Programme Area: Smart Systems and Heat

Project: WP2 Manchester Local Area Energy Strategy

Title: Greater Manchester Spatial Energy Plan: Evidence Base Study

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.

Greater Manchester Spatial Energy Plan: Evidence Base Study

energy technologies institute

Delivered by CATAPULT Energy Systems

The Energy Systems Catapult and Energy Technologies Institute would like to thank the contributors to this report including the Greater Manchester Combined Authority New Economy and Planning Departments, Electricity North West, Encraft and Jones Lang LaSalle.

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About the Greater Manchester Combined Authority

The GMCA is made up of the ten Greater Manchester councils and Mayor, who work 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, like transport, regeneration, and attracting investment.

About the Energy Technologies Institute

The Energy Technologies Institute is a public-private partnership between global energy and engineering companies and the UK Government. Its role is to act as a conduit between Academia, Industry and the Government to accelerate the development of low carbon technologies.

Focussing on targeted commercial investments in technology programmes across heat, power, transport and the infrastructure that links them, the Energy Technologies Institute brings together engineering projects that develop affordable, secure and sustainable technologies to help the UK address its long term emissions reductions targets as well as delivering nearer term benefits.

About the Energy Systems Catapult

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

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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) currently 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, some heating 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.*

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 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 using local 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 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.

* This includes international shipping, but not aviation.

Executive Summary

In some areas there might be technical potential 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 a whole 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 technical 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 electricity can transfer energy between seasons and could have an important role to play in any future smart energy system.

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 consumers 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.

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. 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 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.

GM uses
3%
of total UK energy use.
There is wide variation in energy use across districts.

CO_2
Opportunity for GM to be a low carbon leader.

Manchester is highest energy consumer.
Oldham is lowest energy consumer.

Decarbonisation will require significant change.
Business as usual will not be sufficient.

5%
of homes are off-gas.
Typically, in areas of poor thermal efficiency and high fuel poverty.
Based on postcode areas

Heating accounts for
42%
of energy consumption.
Domestic and non-domestic space heating and hot water

Energy use and heating of existing buildings is a major challenge and requires positive policy and new consumer focused business models.

Future growth in GM could increase energy demand by 3% by 2035 assuming current energy efficiency standards and consumption trends.

Ambitious and consistent local carbon targets are needed supported by evidence based local area energy planning.

9% of electricity demand could technically be met from GM renewable sources.
Varied potential for renewables across districts.

Potential increasing role for district heating, bio-fuels, heat pumps and solar technologies.

Smart energy systems could empower both consumers and communities in GM.

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[1]. 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[2].

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[3].

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[4].
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 sensible to plan now to keep open the possibility of near-full decarbonisation of both buildings and surface transport by 2050.

1 https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/bulletins/subnationalpopulationprojectionsforengland/2014basedprojections/relateddata
2 http://www.compactofmayors.org/press/the-compact-of-mayors-alliance-of-peaking-pioneer-cities-sign-mou-2/
3 https://www.theccc.org.uk/publication/the-fifth-carbon-budget-the-next-step-towards-a-low-carbon-economy/
4 https://documents.theccc.org.uk/wp-content/uploads/2015/11/Fifth-Carbon-Budget_Ch3_The-Cost-effective-path.pdf

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.

Proportion of GM energy consumption by sector

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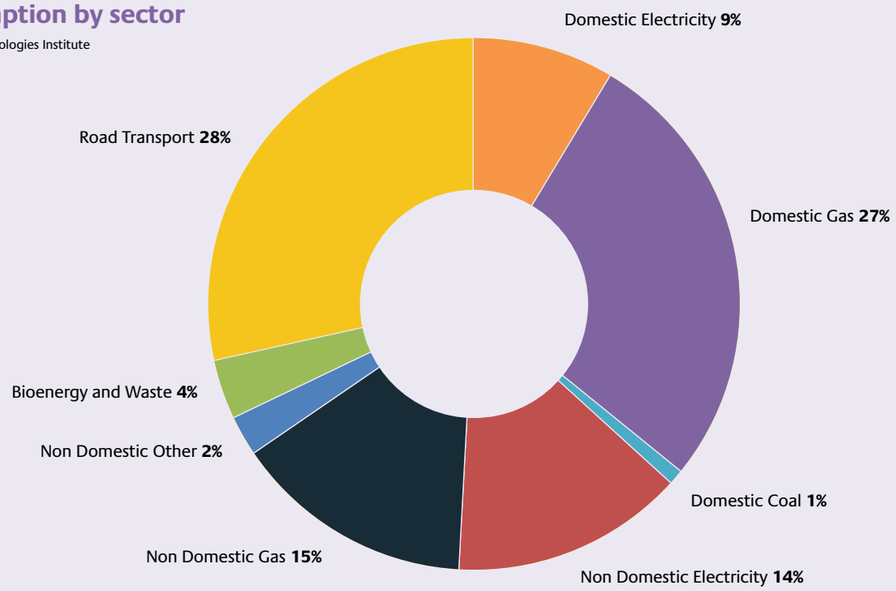
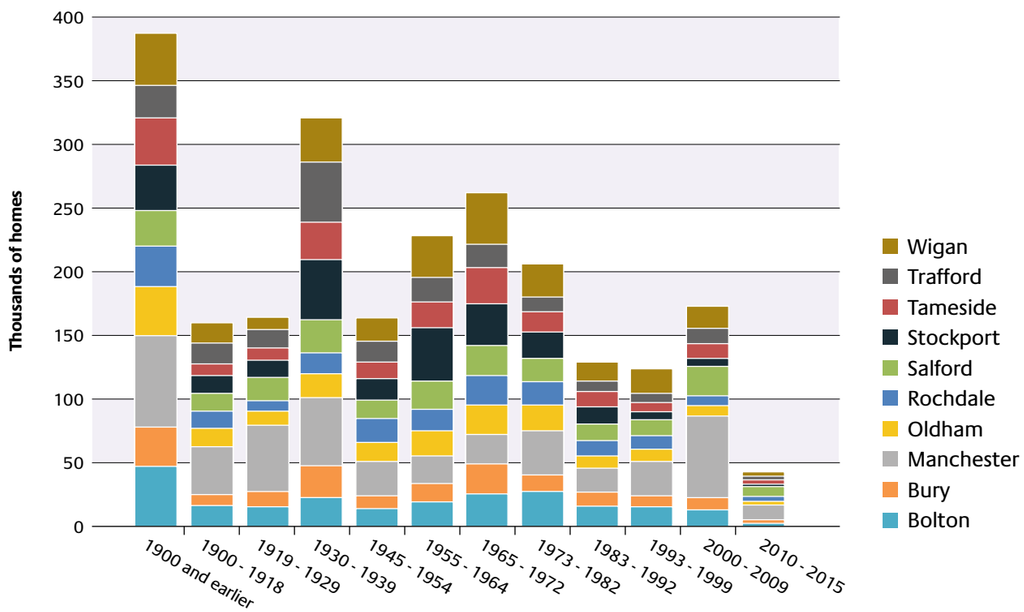


- Homes in GM account for **37%** of energy demand and the non-domestic sector **35%**.
- There is a wide variation in domestic and non-domestic energy demand by district with Manchester being the largest energy consumer.
- **Space Heating and Hot Water** are estimated to account for **77%** of domestic 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.

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.

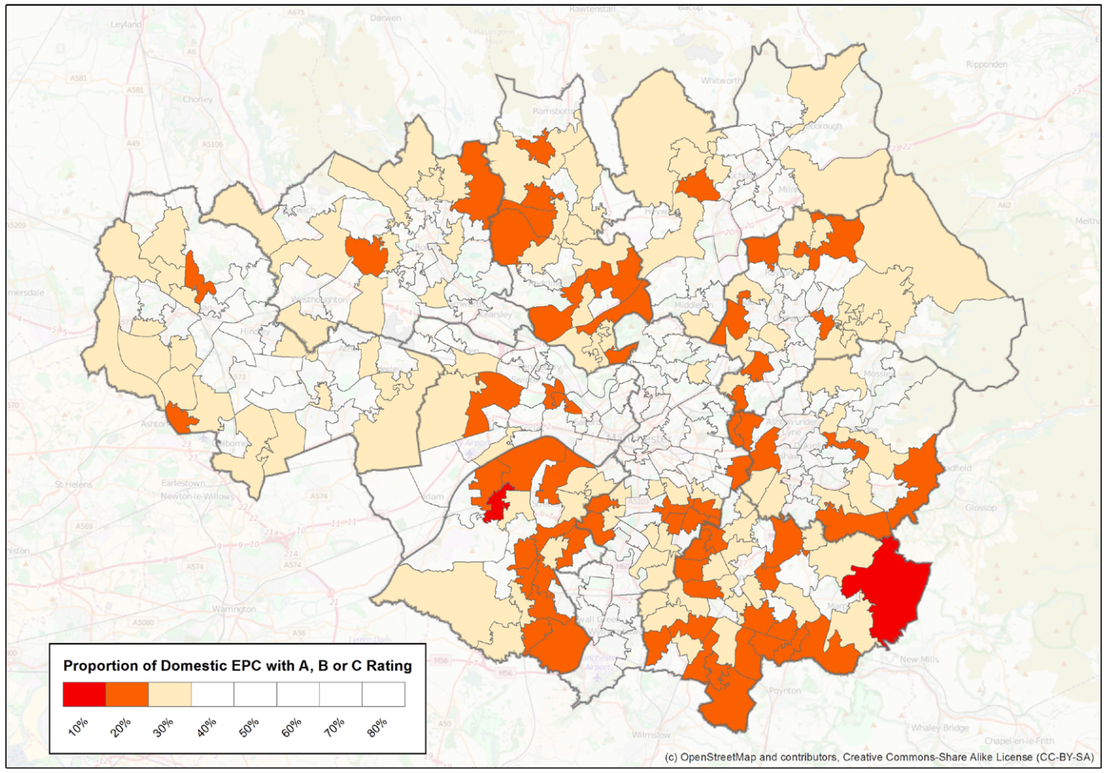
- GM Housing stock is predominately **pre 1980s**, with **Manchester** and **Salford** having the largest proportion of newer stock, **Trafford** and **Stockport** the largest proportion of older stock.
- **126,000 GM households** are estimated to be in **fuel poverty**[5] with the greatest areas of 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[6]. 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.

Ages of GM domestic properties by district



5 https://www.gov.uk/government/statistics/annual-fuel-poverty-statistics-report-2015
6 DCLG figure quoted in http://www.lcmp.eng.cam.ac.uk/wp-content/uploads/081012_kelly.pdf

- 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 a more significant 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[7]. Almost three quarters (67%) of domestic properties have an Energy Performance Certificate (EPC).



- 48% of public buildings (out of 2,053 buildings[8]) 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.

7 Based on % of homes achieving an EPC rating of A, B and C
8 https://www.gov.uk/government/statistical-data-sets/live-tables-on-energy-performance-of-buildings-certificates

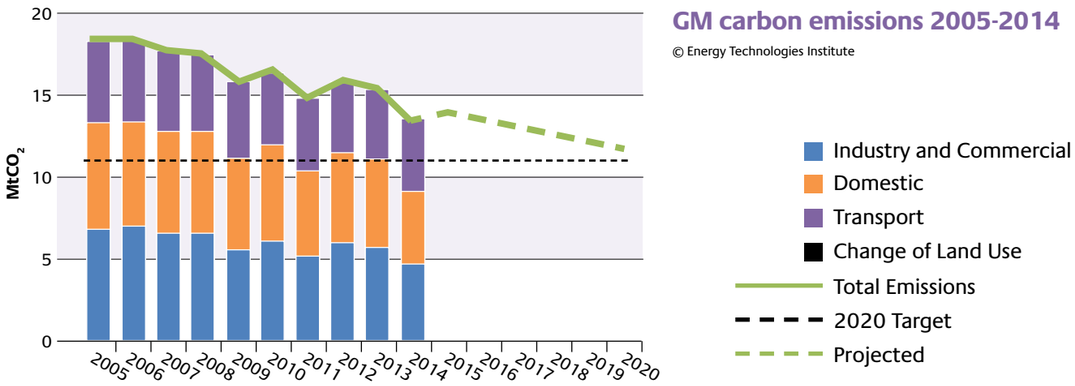
The UK has a legally binding target to reduce emissions of greenhouse gases by 80% from 1990 levels by 2050.

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.
- 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[9].
- There is a wide variation in domestic and non-domestic energy demand and associated carbon emissions by district with Manchester being the largest emitter.

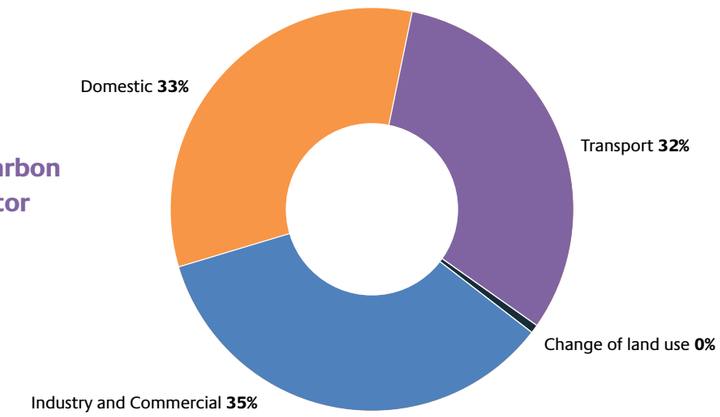
GM carbon emissions 2005-2014

© Energy Technologies Institute



Proportion of carbon emission by sector

© Energy Technologies Institute

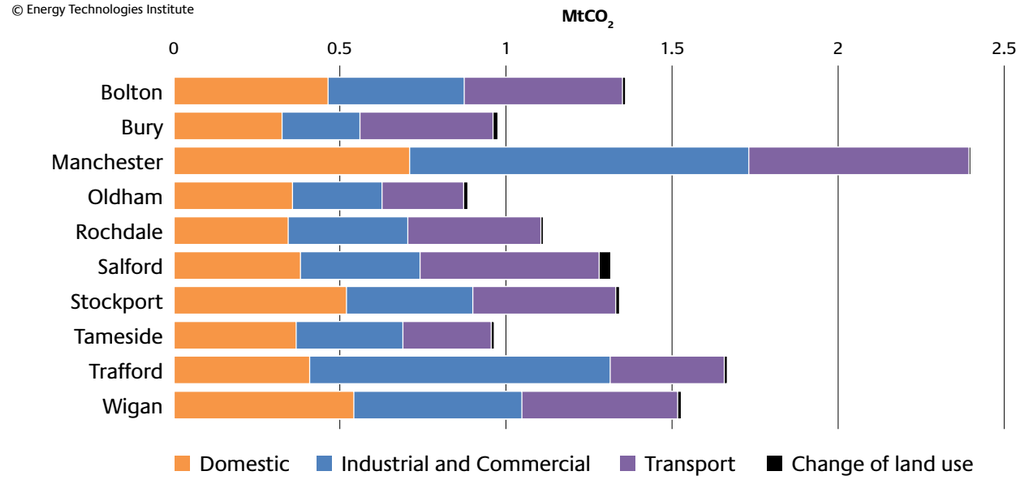


9 Change of land use

Summary Report
1.2.3 Carbon Emissions

GM carbon emission by district

© Energy Technologies Institute

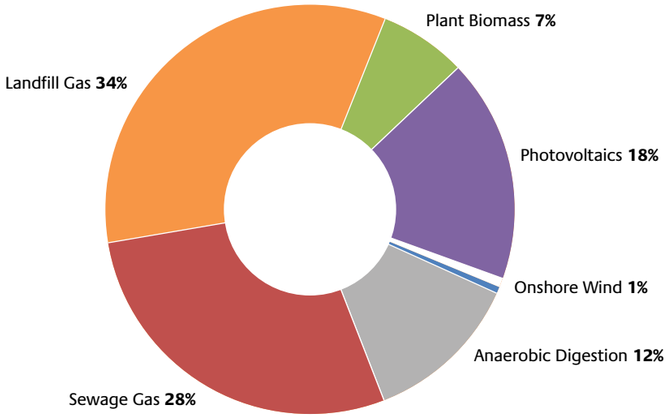


- The capacity of GM's electricity network to accommodate increased demand is considered **generally robust.** There are a number of areas with **limited capacity** to accommodate new demand[10]
- The Entire North West region has **221 MW** of accredited non-domestic renewable heat capacity installed[11] equivalent to 10% of the UK total as of March 2016.
- GM currently has **29 MW** of installed renewable heat capacity and **140 MW** of installed renewable electricity capacity.
- The majority of regional renewable electricity generation in GM is from Landfill, sewage and AD gas (74%).

10 Data from Electricity North West (ENW)
11 Accredited installation claiming the renewable heat incentive (RHI) at March 2016

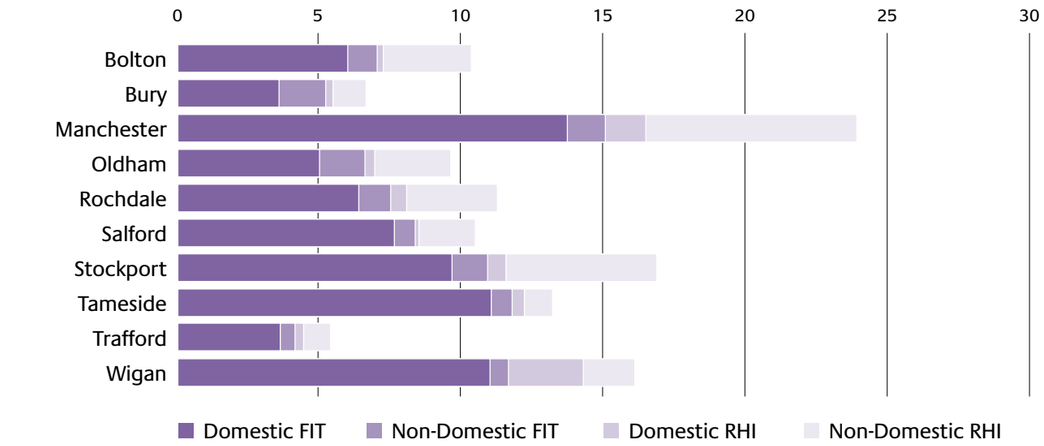
1.2.3 Carbon Emissions

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.

Accredited FIT and RHI capacity (MW)



- 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 currently identified networks that could connect 6,000 households (0.01% of existing households)[12] and a number of non-domestic properties. 161,000 households are within 500m of an identified potential heat network.

12 Heat network masterplan for Greater Manchester, Ramboll 2014

1.3 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 m² 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 **0.4 $MtCO_2$/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[13]. New development could act as a catalyst for establishing new energy centres and decentralised heat infrastructure when located in areas of opportunity.

13 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

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 enegy 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.

- **Ground Source** and **Air Source Heat Pumps** have the technical potential to contribute to **12,400 GWh/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. 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[14].

- **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[15]. 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[16] 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[17] GM Wind power generation currently delivers **2.2 GWh/yr** and has the technical potential to increase and provide a further **140 GWh/yr** focused principally in **Bury** and **Oldham**.

14 https://www.greatermanchester-ca.gov.uk/news/article/52/greater_manchester_smart_energy_project_hits_halfway_mark
15 URBED, AECOM and Quantum Strategy and Technology (2010)
16 Technical potential is that identified through standard DECC methodologies or further specific studies
17 DUKES

Summary Report
1.4 Low Carbon and
Renewable Energy Potential

- **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[18].

- 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**[19].

- 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 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**[20] 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%)**.

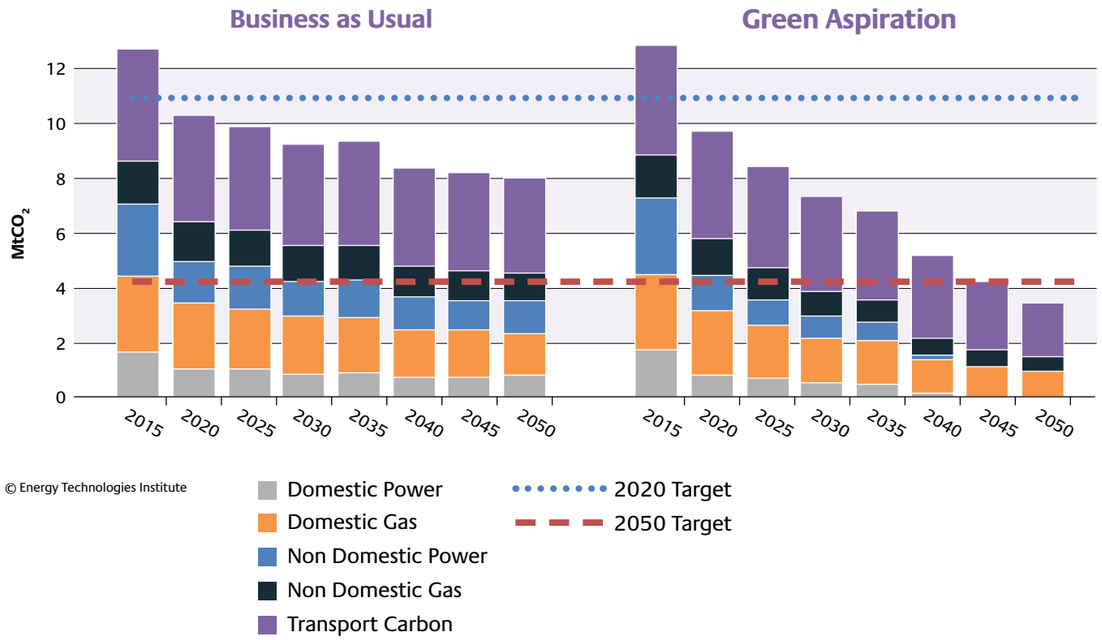
- District Heating provides an opportunity to utilise recovered surplus waste heat from industry, power stations and waste incinerators. The **North West** technical potential for recovering **power station heat** is estimated as **6,000 GWh/yr** and **industrial waste heat 1,000 GWh/yr**[21]. There is technical potential for use of waste heat where district heat networks are planned and installed. Mine water heat extraction in GM has the technical potential to provide **176 MWth/yr**.

- District heating could supply as much as 15-30% of UK space heat generation by 2050 compared to 1-2% currently[22]. This shift across GM would be equivalent to up to **330,000** homes connected to District Heating by 2050.

18 https://www.gov.uk/government/publications/about-shale-gas-and-hydraulic-fracturing-fracking/developing-shale-oil-and-gas-in-the-uk
19 https://www.ofgem.gov.uk/publications-and-updates/ofgem-challenges-power-grid-companies-connect-more-renewables
20 National Comprehensive Assessment of the Potential for Combined Heat and Power and District Heating and Cooling in the UK Report for DECC
21 As above
22 Energy Technologies Institute Options, Choices, Actions – UK scenarios for a low carbon energy system transition

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[23], however, 'Business as usual' will not be enough for GM to achieve its long term carbon targets.
- A strategy for decarbonising existing energy demand within GMs homes and buildings is a priority. Existing homes and buildings are projected to account for over 56% of carbon emissions by 2035 under Business-as-Usual.
- 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, provided decarbonisation of incoming national electricity is achieved.



23 Energy Technologies Institute Options Choices Actions UK Scenarios for a low carbon energy system transition (2015)

Summary Report
1.5 Future Scenarios

- The transport sector is a signficicant contributor to carbon emissions. In GM green aspiration, emission from the transport sector make up 58% of total emissions in 2050.[24]
- 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.

24 Alternative assumptions around transport decarbonisation based on DECC high price transport projections forecast much higher emissions (67% of total emissions by 2050).

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[25]. 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.

- Low carbon heating solutions in GM will need to be consumer focused and appeal to households if they are to achieve their potential[26]. 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.[27] 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[28].

- 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.

- 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.

25 City Initiatives for Technology, Innovation and Entrepreneurship – The Northern Powerhouse Analysis (2016)
26 ETI Smart Systems and Heat Consumer challenges for low carbon heat (2016)
27 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/397291/2903086_DECC_cad_leaflet.pdf
28 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/397291/2903086_DECC_cad_leaflet.pdf

Summary Report
1.6 Smart Systems,
Emerging Technologies
and Innovation

- **Hydrogen** could technically provide a flexible power source when produced from fossil fuel using carbon capture and storage or by the electrolysis of water[29]. 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 overcome and evidence questions the ability to produce sufficient quantities of hydrogen at an acceptable cost 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 could include supporting community-led initiatives for renewable and low carbon energy building on the number of community energy projects already going on across GM[30].

29 http://www.bbc.co.uk/news/uk-england-leeds-36749604
30 https://www.cegm.org.uk/

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[31].

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[32]. 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 to be installed as part of 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.

31 AGMA decentralised energy study (2010)
32 https://www.gov.uk/government/publications/national-planning-policy-framework--2

Summary Report
1.7 Future Local Policy Framework

- 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 retro fit improvements to tackle decarbonisation of existing homes and buildings.

- There are no legislative requirements that promote a compulsion for the improvement of existing homes beyond current building regulations[33], although residential Minimum Energy Efficiency Standards[34] 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.

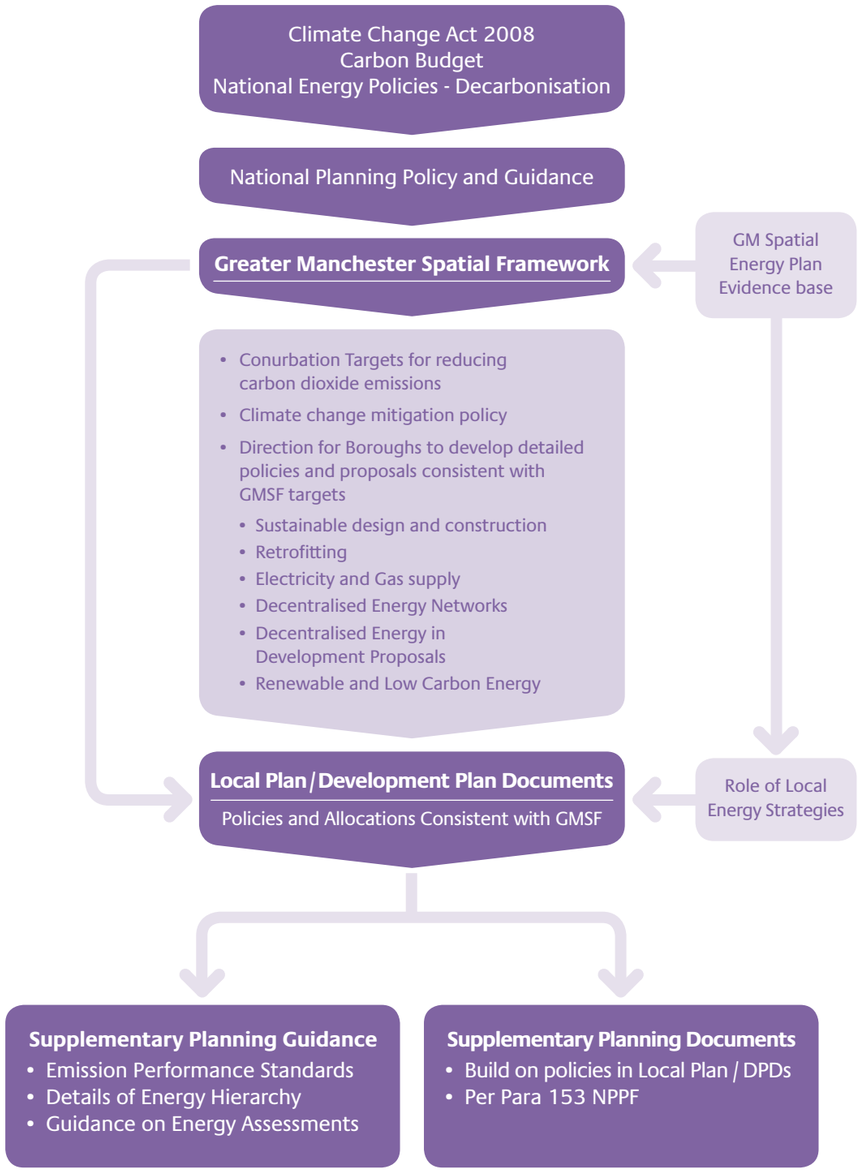
- Despite a lack of consumer demand and the limited uptake of the Green Deal, there remains the opportunity for more consumer focused schemes in existing homes and buildings. Subsidising Pay-as-you-save (e.g. 'Green Deal'-type) loan interest rates and/or allowing loans with a shorter term could address 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.

33 Building (Amendment) Regulations 2016 Part L1B (Conservation of Fuel and Power in existing Dwellings) relates to major extensions.
34 http://www.legislation.gov.uk/ukdsi/2015/9780111128350/contents

- 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.



- **The GM Energy Planning Policy Framework could:**

1. Support development of Local Area Energy Strategies within individual districts to evaluate the impact and trade-offs across the whole energy system and develop cost-effective pathways to support GMs carbon reduction targets.

2. Establish a policy supporting deployment of low carbon and renewable energy within new development reflecting the technical potential identified 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 develop ments energy demands. This policy could also encourage deployment of smart energy systems and innovative technologies.

3. 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.

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. GM could facilitate a centralised carbon offsetting fund for all ten districts as an alternative to the delivery of renewable energy by new development. 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[35]. 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.

8. 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[36]. The shift to a low carbon energy system could represent a significant opportunity for renewable energy generating infrastructure to be funded, owned and operated by local communities in GM[37].

9. 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.

35 Building (Amendment) Regulations 2016 Part L1B (Conservation of Fuel and Power in existing Dwellings) relates to major extensions.
36 http://gm-communityenergypledge.org.uk/
37 http://gm-communityenergypledge.org.uk/#CommunityEnergy

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