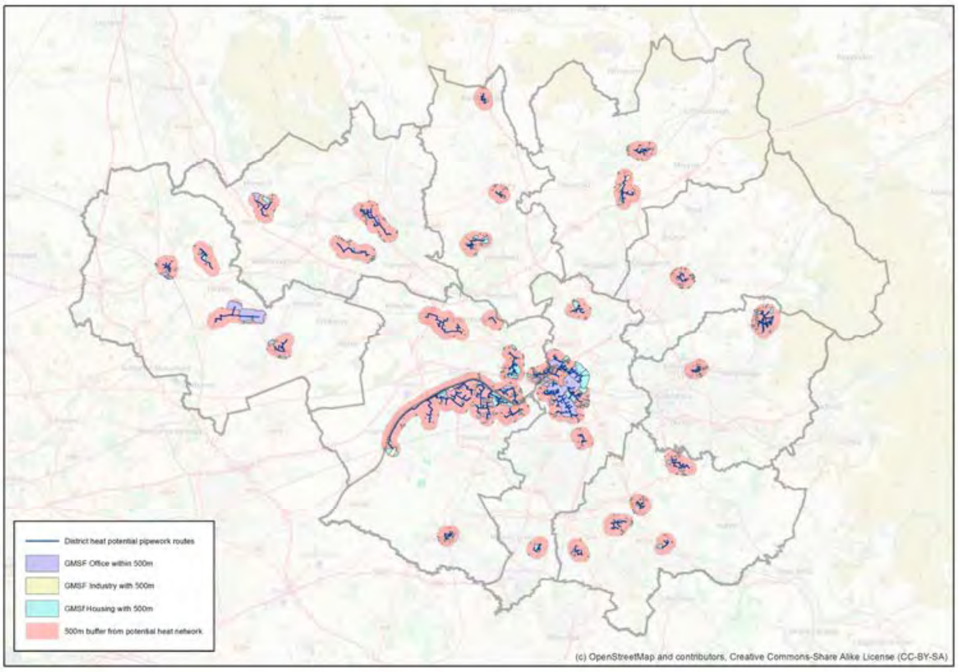

Figure 5-7 GMSF development areas within 500m of potential heat network

Figure 5-7 shows the GMSF planning areas that are within 500m of a potential heat network. Figure 5-8 shows a close up of the major heat network opportunities along the Manchester Ship Canal, Manchester city centre and Salford.

161,000 existing households are within the 500 m of a potential heat network (15 %).

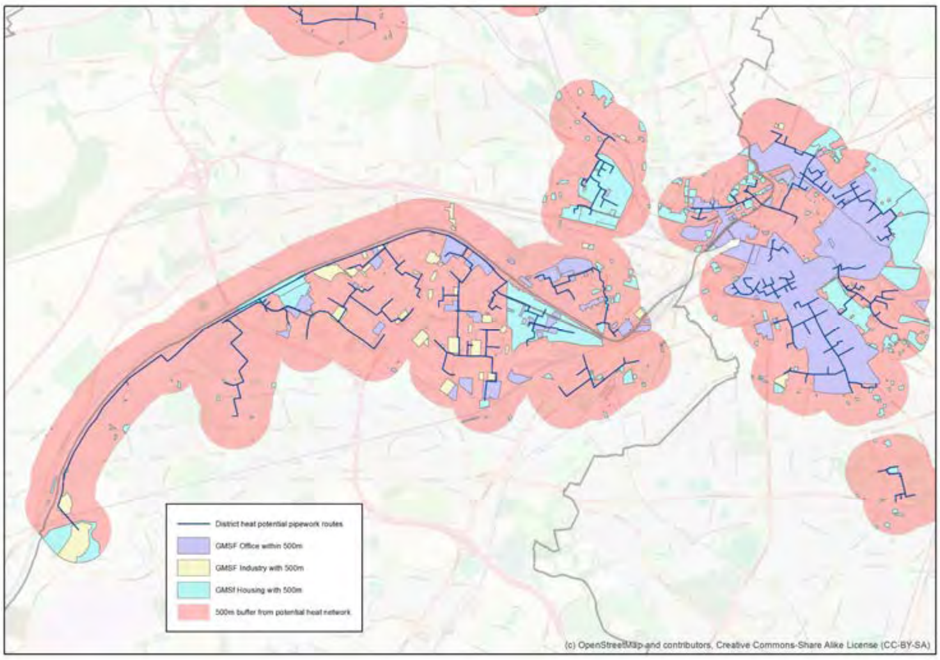

Figure 5-8 GMSF heat network ship canal and city centre

The Ramboll study identifies carbon savings associated with the potential heat networks. Table 5-3 Carbon savings from potential heat networksTable 5-3 give the identified carbon savings for each district and network that are cross district.

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District	Potential carbon savings (tCo2)
Bolton	15301
Bury	19257
Manchester	161387
Oldham	2716
Rochdale	4236
Salford	11015
Stockport	13522
Tameside	737
Trafford	116811
Wigan	10687
GM (multi district)	57100

Table 5-3 Carbon savings from potential heat networks

The total potential carbon savings are 0.4 $MtCO_2$ per year. This is equal to 3 % of GMs carbon emissions in 2014.

District Heating has potential to expand significantly in GM. District Heating can utilise a range of low carbon and renewable technologies and the technical potential for gas CHP led high efficiency District Heating in the North West has been estimated as **37TWh/yr** with a cost-effective potential of **4TWh/yr** (DECC, 2016)**.** This is equivalent to around 200,000 homes.

Urban areas are most likely to move towards heat networks and GM has previously identified feasible opportunities for approximately **35** individual **District Heating Networks** with technical potential to reduce GM carbon emissions by **413 $ktCO_2$ (3 %).**

District heating provides an opportunity to utilise recovered surplus waste heat from industry, power stations and waste incinerators. The **North West** technical potential for recovering **power station heat** is estimated as **6TWh/yr** and **industrial waste heat 1TWh/yr** (DECC, 2016). There is waste heat potential in GM where district heat networks are installed. District heating could supply as much as 15-30 % of UK space heat generation by 2050 compared to 1-2 % currently (Energy Technologies Institute, 2014). This shift across GM would be equivalent to up to **330,000 homes** connected to District Heating by 2050.

In the UK consumers are used to owning their own domestic boiler and few have much knowledge of district heating. There are likely to be considerable challenges in persuading consumers to convert to districting heating due to this lack of knowledge and experience combined with worries about loss of personal control and lack of choice when connected to a monopoly provider. Encouraging new development to connect to district heat networks is likely to be easier, although it could still present a considerable challenge and is unlikely to provide the level of adoption required to meet GM's climate change ambitions at a reasonable cost.

5.2.11 Combined Heat and Power

Gas can be burnt in three different technologies to provide heat for networks.

1) Gas Boilers are large scale versions of domestic systems.

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2) Gas Engine Combined Heat and Power runs a large engine, similar to that in a heavy goods vehicle. This drives a generator to produce electricity and the heat that would be wasted in the truck radiator and exhaust gas is captured and delivered to the heat network.
3) In Gas Turbine Combined Heat and Power an engine similar to that on a jet airliner is used to power a generator to produce electricity. The exhaust heat is captured and delivered to the heat network. These types of systems are only likely to be used where there is considerable demand for both heat and electricity

Biomass can also be used to produce heat and electricity.

1) Use the heat from burning biomass in a boiler to produce steam to power a generation turbine and capture the heat in the boiler flue for delivery to a heat network.
2) Convert the biomass to a flammable gas to use in a gas engine or gas turbine.

In conventional electricity generation the heat in the exhaust gases is allowed to escape to the atmosphere and is wasted. Capturing this heat for use in a heat network significantly improves the overall system efficiency.

Electricity networks have traditionally been designed on the assumption that electricity will be provided from the national grid and flow down to consumers. With local generation through combined heat and power plants this is no longer the case. Network modification and reinforcement may be required to handle locally generated electricity. This can add a considerable cost to a scheme and might influence its commercial viability.

5.2.12 Cold water networks

New heat network infrastructure in GM provides the opportunity to consider district cooling to provide an alternative to energy intensive air conditioning to control temperatures during summer months. This technology is similar to district heating but uses cold water in networks which is used to transfer heat away from buildings.

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6 GM Future Energy Scenarios

In order to understand what the future may look like in terms of consumption, generation and carbon mix it is useful to examine existing trends and project those trend into the future. There are a number of possible directions that may be taken, with factors that are both regional and national in affect. In examining what the future may look like it is helpful to develop a range of scenarios that allow an understanding of the potential possibilities for the future, especially where the factors may be controllable through policy, behaviour or planning.

Projecting current trends in to the future is a useful approach to understand the directions of travel for populations, technologies and consumption. This allows analysis of a number of potential futures. There are a number of approaches that are being used and continuously developed by government and industry. This report focuses on methodologies and data that are publicly available. The focus will be on data produced by DECC, national grid and industry.

Scenarios have been created for GM to enable an understanding of possible energy demands and associated carbon emissions out to 2050. These scenarios show a green aspirational scenario and a business as usual scenario.

6.1 National Context

The 2016 Climate Change Committee (CCC) progress (Commitee on Climate Change, 2016) report released on June 30th 2016 reports emissions fell by 3 % in 2015, from 2014, to 497 MtCO2e. Emissions are below the annual average permitted by both the second and the third carbon budgets (2013-17 and 2018-2022). However, the report makes clear, that the current rate of progress cannot be sustained solely through reductions in emissions in the power sector, which have driven progress in recent years.

The fourth carbon budget and the fifth carbon budget recommended by the Committee require that emissions are reduced by an average of 10 MtCO2e (2-3 %) per year across the economy from 2015 to 2030. That would result in a 57 % reduction in emissions by 2030 relative to 1990 and keep the UK on the lowest cost path to the 2050 target.

6.1.1 Power Sector

The climate change committee point out that whilst emissions have fallen by an average of 4.5 % a year since 2012, this reduction has been almost entirely due to progress in the power sector, particularly reduced use of coal as government policies have driven an expansion of renewable generation and the closure of coal fired power stations.

6.1.2 Other Sectors

Progress across other sectors in the economy have not made such good progress. Emissions have fallen less than 1 % a year since 2012 on a temperature-adjusted basis. This is due to slow uptake of low-carbon technologies and behaviours in the buildings sector (i.e. low rates of insulation improvement, low take-up of low-carbon heat).

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Improved vehicle efficiency has been offset by increased demand for travel as the economy has grown and fuel prices have fallen. There is also minimal evidence of progress in the industrial and agriculture sectors.

The CCC suggests that progress will need to be broader to meet the recommended fifth carbon budget and to prepare sufficiently for 2050. For example, while the complete replacement of coal-fired generation with low-carbon generation in the power sector is an important part of future emission reduction scenarios, this would provide less than half of the total emissions reduction required by 2030.

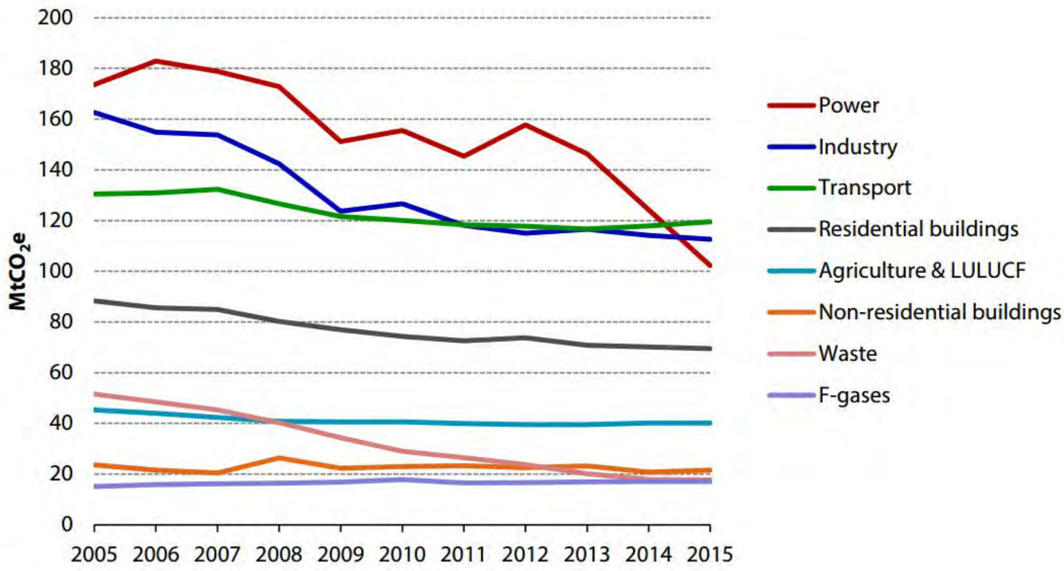

Figure 6-1 UK Historical Carbon emissions by sector (Commitee on Climate Change, 2016)

6.1.3 Heat in Buildings

The CCC report focuses on heat in buildings as a priority in both emissions reduction and in formulating effective policy.

Progress on improving the energy efficiency of buildings has stalled since 2012: annual rates of cavity wall and loft insulation in 2013-2015 were 60 % down and 90 % down respectively on annual rates in 2008-2012. Take-up of heat pumps and low-carbon district heating remains minimal; less than 0.5 % of heat demand in 2015.

The failure of the ECO and Green Deal to deliver more than 1 % of their predicted emissions savings alongside its higher cost (£92-95) per tCO2 saved in comparison to £34 per tCO2 under CERT and CESP, the previous scheme, have been identified as the main reason for the reduction in delivery of measures. This is attributed to; the initial focus on harder-to-treat homes, closing the Green Deal in its early stages, high administrative costs and difficulties for suppliers in identifying eligible households. (NAO, 2016)

The Climate Change Committee recommends that clear, consistent and credible policies that overcome behavioural barriers and that can build up skills and supply chains are needed across the areas that are attractive to owners and landlords of both homes and workplaces.

It is important to recognise that many of the 'easy wins' in domestic retrofit, such as cavity wall and loft insulation have been carried out on the majority of properties. The remaining measures may be less cost effective and more difficult to implement. According the English Housing Survey approximately 9.1

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million (66 %) of dwellings with cavity walls were insulated of the remaining dwellings that could potentially benefit from the installation of cavity wall insulation, 77 % were assessed to have standard fillable walls (DCLG, 2012).

6.2 Greater Manchester

Carbon Emissions statistics to Date (available up to 2014) are from the sub-national data on energy use and emissions which has only been collected since 2005; the latest figures (for 2014) were published in July 2016 and are included in this study.

The sub regional statistics report CO_2 emissions and no other greenhouse gases. This is for consistency in statistics, as reporting on other gases is considered unreliable currently. In some cases, CO_2e (equivalent) is reported. This includes all potential greenhouse gas emissions with other gases normalised in their effect to CO_2 through the use of a forcing factor. Where used this will be explicitly stated.

Data presented in the GMCCS Implementation Plan is for 2010. Since then, data from 2010 has been revised and as such some of the data below does not exactly match that set out in some of the latest GM reports and strategies, such as the GM Implementation Plan and CCS.

As data is not available before 2005, GM's environmental strategy team undertook its own analysis to produce a 1990 baseline for GM (AGMA, 2011). This analysis suggested that emissions in 1990 were 21.1MtCO2e. For 80 % emissions reduction by 2050 on the 1990 baseline, a reduction of 16.88MtCO_2 is required.

6.2.1 2020 Targets

By projecting the trend linearly since 2005 out to 2020, it is possible on 2014 data to predict that GM will come close to meeting its 2020 target by 1MtCO_2 with projected emissions in 2020 of 11.9 MtCO_2 compared to the target of 11 MtCO_2.

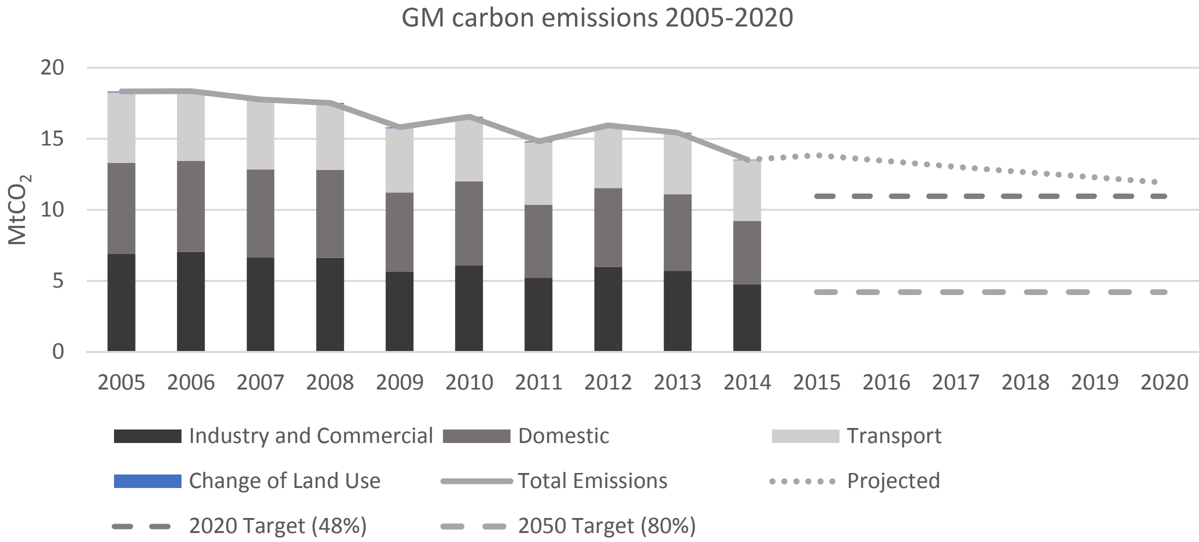

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Figure 6-2 Simple projection of carbon emissions (CO_2) to 2020

This is a very simplistic projection as a series of warmer years would reduce carbon emission from heating and reduce the overall emissions considerably. Conversely, a cold period would increase emissions.

6.3 Projections

6.3.1 Low carbon wedges

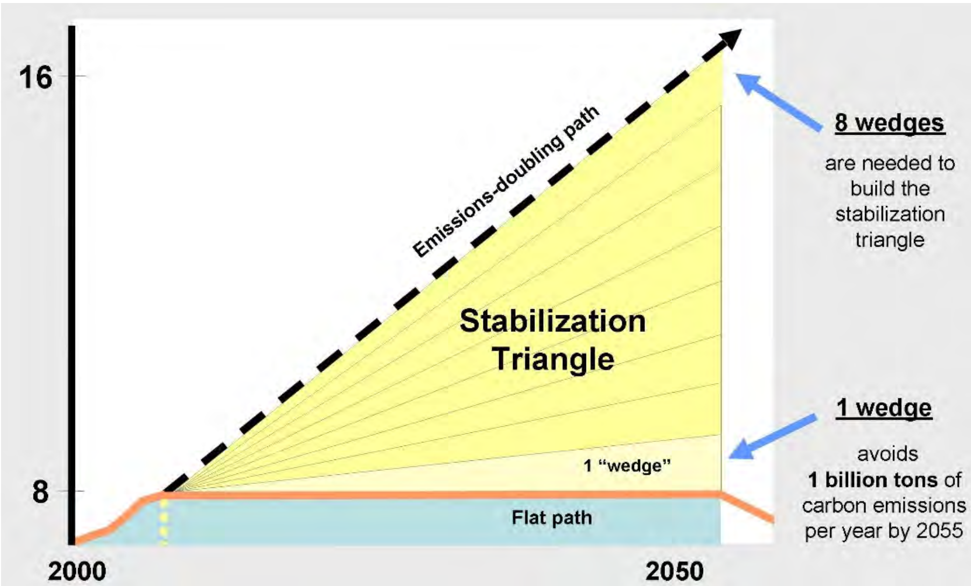
A study was commissioned to develop a wedges approach to illustrate how carbon dioxide equivalent emissions reductions in Greater Manchester (GM) can meet a 48 % reduction target by 2020 against a 1990 baseline (URS, 2014).

The key aims of the study were to:

- Set the baseline by reviewing existing data to establish wedges to achieve the interim target to 2015;
- Develop options for the emissions reduction wedges from 2015 to 2020;
- Appraise the options and make recommendations for meeting carbon reduction targets up to 2020; and
- Produce a performance management framework for collecting and monitoring future carbon savings.

The study supported the delivery of the GM Climate Change Strategy (CCS) from 2015 to 2020. It also coincides with a similar but separate study which assesses emissions reduction measures delivered from transport.

The wedges approach breaks down the reduction of carbon emissions into a number of sections (wedges) that can be sectors, policy approaches or technologies.



The Low Carbon Wedges Work predicts that between 2015 and 2020 the following reductions will be achieved in GM.

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Table 6-1 Low Carbon Wedges

Impact elements	$MtCO_2$	%
National policy will deliver	2.54	34 %
National policy (with local influence)	0.38	5 %
Local Initiatives need to deliver	2.24	30 %
Estimated impact of existing projects	0.28	4 %
Estimated Impact of potential pipeline	0.27	4 %
Estimated gap (projects as yet unidentified)	1.68	23 %

The biggest wedge of carbon emission reduction is predicted to be delivered by national policy. This includes the decarbonisation of electricity. Local initiatives and as yet unidentified projects makes up 53 % of the total identified wedges.

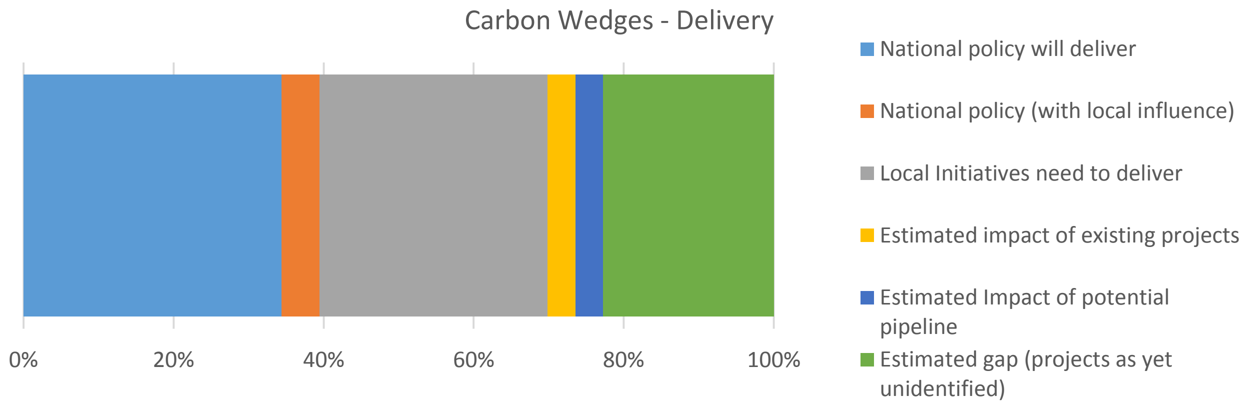

Figure 6-3 Carbon wedges delivery proportions

This demonstrates the challenge that is ahead for Greater Manchester.

6.3.2 DECC Annual energy and carbon projections

Each year DECC publishes updated energy projections (UEPs) (DECC, 2016), analysing and projecting future energy use and greenhouse gas emissions in the UK. These projections allow monitoring of progress towards meeting the UK's carbon budgets and are used to inform energy policy and associated analytical work across government departments.

The projections are based on assumptions of future economic growth, fossil fuel prices, electricity generation costs, UK population and other key variables regularly updated. They also give an indication of the impact of the uncertainty around some of these input assumptions.

Each set of projections takes account of climate change policies where funding has been agreed and where decisions on policy design are sufficiently advanced to allow robust estimates of policy impacts to be made. These projections are publicly available along with the methodology and assumptions.

The reference scenario projections are shown here.

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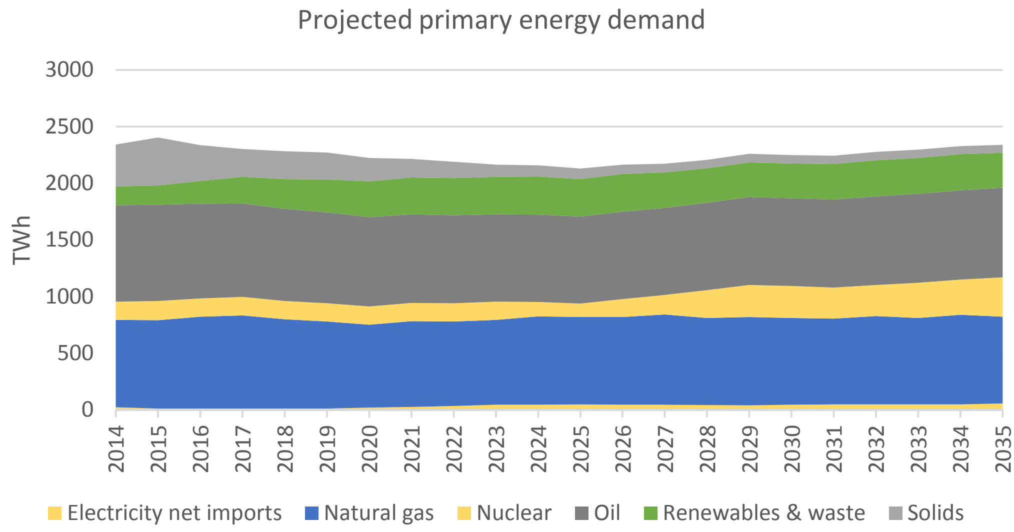

Figure 6-4 DECC projected primary energy demand (DECC, 2016)

Figure 6-4 DECC projected primary energy demand shows that the primary energy demand for the UK will start increasing after 2024, with solid fuels (coals and manufactured fuels) and reducing in quantity with the slack being taken up by renewables (including biofuels). Renewables will slow in growth, with new nuclear coming on line past 2028.

Gas usage stays constant out to 2035

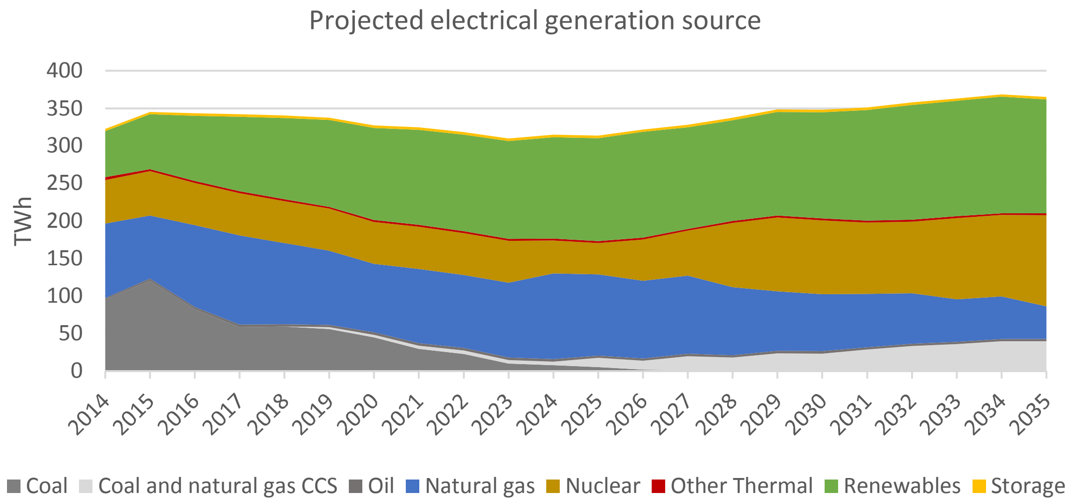

Figure 6-5 DECC projected electrical generation (DECC, 2016)

The fuel mix that makes up electricity generation will transition from coal to renewables, as shown in Figure 6-5. Renewables will make up an increasing proportion of the mix, with nuclear increase from 2028. Gas reduces in the UK electricity mix from around 2027. Around the mid-2020s coal and natural gas carbon capture and storage (CCS) plants start coming online.

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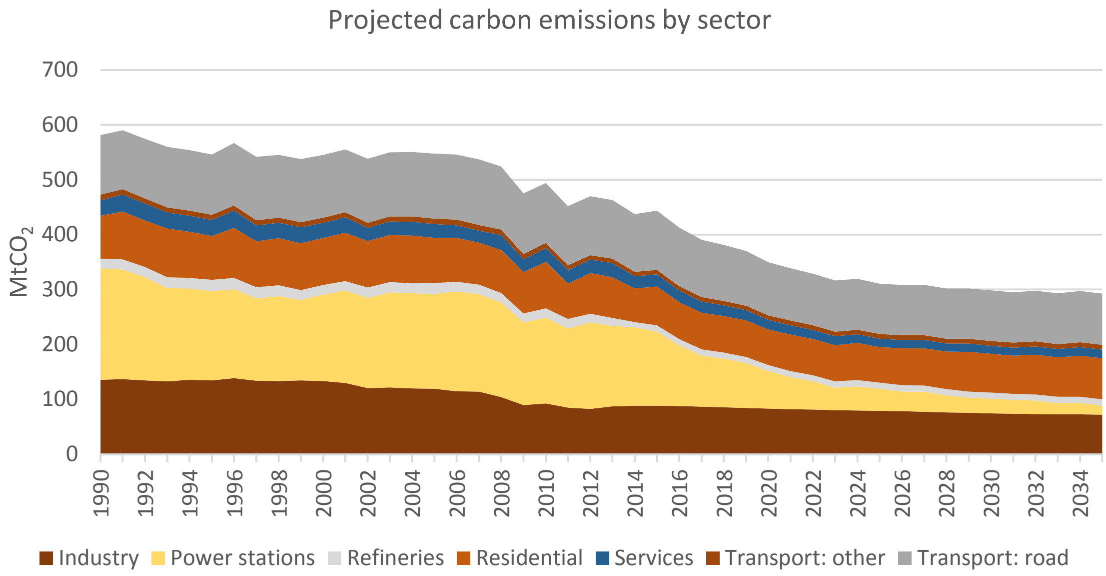

Figure 6-6 DECC carbon emissions projections by sector (DECC, 2016)

The projected carbon emissions from all sectors can be found in DECCs carbon emissions projections (DECC, 2016). The current projections show that the total UK carbon emission will reduce by around 50 % to 2035. The power generation sector reduces its emissions by 92 %. Transport reduces by 14 %, the non-domestic sector (including services and industrial) reduces by 70 %, while the residential sector only reduces by 4 %.

6.3.3 Summary

- The 2016 DECC projections show that while the power sector reduces its carbon emissions other sectors like transport and domestic buildings do not reduce by the same amount.
- The projections do show the UK meetings its carbon budgets out to 2027.
- In order to reach the 2050 target significant work need to be done in the transport and building sectors.

6.3.4 Future Energy Modelling

ETI EMSE

The ETI has developed its Energy System Modelling Environment (ESME) (Energy Technologies Institute, 2014) to identify the lowest-cost decarbonisation pathways for the UK energy system. This involves running many simulations, exploring the variation on cost-optimal designs within a range of assumptions and constraints in order to identify robust strategies against a broad range of uncertainties.

ESME covers the whole energy system for the UK, meaning the ETI can look in detail at possible designs for infrastructure, supply and end-use technologies for heat, electricity, personal transport, freight, industry and so on.

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Using the EMSE approach the ETI have produced scenarios that demonstrate possible pathways to meet the UKs 2050 emissions targets. Two of the scenarios have been published in the UK scenarios for a low carbon energy system transition. (Energy Technologies Institute, 2014).

Both scenarios provide a pathway to the UKs emissions targets of 80 % reduction by 2050. Clockwork is more centralised and is considered likely to be the lower cost option. Patchwork is costlier but has more local and regional responses to the challenge.

Clockwork

- Well-coordinated, long term investments allow new energy infrastructure to be installed like clockwork. A national planning approach establishes a framework for energy system decision-making. There is societal acceptance of chosen solutions.
- The regular build of new nuclear, CCS plants and renewables ensures a steady decarbonisation of the power sector. The policy framework supports large scale investments in CCS and nuclear. Clarity over the role of CCS enables early investment in "outsized" infrastructure and investor support for follow-on CCS projects
- National-level planning enables the deployment of large-scale district heating networks, with the local gas distribution network retiring incrementally from 2040 onwards. A national framework for large scale district heating is introduced, enabled in part by waste heat from thermal power plant
- The transportation system remains in the earlier stages of a transition and people and companies continue to buy and use vehicles in a similar way to today, albeit with regulation and innovation continuing to improve their efficiency.

Patchwork

- With central government taking less of a leading role, a patchwork of distinct energy strategies develops at a regional level.
- Renewables find support at all levels of society: central government backs large scale projects such as offshore wind, while local authorities and communities support combined heat and power, onshore wind and solar
- CCS deployment picks up later, enabling clean hydrogen production from a mixture of biomass and coal, although biomass uptake is limited by societal concerns about land-use change and biodiversity as well as by market failures
- There is "grassroots" support for small and medium scale district heating projects, coupled with private sector and local authority investment
- Society becomes more actively engaged in decarbonisation, partly by choice and partly in response to higher costs.
- Popular attention is paid to other social and environmental values, influencing decision-making. There is a more limited role for emissions offsetting, meaning more extensive decarbonisation across all sectors, including transport.

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- Cities and regions compete for central support to meet energy needs which is tailored to local preferences and resources.
- Over time central government begins to integrate the patchwork of networks to provide national solutions.

Comparing the two scenarios shows that both will reach the UK's 80 % 2050 carbon reduction target, with clockwork providing an additional 30Mt of negative emissions.

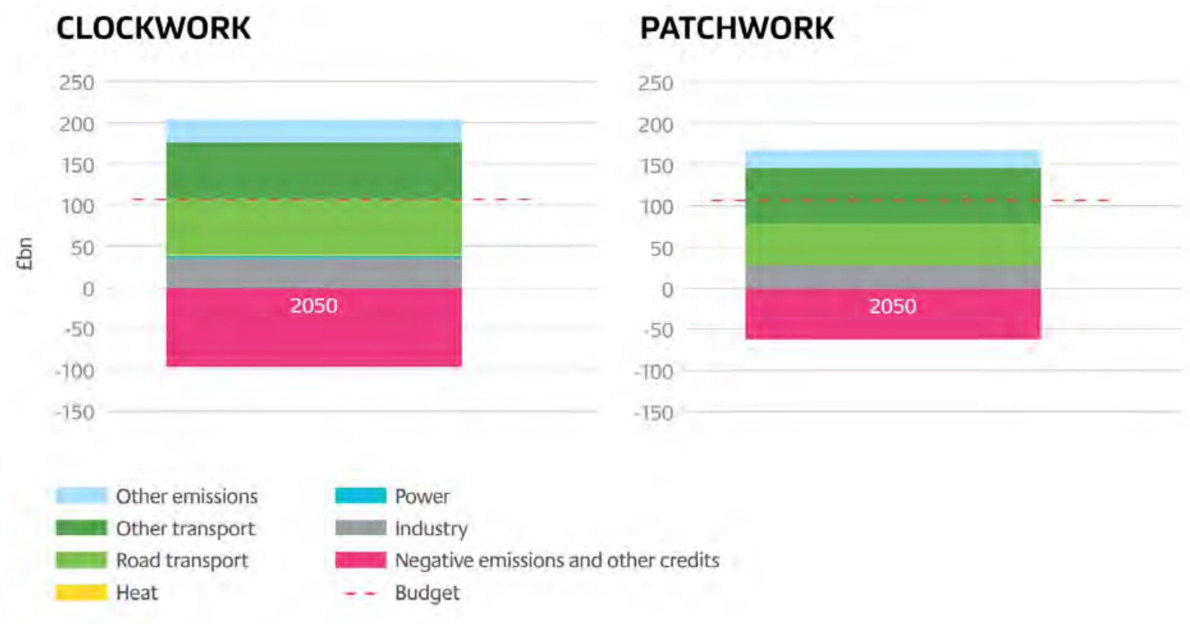

Figure 6-7 EMSI scenarios 2050 carbon emissions (Energy Technologies Institute, 2014)

As Figure 6-8 ESMI additional capital expenditure required (per decade) to meet targets shows the patchwork scenario is more expensive to achieve the target emissions.

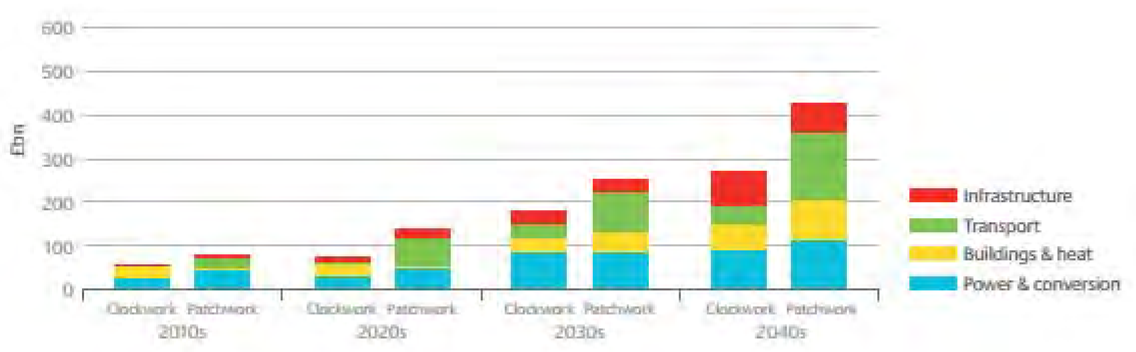

Figure 6-8 ESMI additional capital expenditure required (per decade) to meet targets (Energy Technologies Institute, 2014)

In Clockwork, the cost of abatement action taking place in 2050 constitutes around 1.4 % of GDP for that year. Patchwork has a marginally higher rate of population growth (with the same GDP per capita growth), which after 35 years delivers a measurably higher GDP. So, while the system cost is higher for Patchwork, the cost as a percentage of GDP is still only 1.6 % of GDP.

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ETI EMSE provide routes for meeting the UKs carbon targets, at differing costs. Both scenarios require explicit action and policy, although each scenario assumes different drivers.

National Grid Future Energy Scenarios

National Grid produces its Future Energy Scenarios (National Grid, 2015) annually. They represent transparent, holistic paths through the uncertain energy landscape to help Government, National Grid customers and other stakeholders make informed decisions. These scenarios are not forecasts, instead they show a range of plausible and credible pathways for the future of energy, from today out to 2050.

National Grid continually develop all aspects of the Future Energy Scenarios process ensuring that the outputs are as rich and robust as possible to provide a sound reference point for a range of modelling activities. This includes extensive stakeholder consultation and detailed network analysis, which enables National Grid to identify strategic gas and electricity network investment requirements for the future.

The scenarios are based on the energy trilemma of security of supply, affordability and sustainability. The Government has set a standard for electricity security of supply and through Electricity Market Reform put in place the framework to deliver to this standard. The scenarios flex the two variables of prosperity and green ambition.

The FES examines 4 scenarios.

- Gone Green - a world where green ambition is not restrained by financial limitations. New technologies are introduced and embraced by society, enabling all carbon and renewable targets to be met on time.
- Slow Progression - a world where slower economic growth restricts market conditions. Money that is available is spent focusing on low cost long-term solutions to achieve decarbonisation, albeit it later than the target dates.
- No Progression - a world focused on achieving security of supply at the lowest possible cost. With low economic growth, traditional sources of gas and electricity dominate, with little innovation affecting how we use energy.
- Consumer Power - Consumer Power is a world of relative wealth, fast paced research and development and pending. Innovation is focused on meeting the needs of consumers, who focus on improving their quality of life.

The data outputs from the FES package is available publicly and is used as the basis of the regional analysis.

6.4 GM Future Scenarios

For this study, future projections of energy demand, fuel consumption and carbon emissions for Greater Manchester have been developed. These have been informed by National Grid's Future Energy Scenarios (FES), other related national, regional and local evidence.

The Greater Manchester Forecasting Model (GMFM) has been used to provide specific data collated and analysed for the purpose of this study. All projections for household and non-domestic footprint increases

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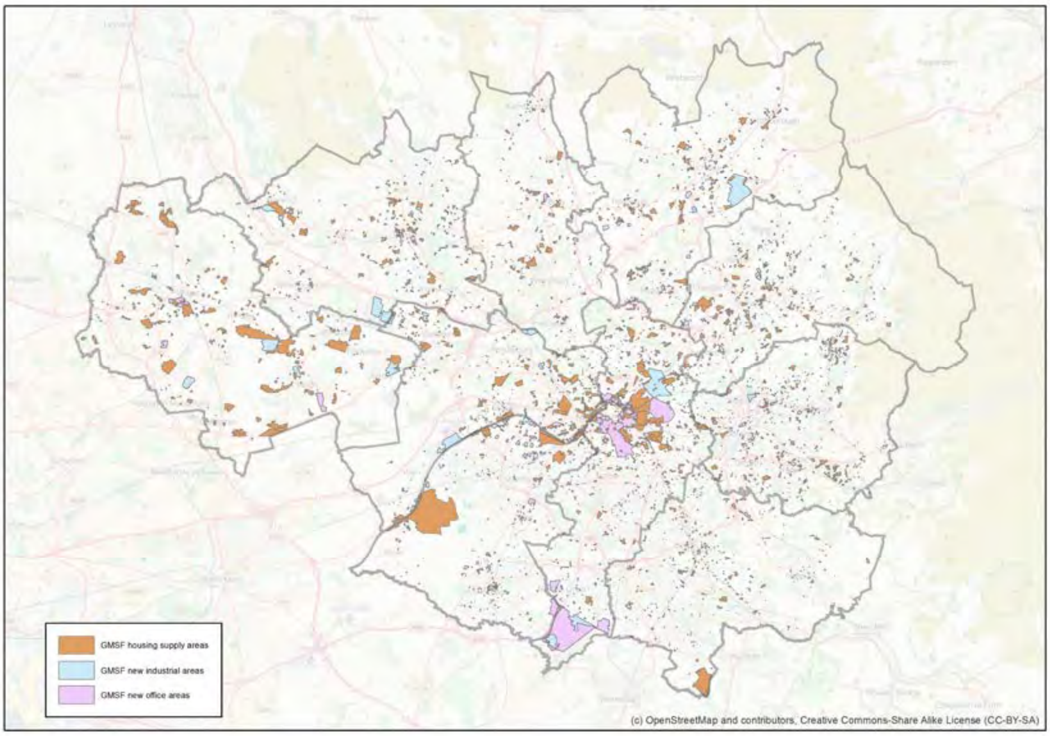
have been provided by GM directly. Projections to 2050 have been based on an extrapolation of the modelled data to 2035.

6.4.1 Strategic development areas

The following map shows the development areas that are identified within the GMSF currently for housing, industry and office space. These areas have been taken from GM spatial framework mapping tool and does not include the latest call for sites.



Combined with the Greater Manchester Forecasting Model (GMFM) it is possible to make projections regarding the locations and numbers of new build housing and non-domestic quantities. The GMSF contains numbers of proposed properties in each area. New build apartments and houses will have different energy benchmarks. From the data the split between houses and apartments in each district can be estimated. Table 6.2 gives the proportions of apartment proposed in each district.

Table 6-2 Proportion of apartments proposed

GM District	2014-2019	2020-2024	2025-2035
Bolton	21.3 %	11.4 %	7.9 %
Bury	36.8 %	23.0 %	41.9 %
Manchester	71.0 %	77.4 %	79.3 %
Oldham	13.8 %	29.5 %	12.4 %
Rochdale	7.5 %	17.9 %	3.6 %
Salford	65.7 %	67.5 %	79.0 %

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Stockport	33.2 %	23.4 %	43.5 %
Tameside	21.5 %	33.2 %	7.9 %
Trafford	61.6 %	58.5 %	54.6 %
Wigan	7.9 %	4.8 %	0.9 %

6.4.2 GM Future Growth Projections

Forecast growth data is available out to 2035 in line with the Greater Manchester Spatial Framework planning period. The Greater Manchester Forecasting Model (GMFM) (New Economy, 2016) provided the projected increase in the number of households and the projected increase in gross value added per district.

- For domestic properties the household data from GMFM was used.
- For non-domestic the GVA data was normalised to non-domestic footprint area. The efficiency of use of space was taken into account, with logarithmic growth models assumed on all data.

Domestic properties

The number of households projected increases steadily up to 2037 from 1.15 million in 2014 to 1.38 million in 2037.

The main projected growth in households is in Manchester and Salford with a combined additional 94,500 households by 2035. Oldham and Tameside are projected to have the smallest number of additional households up to 2035, 16,180 and 13,800 respectively.

The split between apartments and houses is important in understanding the additional energy demand as houses have a higher energy use than apartments.

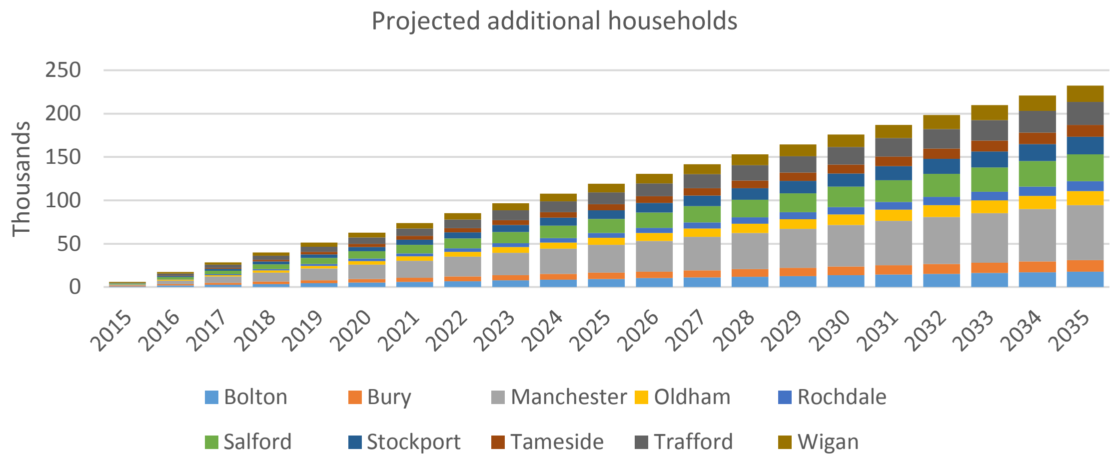

Figure 6-9 Projected additional households

Figure 6-9 Projected additional households shows the number of additional households projected by the GMFM and the split between the different districts. Manchester has the largest number of new households. As shown in Figure 6-10 the majority of these are in apartments. Salford also is mainly additional apartments.

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The number of apartments and houses are projected to be fairly consistent with around 110,000 additional apartments and a slightly greater number of houses (125,000) by 2035.

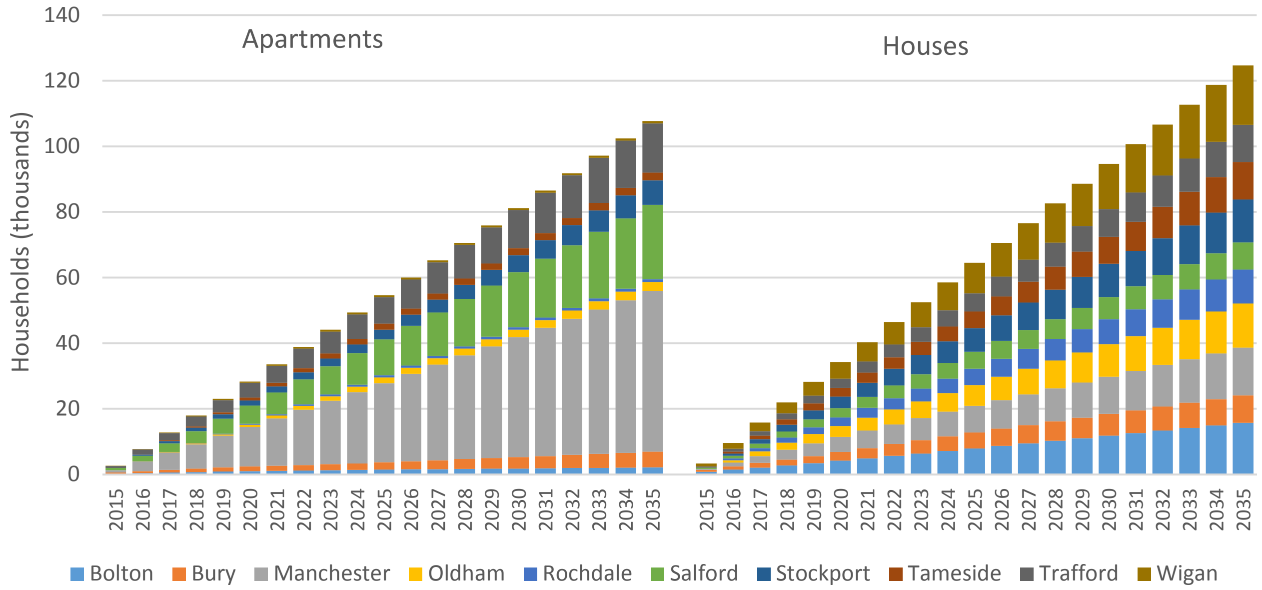

Figure 6-10 Projected apartments and houses

Figure 6-11 shows the total projected households. By 2035 the additional households make up around 17 % of the total number.

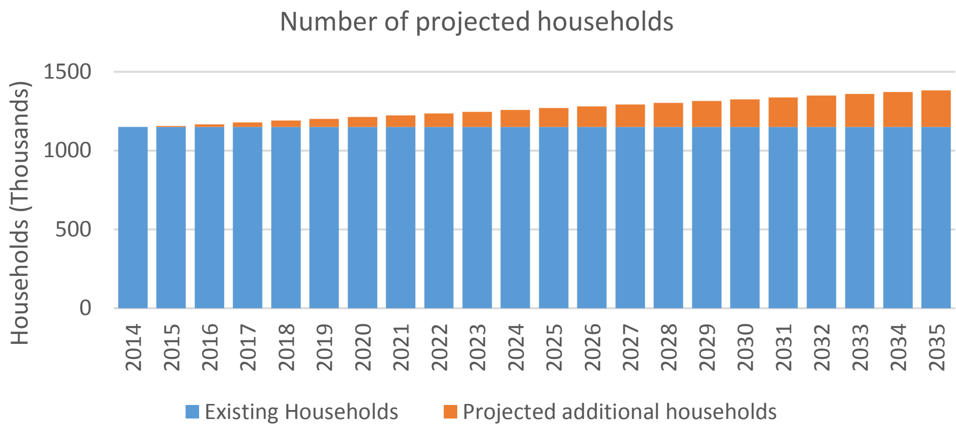

Figure 6-11 Projected households to 2035

Non-Domestic Buildings

Increases in floor area have been taken from the GMFM data provided.

The general trends are for both commercial and industrial floorspace to increase towards 2035.

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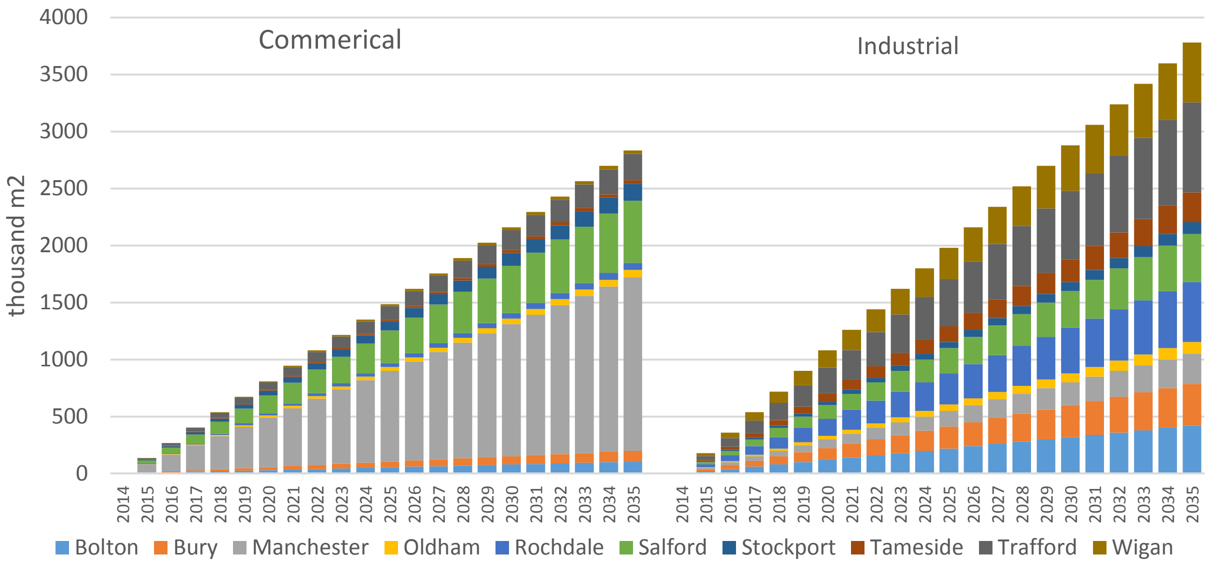

Figure 6-12 additional projected floor space

Figure 6-12 shows that the commercial sector is expected to increase its floor space by 2.8 million m² to 15.6 million m², an increase of 22 %. This is accompanied by an increase in industrial floor space from 17.9 million m² to 21.7 million m²' an uplift of 21 %. The majority of the commercial increase is projected to be in Manchester and Salford. Trafford is projected to have the largest industrial floor space increase.

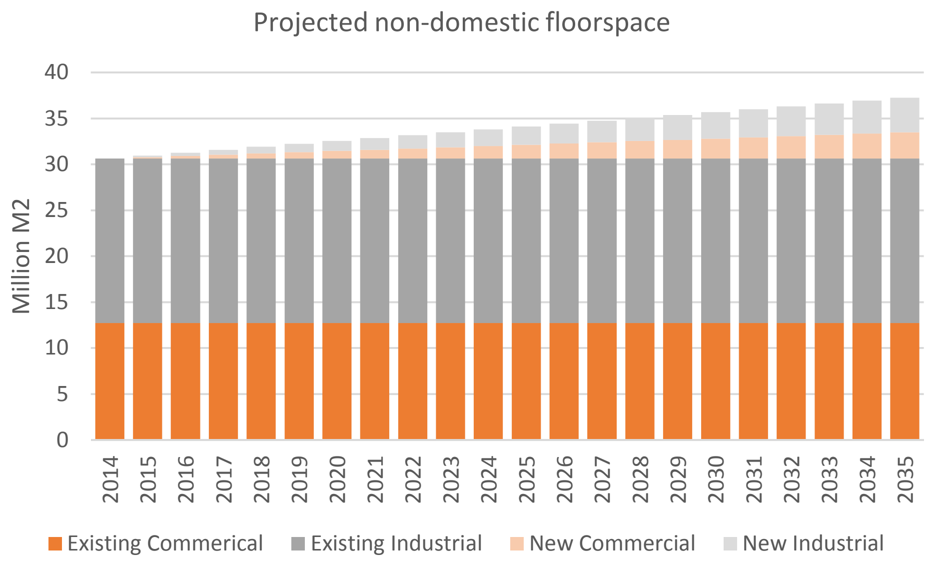

Figure 6-13 Projected non domestic floor space

Figure 6-13 shows that the non-domestic floor space increases from 30 million m² to 33.5 million m².

Please note that following the evidence gathering for this report, revised figures of c 227,200 new homes and for gross new office floor space of 2,450,000m² have been identified. Of this new development, 55% of this land is within the city centre. The Greater Manchester Spatial Framework also outlines an increase to 8,126,000m² of land for industrial and warehousing, which will deliver around 4,000,000m2 in the plan period.' These revised figures closely align with the outputs of this report and should be considered as within existing project tolerances.

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6.4.3 GM Future Energy Scenarios

Two future energy scenarios for Greater Manchester have been developed. These models are based in part on the National Grid Future energy scenarios, but recalculated using the regional projections for households and floor space. Transport projections have been from DECC have been used alongside the FES assumptions.

- **GM Business-as-Usual** - is a world focused on achieving security of supply at the lowest possible cost. With low economic growth, traditional sources of gas and electricity dominate, with little innovation affecting how we use energy. There is low take up of low carbon heating technologies and efficiency of building stock is not prioritised
- **GM Green Aspiration** - represents the scenario where government policy is strongly supportive of renewables and low carbon technologies while meeting carbon reduction targets. Low carbon heating and transport is widely implemented. The electricity grid completely decarbonises and building efficiency is strongly pushed.

These scenarios represent the outliers of what is achievable with GM green aspiration representing the outcome given political and technical will, and GM business-as-usual representing where the only driver is cost and policy is weak in providing signal and direction.

The reality will likely be somewhere between these extremes.

Projected changes in efficiency, technology uptake and fuel mix have been taken from the National Grid Future Energy Scenarios. Two scenarios, Gone Green and No Progression, are used as the source for these figures. These scenarios provide a good range of what may happen with concerted regional and national action to reduce carbon emissions (Gone Green) and a less ambitious business as usual approach (No Progression).

The current and projected future changes in floor area and households have been used to calculate energy demand and fuel mix, with factors introduced to adjust energy benchmarks.

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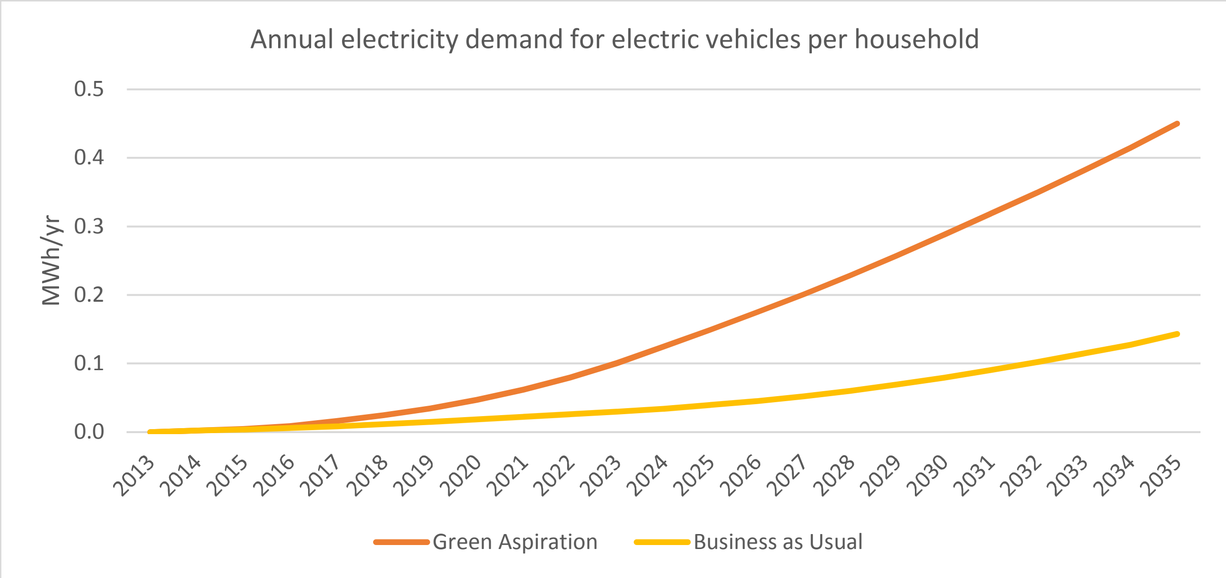

Figure 6-14 Electric vehicle take up

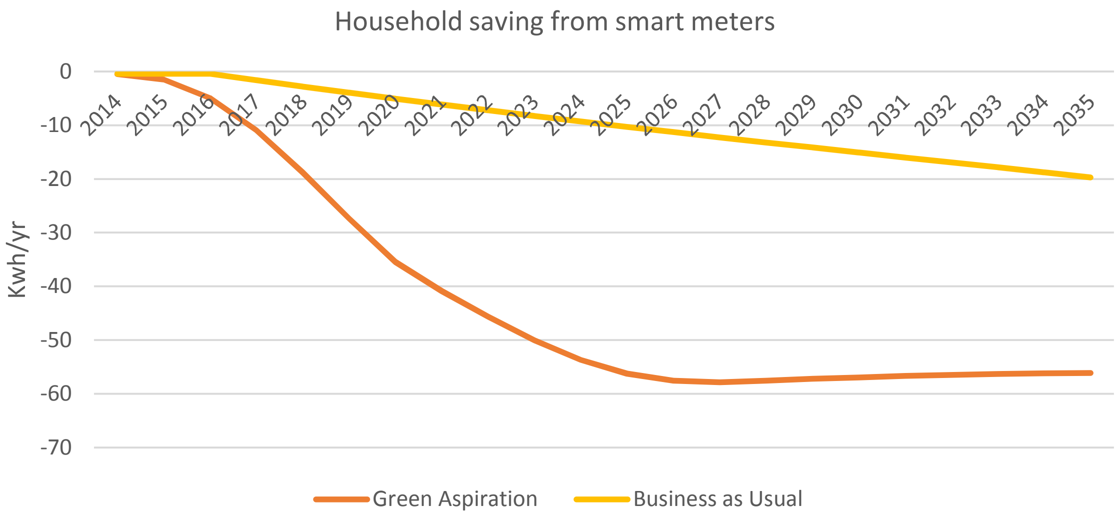

Figure 6-15 Energy savings from smart metering

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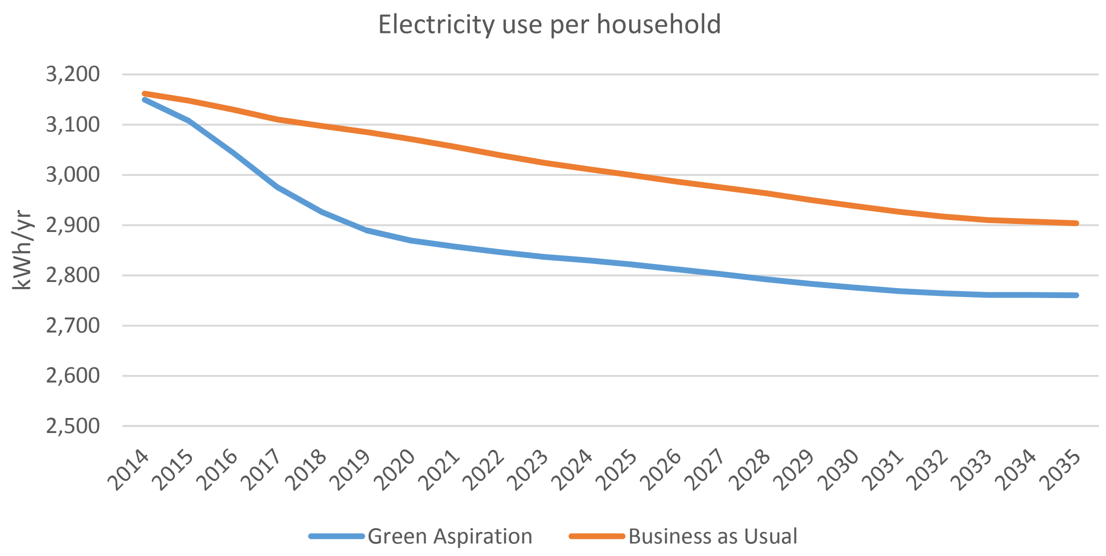

Figure 6-16 Household electricity consumption

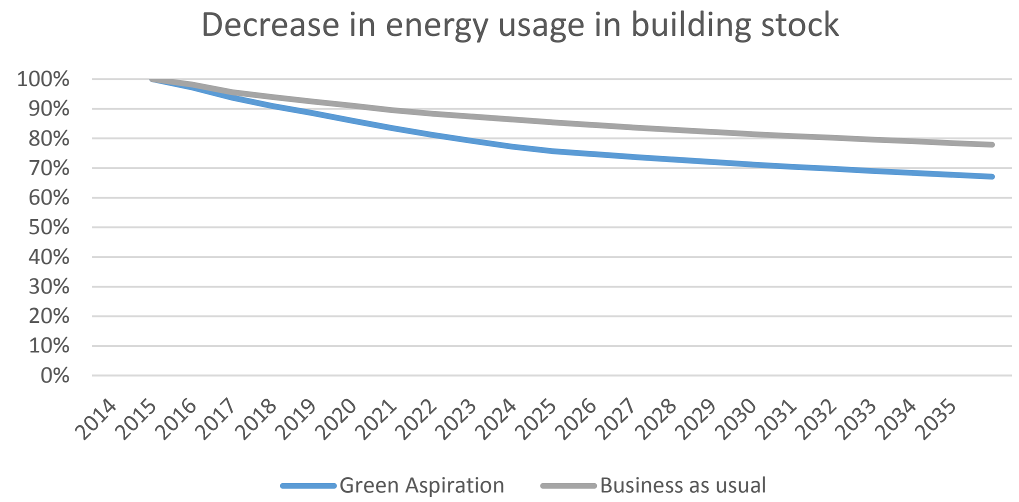

Figure 6-17 Efficiency of building stock

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Installed low carbon heating technologies

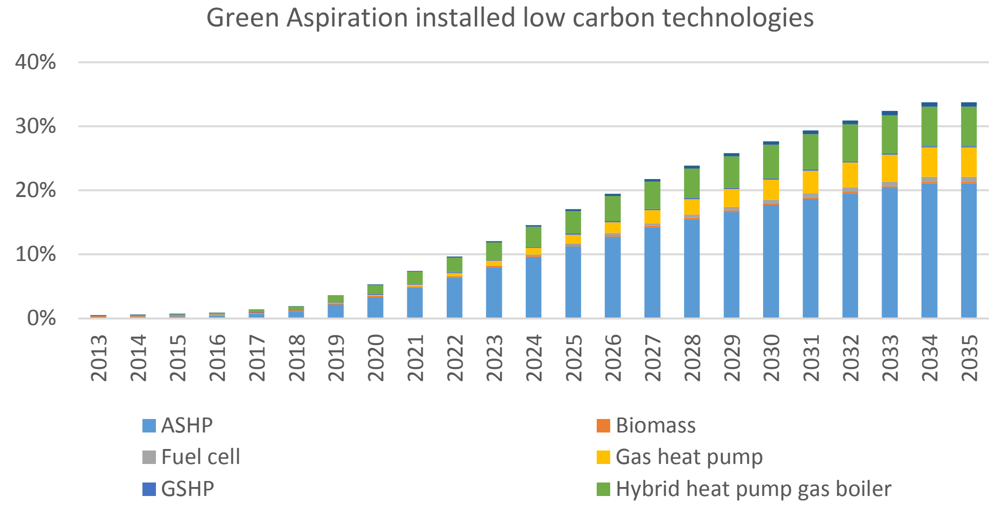

Figure 6-18 Installed low carbon heating technologies (Green Aspiration)

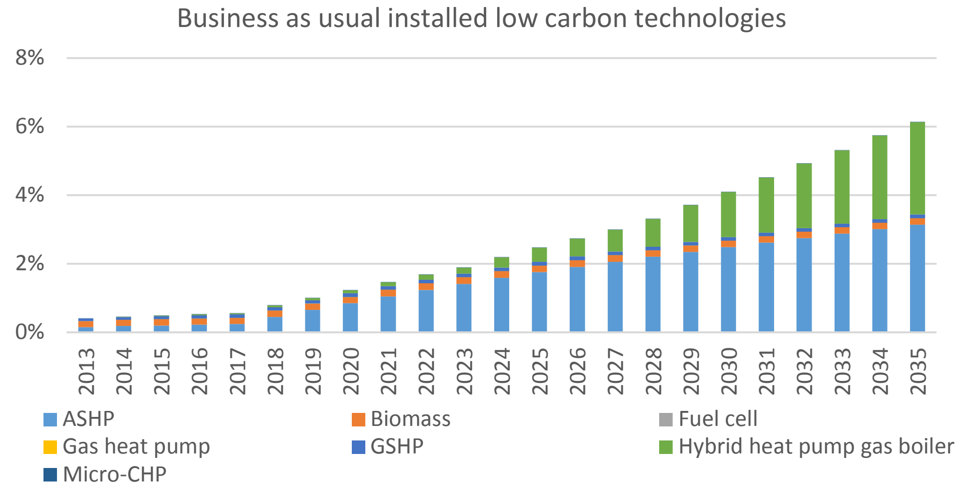

Figure 6-19 Installed low carbon heating technologies (Business as usual)

Domestic Energy Demand

Domestic Demand is directly related to the increase in households and the increase in retrofit measures to improve existing stock.

The energy demand for existing stock depends on the increase in the number of households. New stock is assumed to have better energy performance benchmarks (taken from Code the Sustainable Homes (CfSH). Existing stock is upgraded through retrofit measures.

The electricity demand from the current existing housing stock increases in both scenarios towards 2035. In GM Green Aspiration there is an acceleration after 2020 due to households moving away from gas and towards electrical heating. The greater uptake of EVs also contribute to the increases electricity demand in the GM Green Aspiration scenario.

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The projected gas consumption reduces in each scenario with the low carbon scenario decreasing at a faster rate.

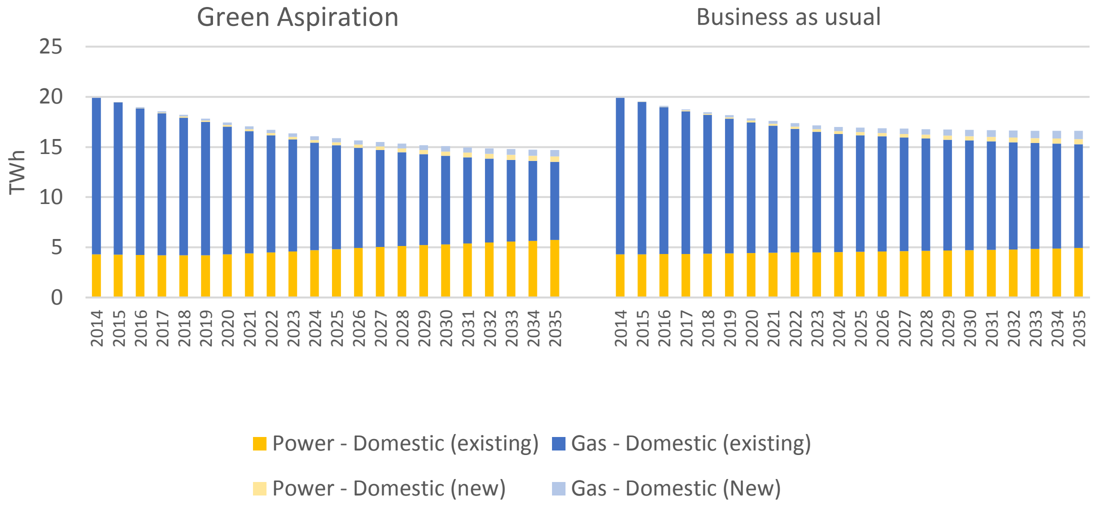

Figure 6-20 Domestic total energy consumption

The total consumption reduces in both scenarios but by a greater amount in GM Green Aspiration. The proportion of electricity increases in the GM Green Aspiration as heating systems move to electrical heat pumps.

In both scenarios the contribution of new stock to the total energy consumption is small. In 2035 the new stock consumes around 1 TWh (8.6 %) in GM Green Aspiration and 1.3 TWh (8.8 %) in GM business as usual. The most significant difference in the 2 scenarios is in the reduction in gas consumption in existing stock. This comes about through retrofitting energy efficiency measures and a conversion of gas to electric heating.

'Green Aspiration' shows a reduction of 22 % in fuel consumption over the 'business as usual'

Non-domestic Energy Demand

Non domestic energy demand depends on the change in floor space for each of the commercial and industrial sectors. New floor space is assumed to have good energy efficiency benchmarks (aligned with CIBSE TM46 and Guide F) with existing floor space having an annual improvement applied as per the FES model.

In the GM Green Aspiration scenario, the electricity demand reduces as the demand from industrial stock decreases and old properties are retrofitted to be more efficient. In business as usual less efficiency measures are fitted and the improvements are outstripped by increases in power usage due to a greater demand from electrical equipment, IT and cooling.

The gas consumption decreases in both scenarios due to the change of heating to electric sources and due to increases in boiler efficiency from replacement and control systems, and retrofit building fabric measures that reduce heating demand.

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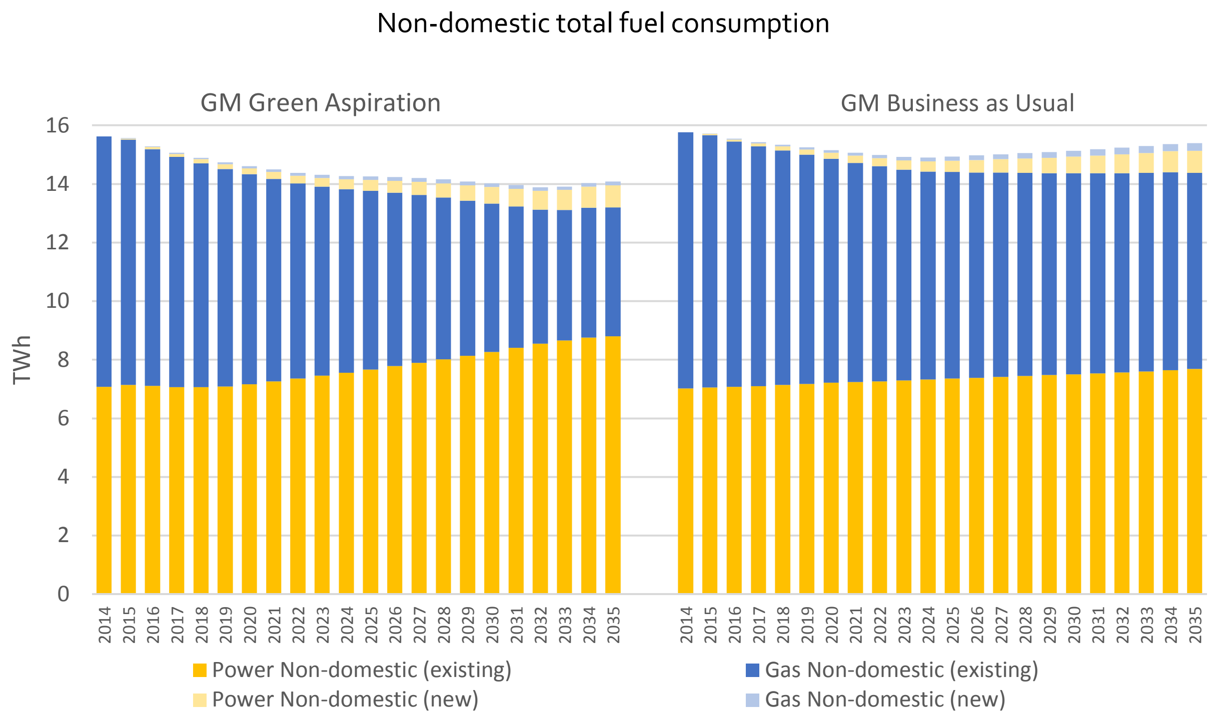

Figure 6-21 Non domestic total projected fuel consumption

In Green Aspiration the total fuel consumption decreases until around 2033 when it starts to increase as efficiency measures are no longer outpacing new demand. In the business as usual scenario the total fuel consumption decreases up to 2024 then increase out to 2035.

In the Green Aspiration the total fuel consumption is 14.1 TWh in 2035 compared to 15.4 TWh in the business as usual scenario this is 8 % lower. The new stock is a small contributor to the total demand by 2035, 6.7 % in Green Aspiration and 7 % in Business as Usual.

6.4.4 Supply

Power

Each of the FES scenarios provide a projection of the carbon intensity of national supplied electricity. The majority of the initial reduction of carbon intensity is from the reduction of coal fired power stations in both scenarios. After 2020 the two scenarios diverge with the Gone Green scenario adding nuclear and offshore wind in large quantities. The low carbon scenario (Gone Green) reduces emissions meeting carbon targets out to 2050 with the grid decarbonised by 2050. The No Progression scenario makes little progress once the coal fired power stations go off line, and relies on gas as the main baseload provider.

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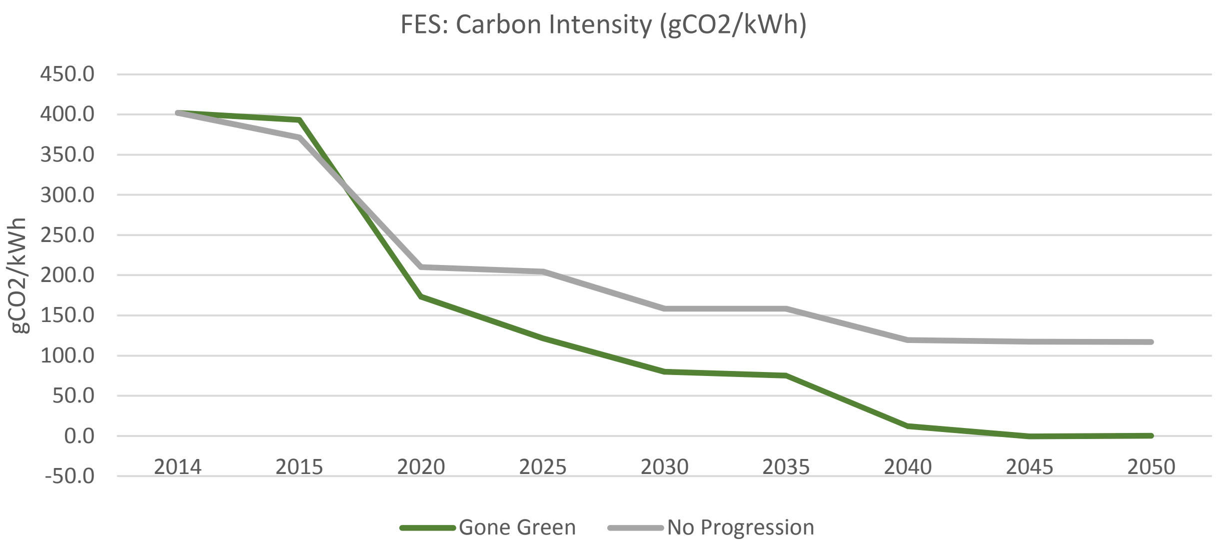

Figure 6-22 Carbon Intensity

6.4.5 Transport

The transport sector is extremely challenging to decarbonise.

The current petrol/diesel infrastructure is likely to supplemented with a range of fuels, including electricity, hydrogen and gas alongside existing fuels. Light vehicles are likely to become more electric with heavy goods moving to gas hybrid engines. Hydrogen may play a part in the future transport system. How quickly and to what extent these changes happen is driven by a wide range of factors.

DECC

Each year DECC publishes updated energy projections (UEPs) (DECC 2016), analysing and projecting future energy use and greenhouse gas emissions in the UK. The projections contain a number of potential scenarios and the outputs are available by sector.

The 2 used here are

- The reference scenario

DECCs reference scenario is based on central estimates of economic growth and fossil fuel prices. It contains all agreed policies where decisions on policy design are sufficiently advanced to allow robust estimates of impact (i.e. including "planned" policies).

- High price scenario

The high price scenario contains assumptions similar to reference scenario but with higher projected fossil fuel prices.

The DECC projections cover to 2035. Beyond this date data has be extrapolated on an exponential growth basis.

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ESME covers the whole energy system for the UK, meaning the ETI can look in detail at possible designs for infrastructure, supply and end-use technologies for heat, electricity, personal transport, freight and industry.

Using the extracted figures form transport outputs for each of the two scenarios, clockwork and patchwork, a picture can be formed of a possible carbon reduction plan that would assist in a green aspiration scenario.

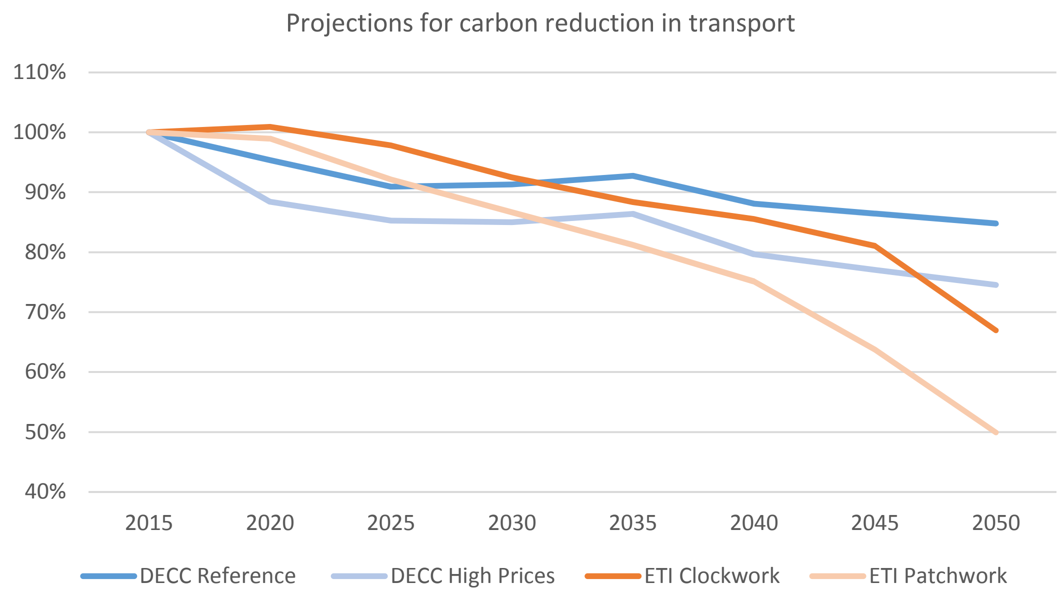

Figure 6-23 Transport carbon projections

Business as Usual

In the GM business as usual scenario the carbon emissions from transport have been taken from DECCs transport carbon projections (DECC 2016). The reference scenario has been used as this represents the lowest carbon reduction path.

Green Aspiration

For the GM Green Aspiration scenario the projections from the ETI patchwork model have been used. This represents the best case carbon reduction path and will allow an understanding of the potential maximum reduction in emissions from transport.

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6.4.6 Carbon

By applying the FES grid carbon projections alongside the ETI and DECC projections, it is possible to create carbon projections based on the GM Green Aspiration future and GM business as usual scenarios.

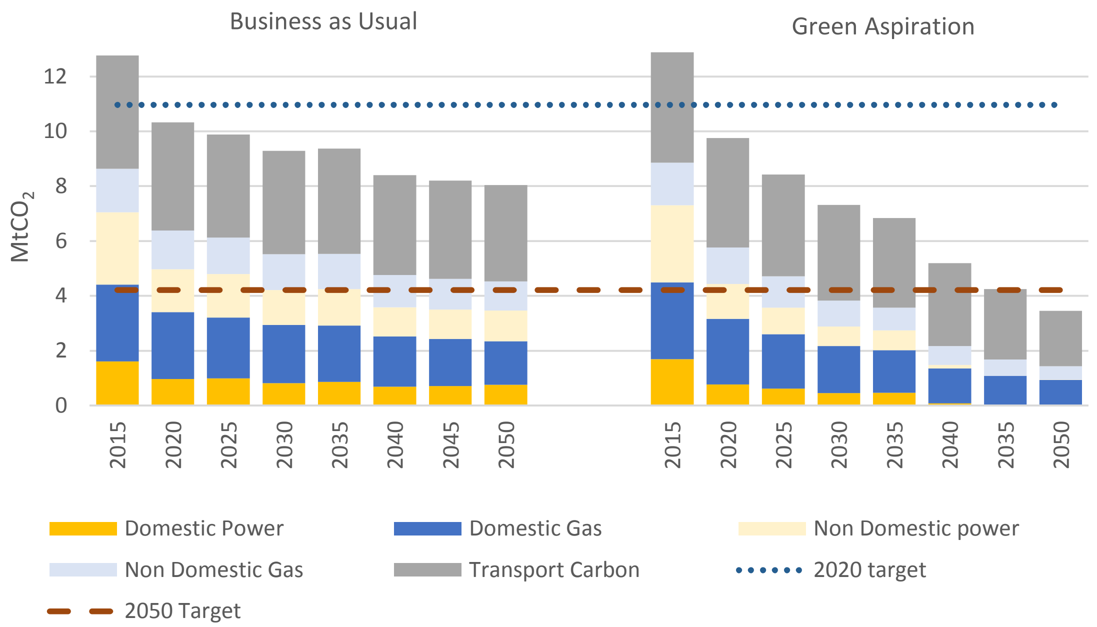

Figure 6-24 Carbon emissions from scenarios

Figure 6-24 gives the projected carbon emissions from each scenario. The Green Aspiration scenario has emissions in 2050 at a level of 43 % of the business as usual scenario and exceeds the target reductions.

In GM Business as usual the 2020 target is reached, but the 2050 target is missed by a $4MtCO_2$. In 2050 the project carbon emissions are $8MtCO_2$ with 44 % coming from the transport sector. The failure of the grid to decarbonise and a large amount of residual gas in the system means that the carbon from the building stock is slightly more than the carbon from transport with 29 % from the domestic sector and 27 % from the non-domestic sector.

In GM Green Aspiration the 2050 target is reached (3.4 $MtCO_2$ in 2050 compared to the $4.2MtCO_2$ target) , with the grid completely decarbonising and the residual gas demand reducing enough that the emissions remain close to the 2050 target despite significant emissions from the transport sector which make up 58 % of all emission in 2050. The domestic sector with 27 % is emitting almost double that of the non-domestic sector (14 %).

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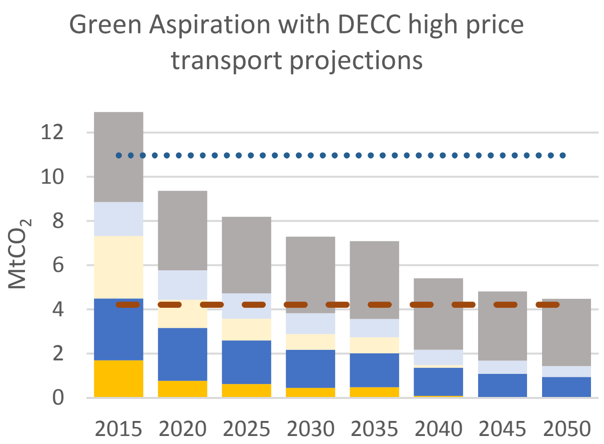

Figure 6-25 Carbon emissions in Green Aspiration Scenario

Figure 6.25 shows the impact of a different transport carbon reduction has on achieving the overall target. The 2050 target is just missed if the carbon from emissions follows the DECC high price scenario.

6.4.7 Summary

The scenarios show that given an aggressive decarbonisation of the grid alongside improved efficiency of existing stock, through retrofitting fabric and heating system measures the carbon targets are achievable, if challenging.

Business as usual is not an option if targets are to be achieved. Due to the difficulty in reducing carbon emissions from the transport sector, the built environment must do much more than just reach 80 % reductions. A heavy reliance on a decarbonised electricity grid is an important part of GMs low carbon transition but reducing and decarbonising heat particularly in existing buildings will be critical.

6.5 Areas of opportunity

The data collated in this report allows the identification of a number of opportunity areas within GM that may be used to inform planning policy. These are areas that have high energy use, fuel poverty or other potential considerations. These can be laid alongside the opportunities for district heat, new build and retrofit schemes.

Planning areas of significance will include a number of detailed areas where the following are true

- High fuel poverty
    - These are areas where more than 15 % of households are considered fuel poor. These are areas that would benefit from retrofit programs and low carbon technologies.
- Potential heat network
    - These are areas within 500m of a heat network. Heat networks can serve domestic and non-domestic properties and can act as a catalyst for upgrading of the energy performance of stock.
- Low EPC scores

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- o Areas of identified Low performing building stock.
- Off gas postcodes
    - o Areas that are off-gas are a good focus for energy efficiency measures and heat networks, as the existing heating systems are likely to be electrical or oil/LPG based.

This data is used to produce a series of opportunity areas that could be targeted for low carbon zoning or development.

In order to group areas, postcode level data has been captured from the previous mapping exercise. Any identified postcodes that were physically bordering were chosen in the same group, except in the densest area in the Manchester/Salford area where a border between areas was manual selected.

Outlying or 'island' postcodes were selected alongside the nearest largest cluster. Postcode islands with very low property counts (<50) were excluded from selection.

31 Zones were identified along with the number of domestic address within each and the non-domestic footprint areas (OSMM).

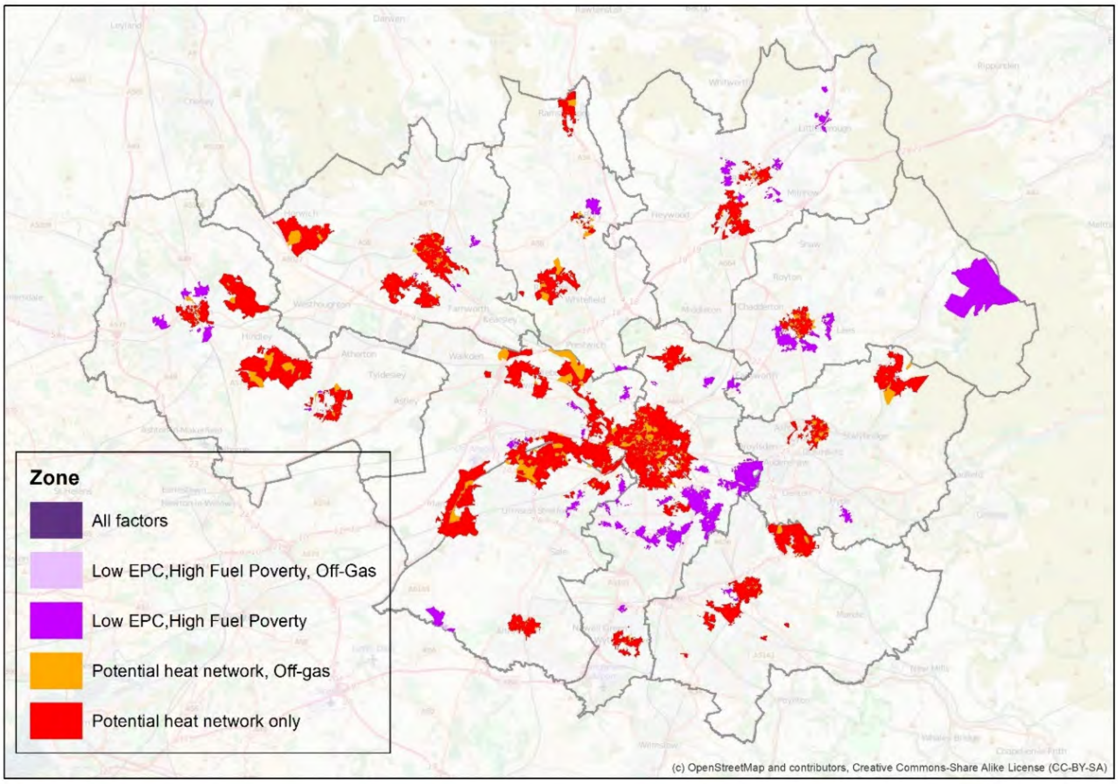

Figure 6-26 Identified postcodes with a combination of factors

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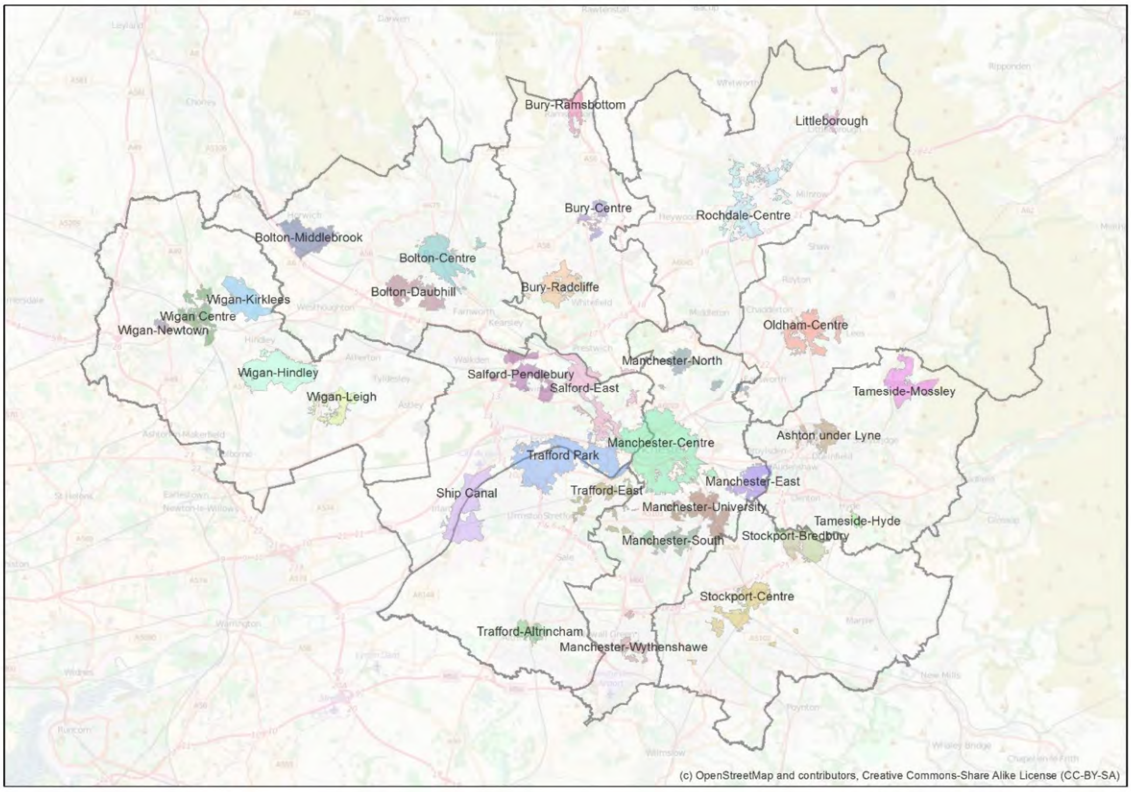

Figure 6-27 Identified opportunity zones

Table 6-3 Households and non-domestic footprint in zones

Zone	Domestic households	Non-domestic footprint (m2)	Description
1	1,174	16,848	Wigan-Newtown
2	2,843	715,743	Wigan Centre
3	1,303	172,357	Wigan-Kirklees
4	1,692	328,628	Bolton-Middlebrook
5	3,164	223,558	Wigan-Hindley
6	3,111	322,184	Wigan-Leigh
7	5,344	152,732	Bolton-Daubhill
8	5,005	663,675	Bolton-Centre
9	1,977	161,189	Bury-Centre
10	5,186	505,125	Rochdale-Centre
11	1,292	22,532	Bury-Ramsbottom
12	4,051	110,693	Bury-Radcliffe
13	3,810	61,590	Ship Canal

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14	4,965	242,888	Salford-Pendlebury
15	3,063	67,576	Tameside-Mossley
16	8,495	446,701	Oldham-Centre
17	2,217	313,674	Ashton under Lyne
18	937	14,789	Tameside-Hyde
19	2,215	236,053	Stockport-Bredbury
20	7,099	384,523	Stockport-Centre
21	2,460	89,092	Manchester-Wythenshawe
22	2,344	147,882	Trafford-Altrincham
23	6,778	39,019	Manchester-East
24	11,562	174,079	Manchester-University
25	6,381	71,497	Manchester-South
26	6,586	177,929	Trafford-East
27	3,496	127,639	Manchester-North
28	5,563	350,206	Salford-East
29	8,698	1,441,053	Trafford Park
30	23,354	2,609,308	Manchester-Centre
31	822	28,491	Littleborough

The top 5 zones by number of domestic properties and non-domestic footprint provide 8 opportunity areas, with Manchester Centre and Trafford Park being in the top 5 of each category.

Table 6-4 Opportunity areas

Opportunity area	Domestic households	Non-domestic footprint (m2)
Manchester-Centre	23,354	2,609,308
Manchester-University	11,562	174,079
Trafford Park	8,698	1,441,053
Oldham-Centre	8,495	446,701
Stockport-Centre	7,099	384,523
Wigan Centre	2,843	715,743
Bolton-Centre	5,005	663,675
Rochdale-Centre	5,186	505,125

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These 8 zones cover 6.9 million m^2 of non-domestic footprint, and 72,242 domestic properties. These will be some of the most inefficient and fuel poor households. This covers around 5 % of the total households within Greater Manchester.

6.5.1 Manchester Centre

Manchester centre has off gas properties and district heat potential as well as a high number of both domestic properties and non-domestic footprint. This makes the city centre a very important area with respect to energy efficiency measures and installation of low carbon technologies.

Domestic Properties: 23,354

Non-domestic footprint: 2.6 Million m^2

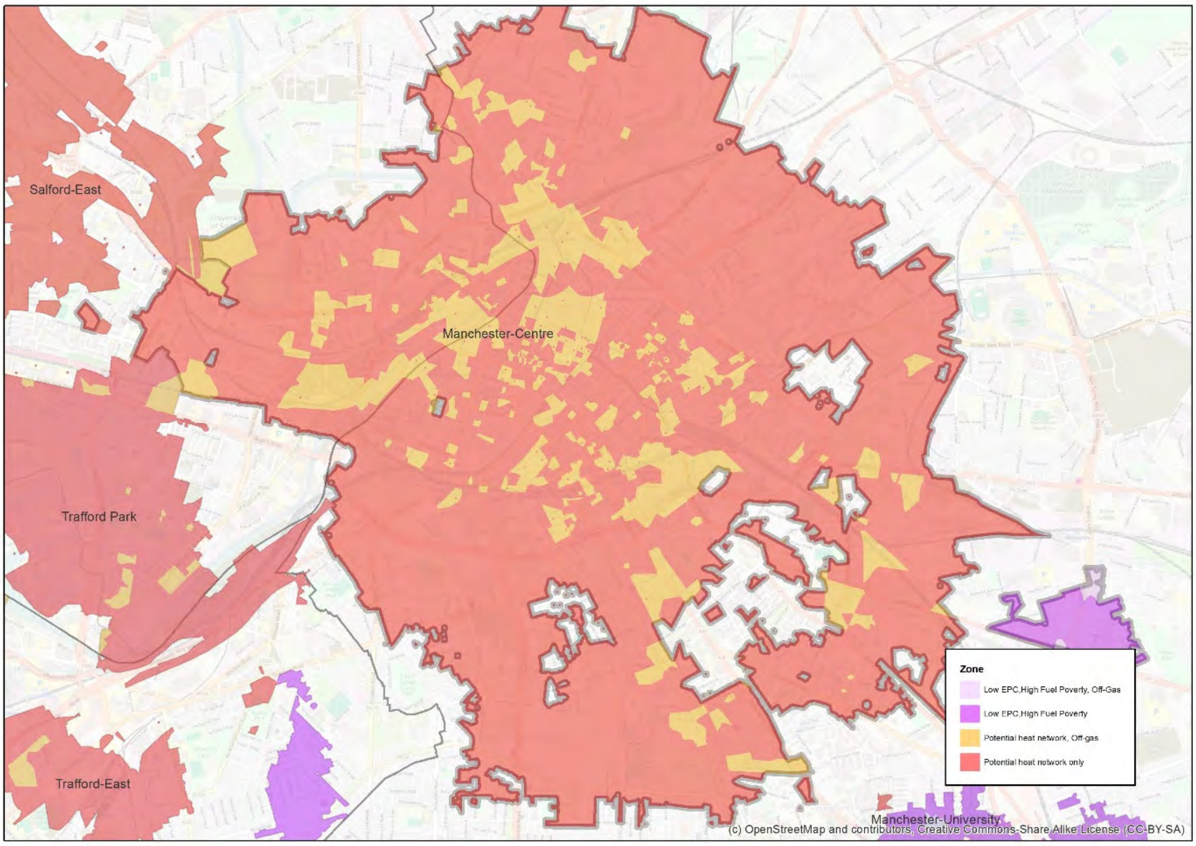

Figure 6-28 Manchester centre

6.5.2 Manchester University

The Manchester University cluster has a high proportion of households in fuel poverty along with badly performing housing stock. It has identified opportunities for heat networks and is not off gas.

Domestic Properties: 11,562

Non-domestic footprint: 174,000 m^2

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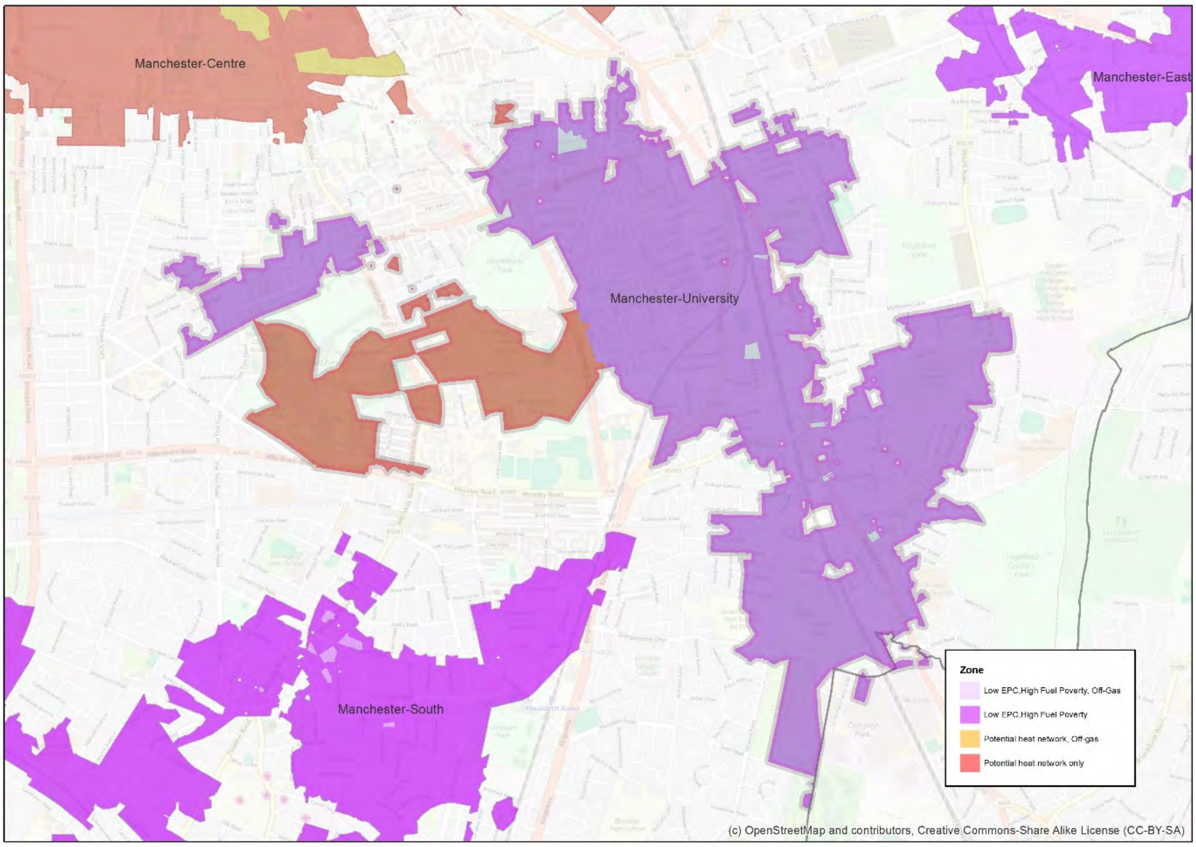

Figure 6-29 Manchester University

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6.5.3 Trafford Park

Trafford park has areas that are in fuel poverty with badly performing domestic stock, have heat network potential and are off-gas.

Domestic Properties: 8,698

Non-domestic footprint: 1.4 million m²

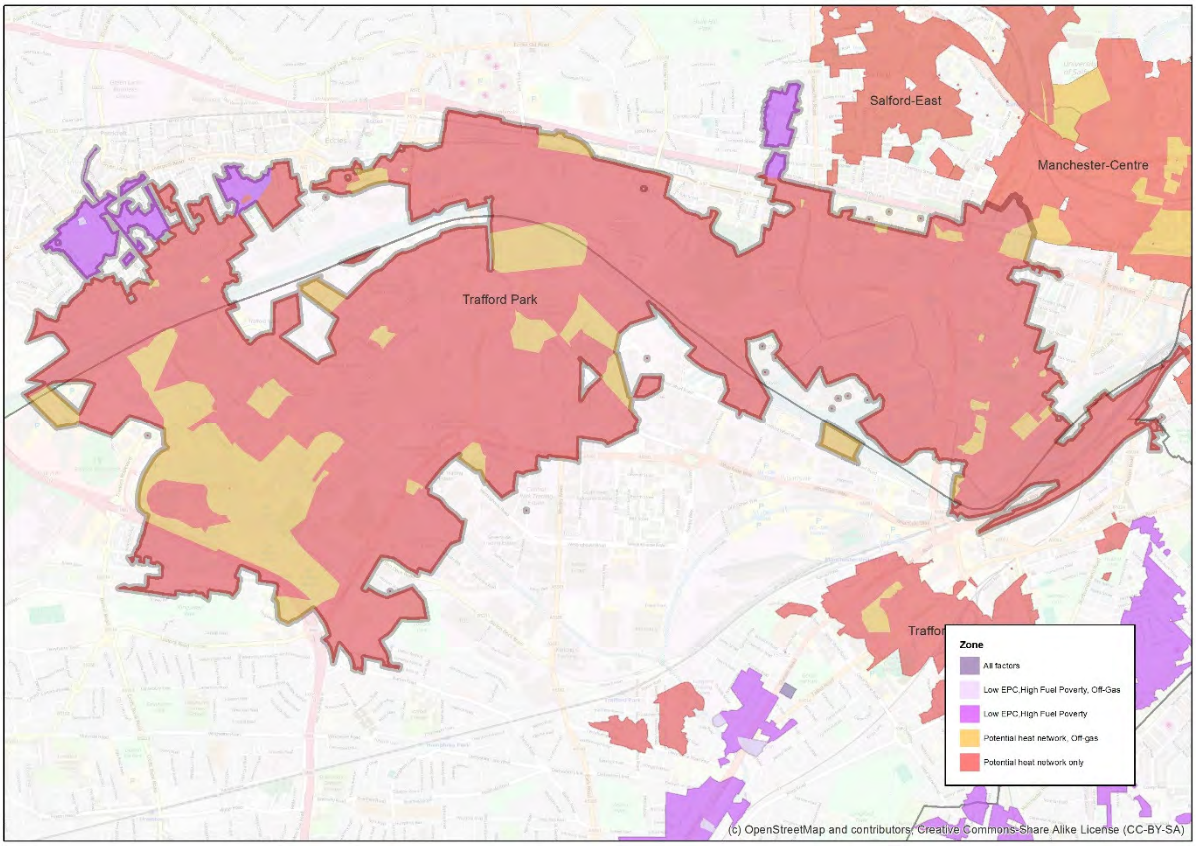

Figure 6-30 Trafford Park

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6.5.4 Oldham Centre

Oldham centre has large areas in fuel poverty as well as potential for heat networks, and a number of areas that are off-gas.

Domestic Properties: 8,495

Non-domestic footprint: 447,000 m²

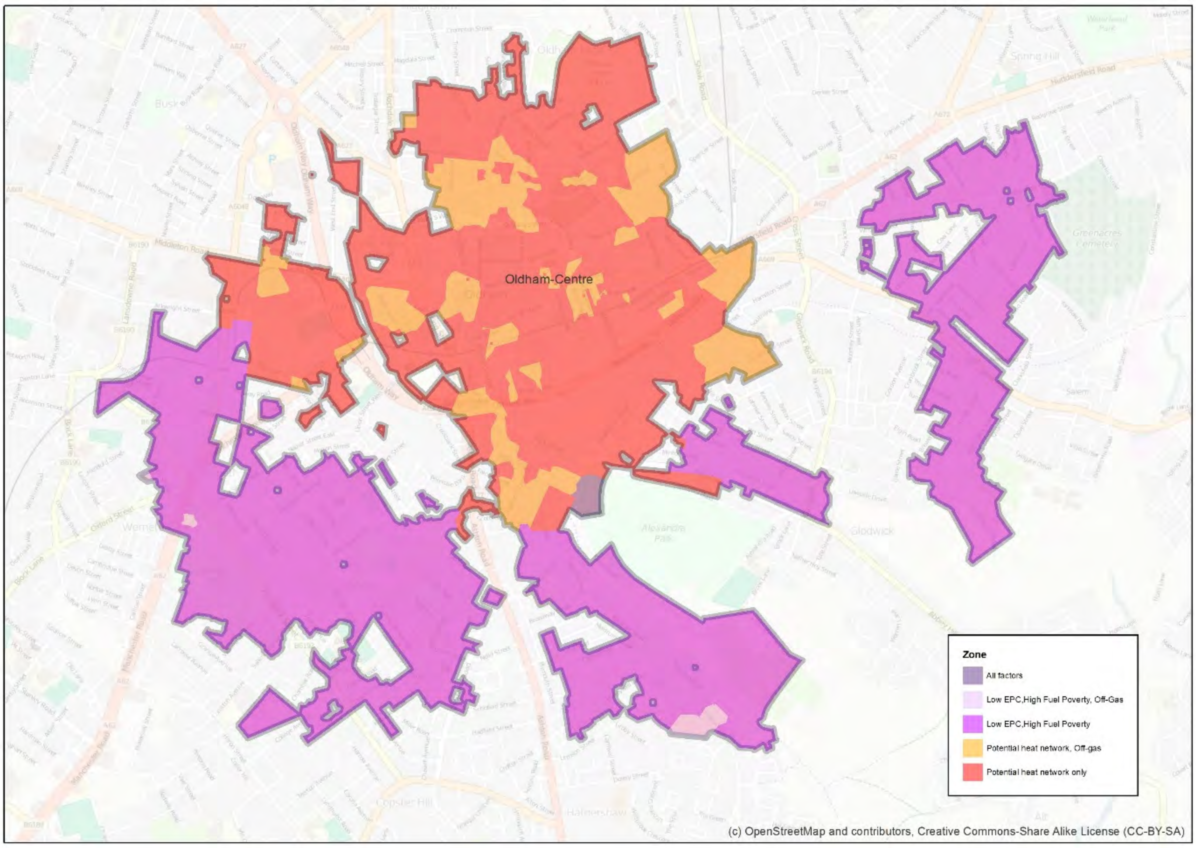

Figure 6-31 Oldham Centre

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6.5.5 Stockport Centre

Stockport centre has a small number of households in fuel poverty areas. The town centre has the potential for heat networks along with some areas of off-gas properties.

Domestic Properties: 7,099

Non-domestic footprint: 385,000 m²

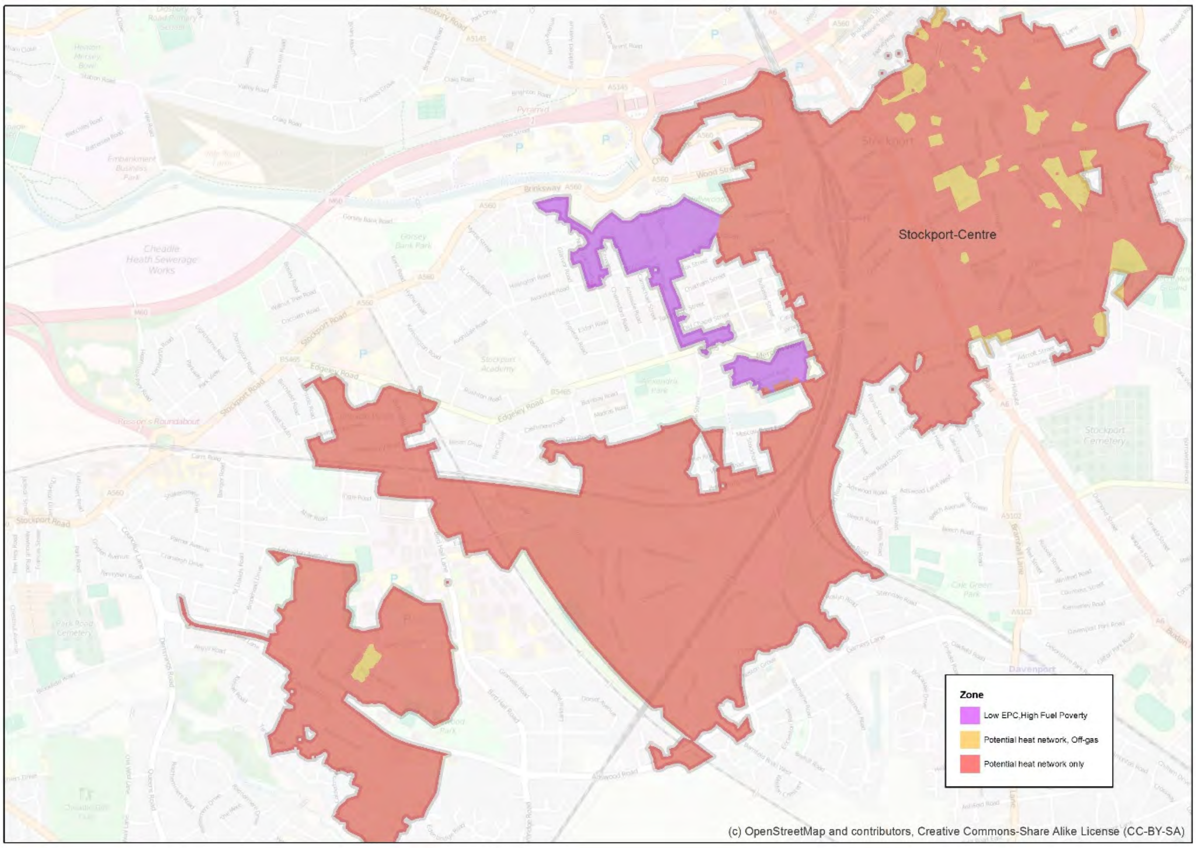

Figure 6-32 Stockport Centre

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6.5.6 Wigan centre

Wigan centre has a number of areas with a high proportion of households in fuel poverty, along with identified potential for heat networks. The areas without historical gas connections with the zone.

Domestic Properties: 2,843

Non-domestic footprint: 715,000 m²

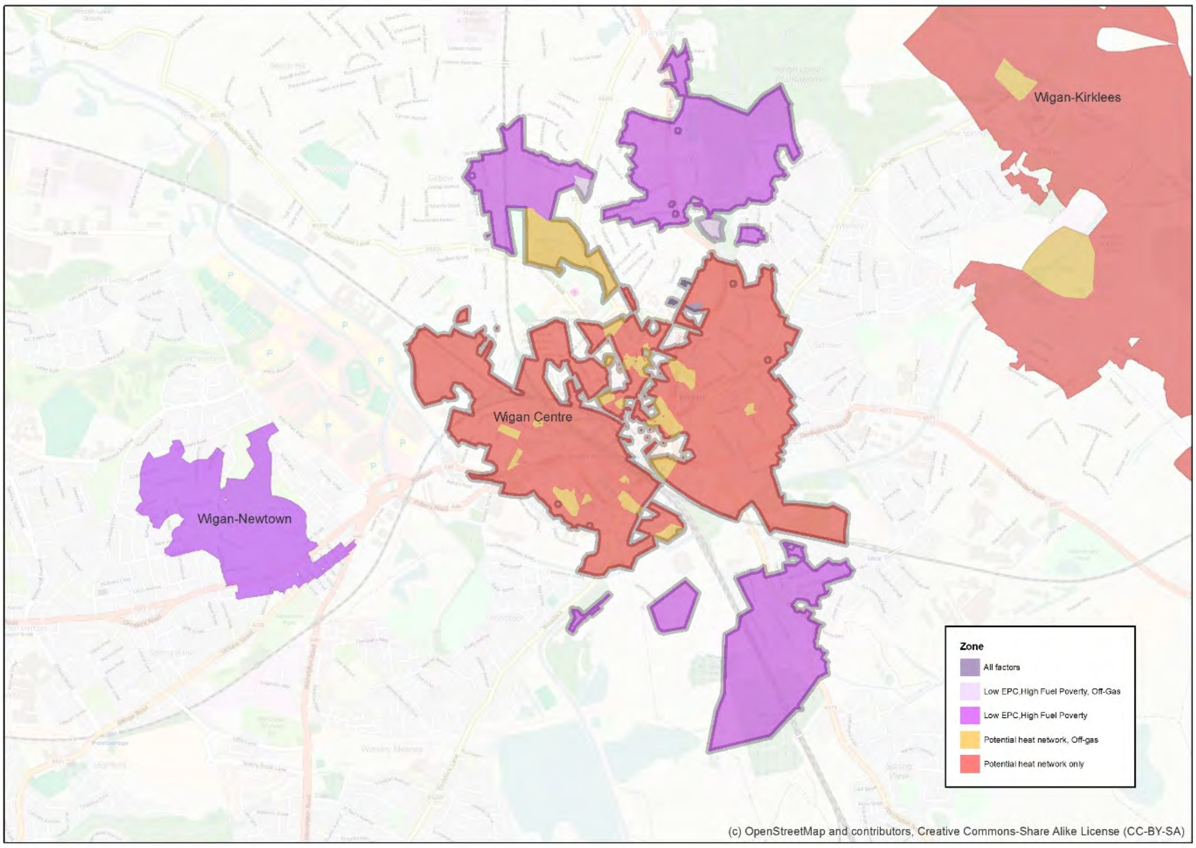

Figure 6-33 Wigan Centre

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6.5.7 Bolton centre

Bolton town centre has potential heat network opportunities, with some off gas properties. There are some outlying fuel poor areas that have been included.

Domestic Properties: 5,005

Non-domestic footprint: 664,000 m²

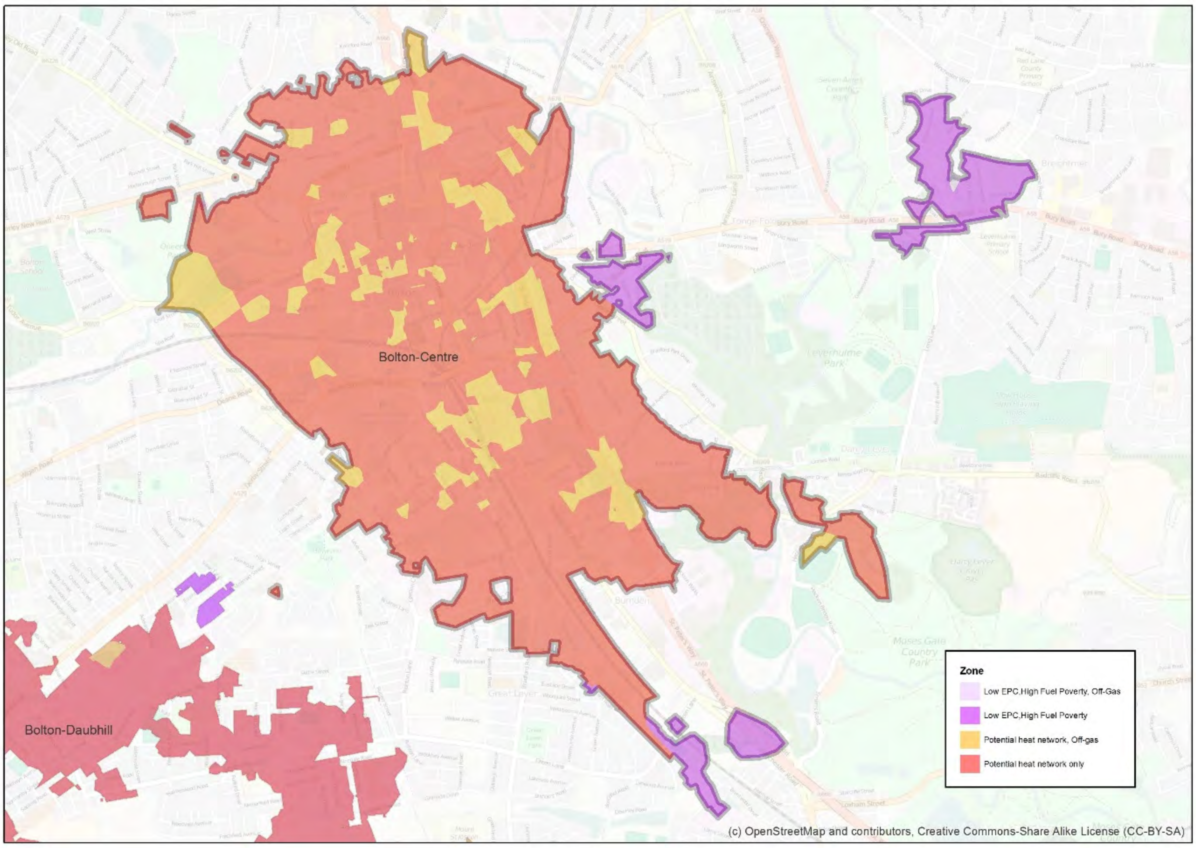

Figure 6-34 Bolton Centre

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6.5.8 Rochdale centre

Rochdale centre is a fragmented area with some areas of fuel poor and badly performing domestic properties. There are a number of potential district heat opportunities.

Domestic Properties: 5,186

Non-domestic footprint: 505,000 m²

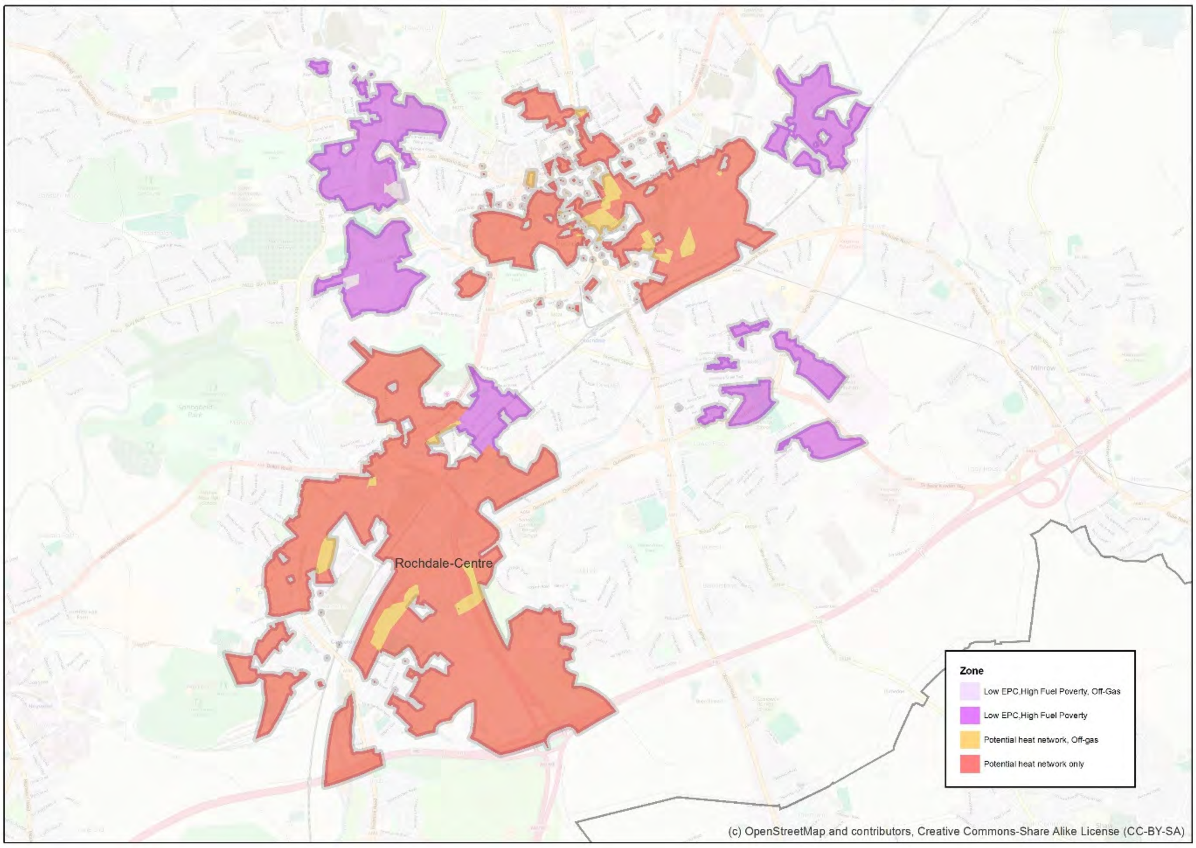

Figure 6-35 Rochdale Centre

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7 Conclusion

This section presents a summary of the key conclusions based on the results of the analysis presented in the report.

7.1 Energy Demand and Consumption

- *Greater Manchester is a significant energy consumer and there is a wide variation in energy use between its different districts. Gas is the principle fuel used for space and water heating and is the predominant fuel within GM making up 42 % of total energy consumption.*
- *Coal and oil still play a key part of the energy mix in some districts and around 5 % of homes in GM remain off- gas, often with poor thermal efficiency and high levels of fuel poverty. Electricity makes up 23 % of GM's total energy consumption.*
- *Projected growth in GM from new homes and non-domestic buildings is forecast to increase energy demand by around 3 % by 2035. New development within GM could also act as a catalyst for development and growth of low carbon energy infrastructure.*
- *There are opportunities to reduce existing energy consumption in the region and over 60 % of the domestic buildings in GM have low levels of thermal efficiency. It is expected that as much as 90 % of these buildings will still be in use in 2050. Some cost-effective retrofit measures to improve these homes thermal performance are likely to be needed as part of a low carbon transition.*

7.2 The Challenge of Climate Change

- *The UK has a legally binding target to reduce emissions of greenhouse gases by 80 % from 1990 levels by 2050 and the UK's fifth carbon budget has been set to reduce emissions by 57 % by 2030.*
- *National policy recognises the important role of spatial planning in meeting the challenge of climate change. Current energy consumption in GM results in total carbon emissions of 13.5MtCO2/yr (2014) and The GMCA has committed to achieving emissions reductions of at least 80 % by 2050 and has adopted a carbon target to deliver a 48 % reduction by 2020 against a 1990 baseline and 41 % by 2020 from 2005 levels.*
- *Achieving GM's long term decarbonisation ambitions will require significant changes to what types of energy are used as well as how, and when, they are used. Future energy sources must be secure, affordable and sustainable for GM to continue to grow. This will require action at both a local and a national scale and business as usual will not be sufficient.*
- *GM will be dependent on national action to decarbonise central generation of electricity. To meet long term carbon targets there will have to be a significant reduction in the use of gas. It is expected that buildings will have to change almost entirely to different sources of energy for heat and hot water.*
- *This is likely to include use of electrically powered heat in individual buildings and heat provided from central locations via district heat networks. The dense urban nature of some parts of GM means that there*

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are opportunities for growth of heat networks aligned with, and building out from, strategic development sites. In some areas there might be opportunities to provide heat to these networks using waste heat from industry.

- *Electricity will remain a core part of the energy system and is likely to be used increasingly for both heat and transportation posing significant challenges. It is expected that a significant proportion of GM's future electricity demand is likely to be met from the National Grid. The electricity network within GM has capacity to accommodate new demand although some areas have limited spare capacity and growth of decentralised renewables, electrification of heat and increased use of electric vehicles will all create increasing network pressures.*

7.3 Low Carbon and Renewable Energy

- *Recent years have seen a growth in installed renewable energy capacity stimulated by national policy initiatives. However, the opportunities for GM to generate low carbon electricity locally are constrained.*
- *Up to 9 % of GM's electricity could, technically, be generated locally using renewable sources. It is likely, however, that only a small proportion of this will be economically viable. Deployment could also be limited by the need to ensure reliable supply at all times.*
- *GM has seen increasing deployment of low carbon and renewable technologies in recent years, supported by policy and subsidy such as the Feed-in-Tariff and Renewable Heat Incentive. There remains significant technical potential for further deployment in support of GM carbon targets.*
- *The technologies with the highest technical potential to contribute to a new, low carbon energy system in GM include district heating, individual electric heat pumps, bio-fuels and solar technologies for both hot water and electricity. In each case the economic feasibility will need to be assessed to establish what is viable whilst maintaining security of supply and meeting decarbonisation targets.*
- *Effective planning for new networks will be needed to support roll out of district heating and to manage the transition from the predominant gas system in GM. Electrification of heating is also likely to require reinforcement of electricity networks with associated cost and disruption.*

7.4 Smart Systems

- *Smart energy systems and markets could empower both consumers and suppliers in GM to manage energy supply and demand more cost effectively and support a low carbon transition.*
- *GMs future energy systems might be better thought of as a constantly evolving supply chain where the primary driver is customer service. Consumers want the warmth, comfort and wellbeing that is provided by that energy. Innovation can enable consumers to make real choices around energy services, making them more likely to engage with the changes required to meet carbon reduction targets.*
- *The shift to lower carbon and decentralised energy provides an opportunity for innovative business models, governance and funding solutions to support energy systems change. Smart systems can enable an ecosystem to be established within which the consumer is empowered with data and control.*

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- *Deployment of new low carbon energy networks and buildings technologies in combination with smart systems can enable Local Authorities and communities to be active participants in the delivery of GMs future energy system.*

7.5 Future Policy Framework

- *Local policy including that defined within the emerging Greater Manchester Spatial Framework can support transition to a low carbon energy system. Devolution presents significant opportunity for GM to continue to be a low carbon innovation leader.*
- *GM needs to set an ambitious, and consistent, local carbon target for the region and individual Local Authority areas. There is a need to investigate specific transition pathways and identify near term low regret priorities through positive energy planning within individual districts.*
- *This must consider the complex interrelationship of existing buildings and all energy networks as well as local priorities and constraints which might influence future pathways. There should be a clear focus on development of cost effective energy strategies for individual districts that can utilise smart systems to support a consumer and community driven low carbon transition.*

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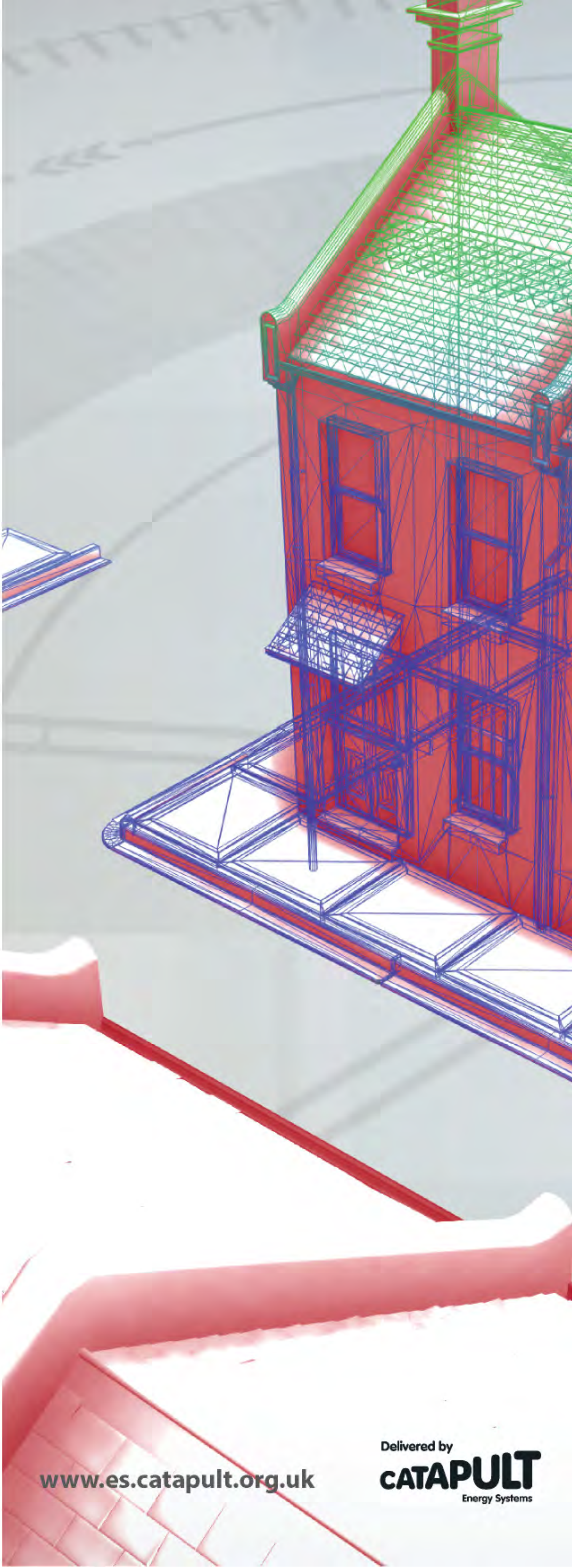

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