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Greater Manchester, United Kingdom

Applied Research

Case Study Report

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Territories and low-carbon economy

Regional Case Study:
Greater Manchester, United Kingdom

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1 General description of the region

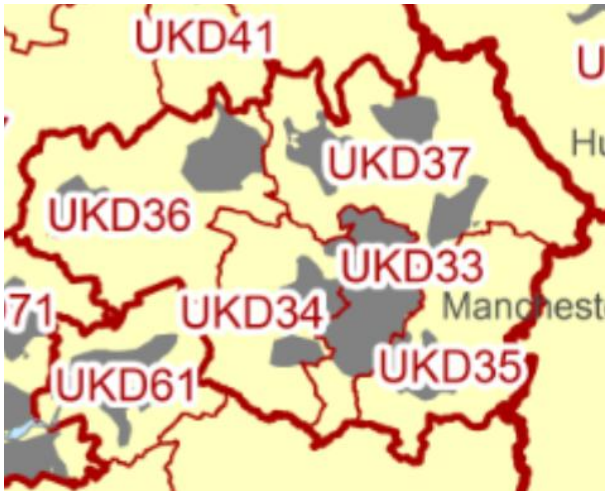
1.1 Location of region and characteristic

Greater Manchester is a metropolitan city region (NUTS 2) comprising 10 metropolitan local authorities (NUTS 4) situated in North West England. Economically, Greater Manchester is considered the UK's second city. The area covers 1,277 km^2 with the South Pennines uplands to the north and the Cheshire plain to the south. The region is landlocked but intersected by several canals and rivers including the Tame the Irwell and the Mersey. Much of the land is dense urban, sub-urban or industrial land, however there are distinct areas of greenbelt, mature woodland, agricultural land, scrubland, grassland and high moorland, wetlands, mosslands and lakes, river valleys and embankments, urban parks and suburban gardens that provide biodiversity habitats including 21 Sites of Special Scientific Interest (SSSI).

Figure 1.1: Greater Manchester (NUTS 2) situated within the North West Region (NUTS1) and located within the UK

Source: Cowie et al 2013

Figure 1.2: Greater Manchester NUTS 3 Boundaries



UK D37 = Greater Manchester North East (Bury, Oldham, Rochdale)
UK D36 = Greater Manchester North West (Bolton and Wigan),
UK D35 = Greater Manchester South East (Stockport and Tameside,
UKD34 = Greater Manchester South West (Salford and Trafford)
UKD33 = Manchester (Manchester City).

Source: Eurostat (2013)

In 2015, the population of the Greater Manchester region totalled 2.7 million (Nomis 2016) living in 1.17 million households (New Economy 2016). This population grew by 9.5% during the period 2001 to 2015 see Table 1.1 below (Nomis 2016):

Table 1.1: Population time series for Greater Manchester 2001-2015

Year	Population total	Population total	Population total
	Greater Manchester	North West	UK
2001	2,516,100	6,773,000	57,424,200
2002	2,523,200	6,784,900	57,668,100
2003	2,538,600	6,814,700	57,931,700
2004	2,549,800	6,840,400	58,236,300

Year	Population total	Population total	Population total
	Greater Manchester	North West	UK
2005	2,564,100	6,870,000	58,685,500
2006	2,582,300	6,901,600	59,084,000
2007	2,598,600	6,929,300	59,557,400
2008	2,620,000	6,958,500	60,044,600
2009	2,639,800	6,986,200	60,467,200
2010	2,661,800	7,019,900	60,954,600
2011	2,685,400	7,056,000	61,470,800
2012	2,702,200	7,084,300	61,881,400
2013	2,714,900	7,103,300	62,275,900
2014	2,732,900	7,133,000	62,756,300
2015	2,756,200	7,173,800	63,258,400

Source: ONS mid-year population estimates

This steady population growth can be understood in contrast to a marked population decline during the 1990s (Cowie et al 2013) increasing from around 1997 (Deloitte 2008:46). The population is broadly distributed between local authority areas within GM, as follows:

Table 1.2: Municipalities and inhabitants

Municipalities	Population (Mid-year projections)	Municipalities	Population (Mid-year projections)
Bolton	281,619	Salford	245,614
Bury	187,884	Stockport	288,733
Manchester	530,292	Tameside	221,692
Oldham	230,823	Trafford	233,288
Rochdale	214,195	Wigan	322,022
Total for Greater Manchester			2,756,162

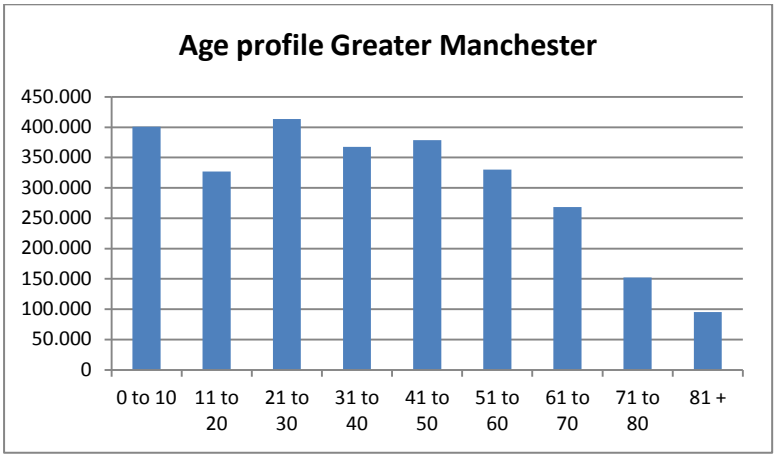
Source: ONS 2015

Although Manchester City is the largest population centre, and together with Salford and Trafford makes up a strong regional centre for the city-region (Interview 4), each local authority boroughs contains their own major towns, making Greater Manchester polycentric (Greater Manchester Transport Authority 2007). It is suggested that the "eight key town centres outside this regional centre employ some 122,000 people representing 17% of employment" (New Economy Manchester 2013:27).

1.2 Socio-demographic structure and development

The population of 2.56 million is divided into the following age structure:

Figure 1.3: Demographic structure – age structure



Source: ONS 2015 mid-year estimates

Although Greater Manchester is arguably the largest economic region outside London, it has a comparatively low-skilled workforce (Ofsted 2014:4). The number of people holding an NVQ level 4 or above (equivalent to a bachelor's degree) in Manchester is 4% lower than the UK population, while those holding a maximum of NVQ level 3 (equivalent to 2+ A Levels) and NVQ Level 2 (5+ GCSEs at grades A*-C) are both 1% above the UK average. The proportion of working age population holding no qualifications at all is 1.6% higher than the UK figure (New Economy 2016). Greater Manchester Combined Authority have identified that "Skills already account for around three-quarters of the gap in productivity between GM and the South East of England" (GMCA 2016:10).

Table 1.3: Demographic structure – educational profile

Education level	**Number aged 16 -64**	**% of pop aged 16 – 64**
NVQ4 and above (HND, Degree and Higher Degree level qualifications or equivalent)	589,700	33.7
NVQ3 and above (2 or more A levels, advanced GNVQ, NVQ 3, 2 or more higher or advanced higher national qualifications (Scotland) or equivalent)	933,100	53.2
NVQ2 and above (5 or more GCSEs at grades A-C, intermediate GNVQ, NVQ 2, intermediate 2 national qualification (Scotland) or equivalent)	1,254,300	71.6
NVQ1 and above (fewer than 5 GCSEs at grades A-C, foundation GNVQ, NVQ 1, intermediate 1 national qualification (Scotland) or equivalent)	1,451,200	82.8
Other qualifications (includes foreign qualifications and some professional qualifications)	124,200	7.1
No qualifications	176,900	10.1

Source: ONS 2015

Education levels can further be broken down by age showing clear differences in qualification levels across the age profile:

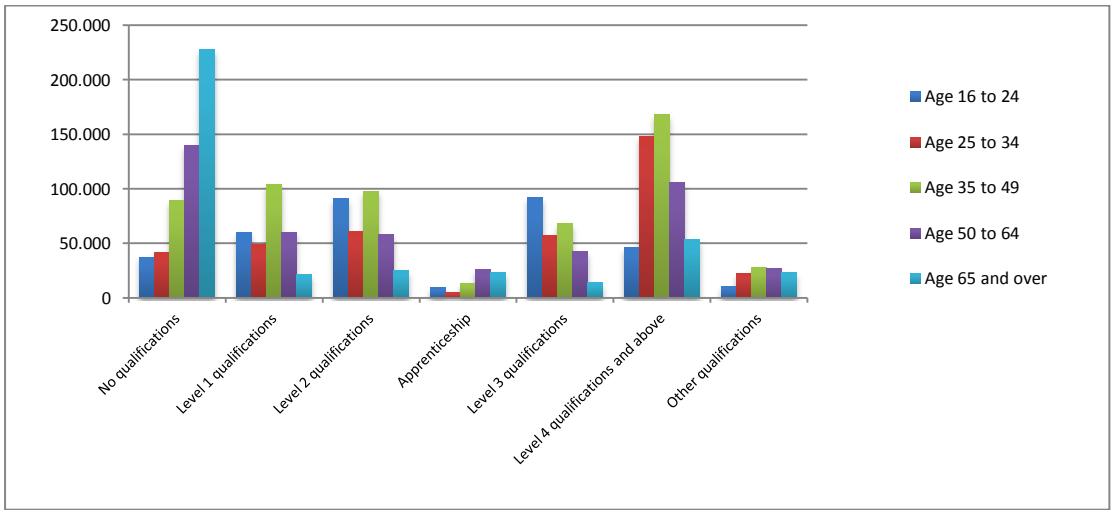
Table 1.4: Highest level of qualification by age for Greater Manchester (Former Metropolitan County)

Highest Level Qualification	Age 16 to 24	Age 25 to 34	Age 35 to 49	Age 50 to 64	Age 65 and over
All categories: Highest level of qualification	346,259	383,912	569,272	459,313	389,749
No qualifications	37,524	41,943	89,413	139,665	228,222
Level 1	59,842	48,767	103,885	60,083	21,812
Level 2	90,892	60,534	98,048	58,349	25,304
Apprenticeship	9,236	4,820	13,453	25,858	23,412
Level 3	91,906	57,699	68,463	42,746	14,513
Level 4 and above	46,458	147,854	168,163	105,795	53,507
Other qualifications	10,401	22,295	27,847	26,817	22,979

Source: ONS Nomis 2011, user query Nomis on 15 December 2016 of LC5102EW – Highest level of qualification by age

Represented graphically it can be seen more clearly that the skills profile is changing rapidly in the city region with those over 65 making up the majority of the "no qualifications" category and those between 35 and 49 most commonly holding Level 4 qualifications, shortly followed by those between 25 and 34:

Figure 1.4: Highest level of qualification by age for Greater Manchester



Source: ONS Nomis 2011, user query 15/12/2016 of LC5102EW – Highest qualification by age

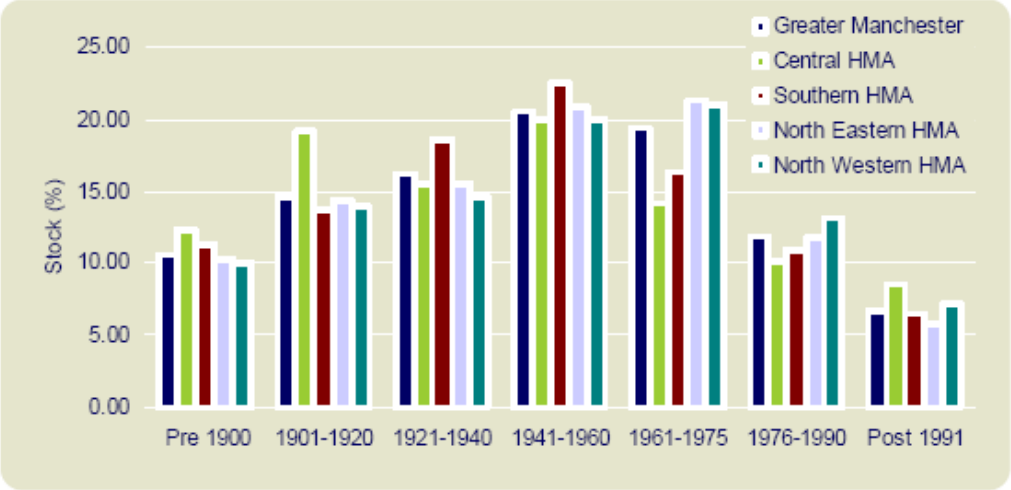
Both the GM Strategic Housing Market Needs Assessment conducted by Deloitte in 2008 and the Strategic Housing Market Assessment Update conducted by AGMA in 2010 identify a shift from elementary and manual occupations (being in the majority in 1987) to medium and high-end service occupations (being in the majority in 2007) (GM SHMA Deloitte 2008:37).

1.3 Settlement type and building stock

With 41% of Greater Manchester's housing stock built before 1940, and 40% built between 1941 and 1975 (Deloitte, 2008), Greater Manchester has a large volume of "hard to treat" properties in energy efficiency terms (Hunt 2012:23). Hard to treat properties are defined as those that "for whatever reason cannot accommodate "staple" or cost effective fabric energy

efficiency measures" (BRE 2008:1) Four categories of dwellings are typically considered as hard to treat – those with solid walls, those off the gas network, those with no loft, and high rise flats (BRE 2008:1). Age of building stock is reasonably evenly distributed across the housing market areas although both newer houses (post 1991) and older housing stock (pre-1920) are concentrated in the Central housing market area (Hunt 2012:23) see Figure 1.5:

Figure 1.5: Age distribution of housing stock 2007



Source: Deloitte, 2008

The majority of housing stock across all ten local authority areas is semi-detached or terraced, with higher levels of flat habitation occurring in Manchester and Salford city centres, and higher proportions of detached homes in Stockport and Bury (see Table 1.5 below). There has been an overall increase in the number of households since 2000 due to population change and household formation changes (Deloitte 2008).

Table 1.5: Housing Type in Greater Manchester 2008

	Total Households	Detached (%)	Semi Detached (%)	Terraced (%)	Flat, Maisonette or Apartment (%)
Bolton	113,443	16.0	35.3	37.1	11.4
Bury	79,041	18.2	38.8	31.0	11.8
Manchester	206,306	4.3	32.2	36.0	26.6
Oldham	91,733	11.5	33.6	41.9	12.8
Rochdale	88,311	14.9	33.3	38.6	13.0
Salford	99,027	8.6	37.0	32.5	21.6
Stockport	123,820	21.4	42.2	22.2	14.0
Tameside	95,129	11.1	38.6	37.1	12.8
Trafford	94,036	15.4	44.8	22.3	17.2
Wigan	133,609	16.6	46.5	29.2	7.5

Source: GMSHMA 2010:36 data from Community Insights 2008, CACI

Manchester city itself has almost no suburban population (Gibbs, Jonas and While, 2002). This lack of affluent suburban areas, present in most large UK cities, has implications for the city's tax base and was a key driver in the push to bring people back to the city centre" (Hunt 2012:8). Greater Manchester has undergone a widespread social renewal programmes with

Manchester and Salford coming to the end of their programmes in 2007/8 and Oldham and Bury increasing clearances as their programmes began (GMSHMA 2010:47).There have been explicit policy changes to increase housing densities – in Greater Manchester by almost 40% and in Rochdale by 84% by 2008 (GMSHMA 2010:49).

In terms of housing size figures are available as total rooms (not number of bedrooms). Most homes across all local authority areas have 5-6 rooms. Stockport and Trafford have the highest proportion of homes over 7 rooms (see Table 1.6 below) but low levels of council-owned and social-rented housing containing 7 or more rooms limits housing availability for families (Deloitte 2008:6). There are few 1-2 room apartments even in the areas that have the highest proportion of flats – Manchester and Salford.

Table 1.6: Housing Size in Greater Manchester (2008)

	1-2 Rooms* (%)	3-4 Rooms*(%)	5-6 Rooms* (%)	7+ Rooms* (%)
Bolton	2.1	32.7	49.7	15.5
Bury	1.8	29.1	50.6	18.5
Manchester	5.6	32.7	51.2	10.5
Oldham	2.1	36.9	48.9	12.1
Rochdale	2.5	34.6	48.6	14.3
Salford	2.7	32.2	52.6	12.5
Stockport	2.1	24.8	52.0	21.1
Tameside	2.1	34.5	51.9	11.6
Trafford	2.5	22.7	51.1	23.7
Wigan	1.6	26.1	58.4	14.0

Source: GMSHMA 2010:37 data from Community Insights 2008, CACI (Rooms refers to "all rooms" not just "number of bedrooms")*

In terms of housing tenure, 64% of homes in Greater Manchester are owner occupied (Deloitte 2008:64), although since 1997 there has been a strong relative shift away from owner occupation into the private rented sector (Deloitte 2008:4) and the high earnings to house price affordability ratio (most significant in the Southern Housing Market Area of Manchester – Stockport and Trafford) is generating a strong rental economy (Deloitte 2008:6).

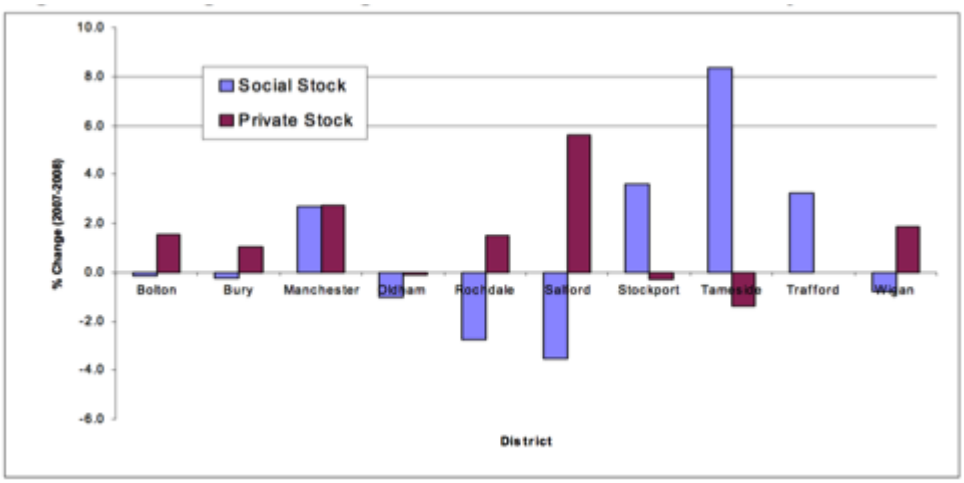
Table 1.7: Housing Stock breakdown by tenure April 2008

	LA	RSL	"Other" public	Private	Total
Bolton	15.3	6.1	0.0	78.6	119,254
Bury	10.4	5.2	0.0	84.4	80,898
Manchester	13.2	20.5	0.2	66.1	213,965
Oldham	15.4	6.2	0.0	78.4	92,639
Rochdale	15.6	8.2	0.0	76.2	90,056
Salford	24.3	5.5	0.0	70.2	104,325
Stockport	10.2	4.2	0.0	85.6	125,049
Tameside	0.0	23.1	0.0	76.9	97,885
Trafford	0.0	16.3	0.0	83.7	95,815
Wigan	16.6	2.1	0.0	81.3	137,788

Source: GMSHMA 2010:35

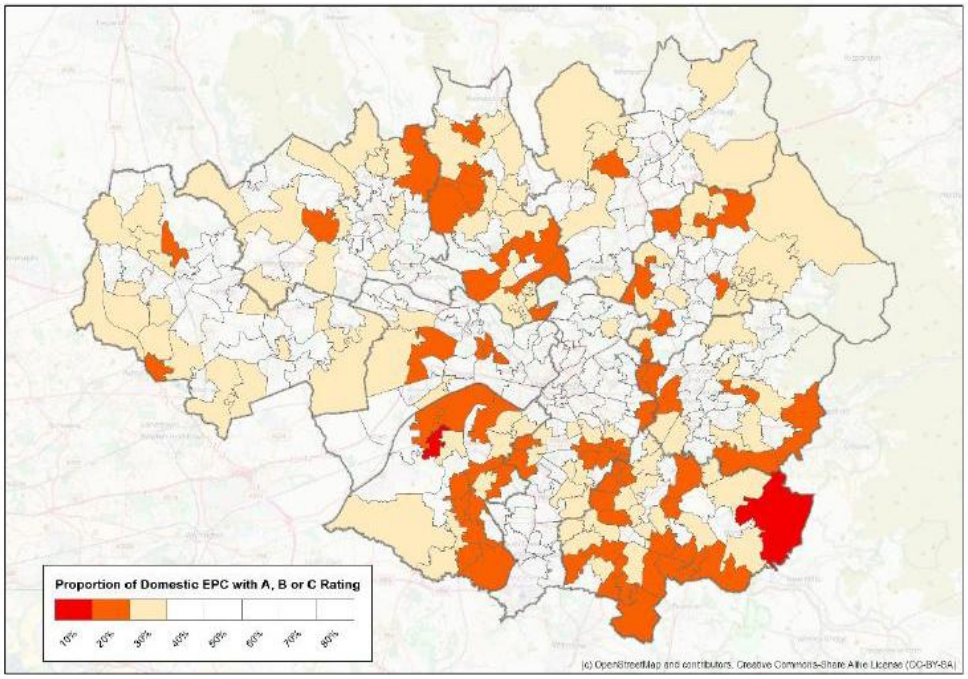
Rental is available through local authority, social housing provision and private landlords with most rental in 2008 occurring through private landlords. Where Greater Manchester has seen a slight increase in private rental (up from 7.6 to 8.7 per cent since 1997), social rented household numbers have remained relatively stable (at 27.3-27.4 per cent) (Deloitte 2008:48). However, there have been spatial differences within Greater Manchester, with significant changes from social to private housing stock in Salford, Rochdale, Bury, Bolton and Wigan and significant increases in social housing stock in Stockport, Trafford and Tameside (see Figure 1.6 below):

Figure 1.6: Greater Manchester Housing Tenure Change 2007-2008



Source: GMSHMA 2010:39 data from HSSA

Figure 1.7: Distribution of Domestic Properties with EPC rating of A, B or C



Source: ETI 2016:21

Data on average building standards and heat demand per m^2 is only available at a generalised level with Greater Manchester project officers relying on figures made available through

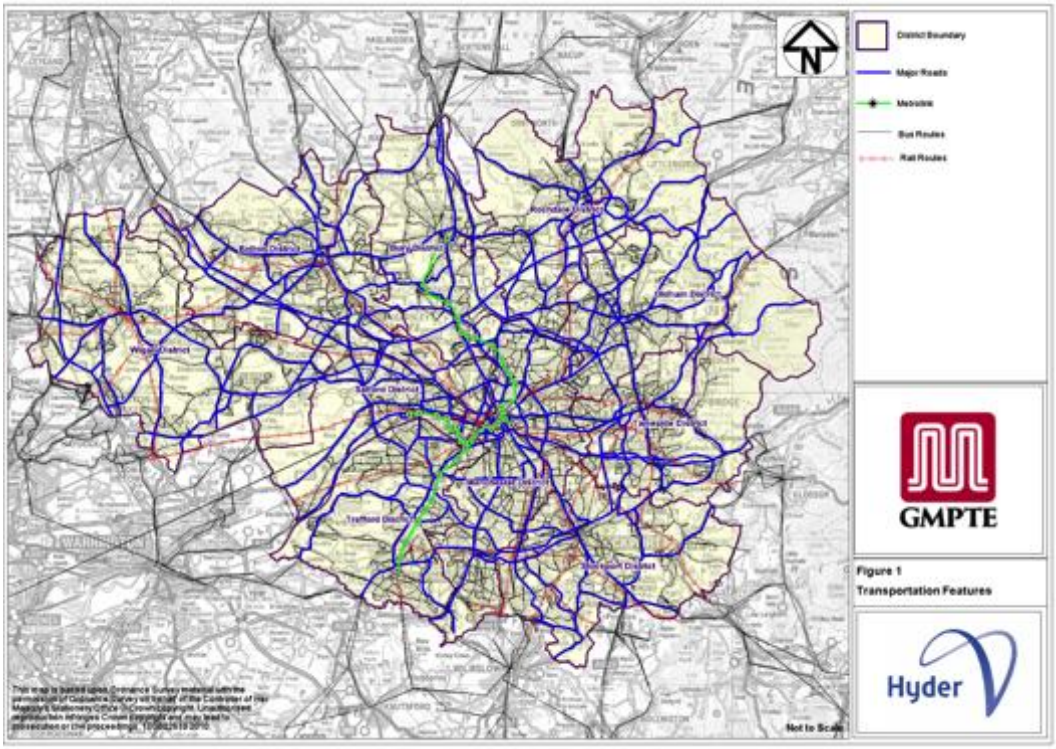
the Energy Savings Tust (http://tools.energysavingtrust.org.uk/Energy-Saving-Trust/Our-calculations) (Interview 3). However the following map gives some indication of the distribution of energy efficiency in homes from ETI data from Energy Performance Certificates:

The primary heating fuel is gas (96% of homes in Greater Manchester), with electricity accounting for less than 2%, and Coal and oil (2%) forming part of the energy mix in certain districts – particularly Wigan (Energy Technologies Institute 2016:19). This is consistent with many areas of the UK (especially English and urban areas) where "around 80% of all the heat used in the UK – in homes, in commercial buildings and in industrial processes – comes from gas" (DECC 2012:1). Although predominantly based on individual supply – there are several small scale district heating schemes is operation (also gas) which are currently estimated to supply around 2,000 homes in Greater Manchester (Halsay 2016). Greater Manchester currently has 29MW of installed renewable heat capacity and 140MW of installed renewable electricity capacity – mostly from landfill, sewage and anaerobic digestion gas (74%) (Energy Technologies Institute 2016:23). For further detail see section 2.3-2.6.

1.4 Transport System and modal Split

Greater Manchester has extensive public transport, and road and motorway networks. See map below which highlights major roads, bus routes, railways and metro lines:

Figure 1.8: Major Transport Links in Greater Manchester



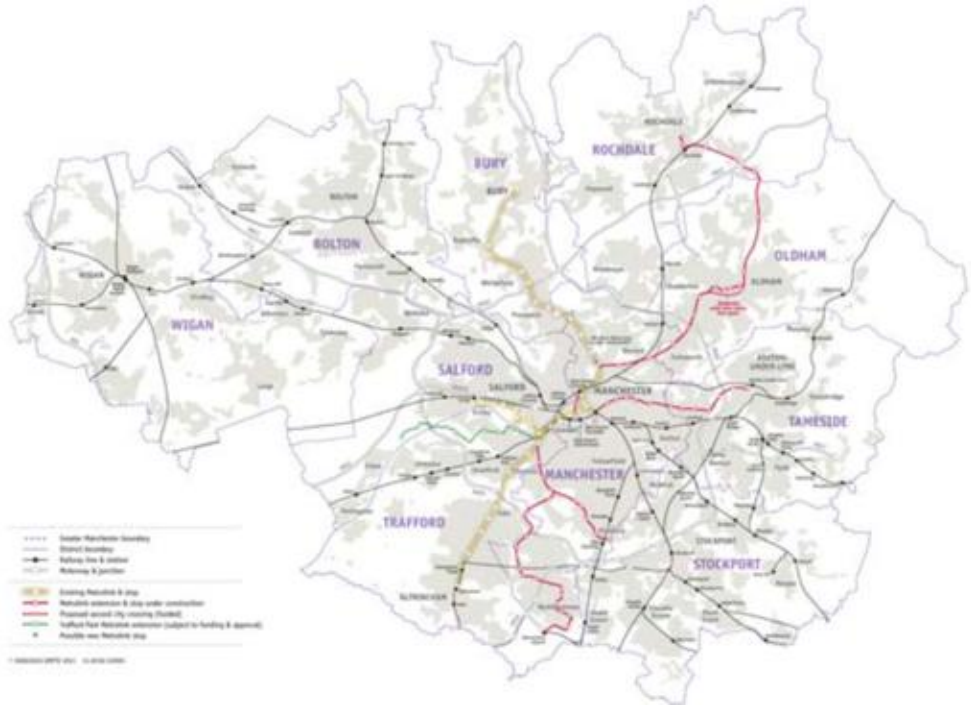
Source: TFGM 2011a

The road network is made up of a mix of local roads and high speed motorways including the orbital M60, the M6 main north-south link, to the West Midlands, Cumbria and Scotland, the

M62 connecting east-west with Liverpool and Yorkshire, as well as the M61 and M66, serving south Lancashire and the M56 to Chester, North Wales and the Wirral. This 9,000 km of roads carry an annual traffic of 13,000 vehicle kilometres (TfGM 2011). ONS 2011 census data shows 440 cars for every 1000 head of population – this is an increase from 409 cars in 2001 (New Economy 2014:016).

The bus network has radial routes into Manchester City Centre, and smaller local networks focusing on each of the main town centres and carries around 227 million passengers per year (GNTR cowrie). The rail network carries over 22 million journeys each year – for commuting and long distance journeys (GNTR cowrie). A number of rail corridors come together in the centre of Manchester. This is referred to as the "Northern Hub" and is recognized to be the single largest rail bottleneck in the North of England currently limiting rail capacity as an alternative transport mode (GM LTP). The Metro link light rail/tram system is also heavily used for commuting carrying around 19 million passengers per year on lines between the city centre and Altrincham, Bury and Eccles via MediacityUK. An expansion of this metro network is underway, which will double its size

Figure 1.9: Metro link and Rail Network Connections in Greater Manchester

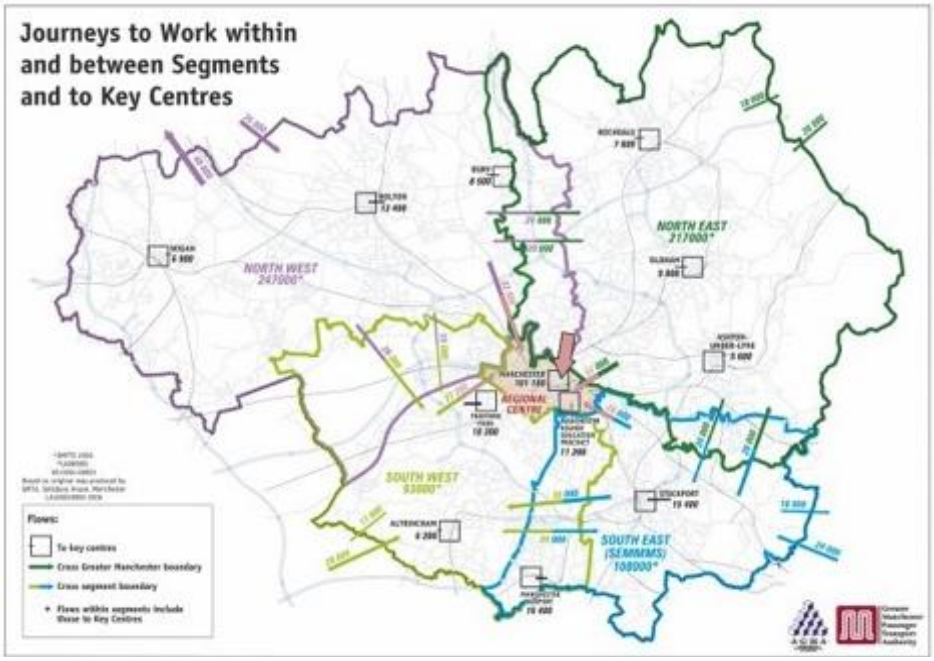


Source: TFGM 2011:81

Transport infrastructure is managed by the Greater Manchester Passenger Transport Authority and Executive (Hunt 2012:8). With a total population of 2.6m people, and an additional 4.4m living within an hour's drive (GMCA 2016:5), The Greater Manchester has the largest travel-to-work area of any conurbation in the UK outside of London, with 7 million people living within one hour's drive of the city centre (New Economy 2016). GMCA identify labour markets and supply chains stretching across the whole of the North (GMCA 2016:5). These transport links include national connections north-south and east-west as well as within the

city region to facilitate leisure, retail, tourism, trade and commuting travel needs. In 2008 Deloitte reported that "Manchester City Region sees a net increase in its daytime working population of more than 100,000 persons, both Greater Manchester and the Manchester City Region as a whole see significant net inflows of 28,000 and 22,000 respectively. Other "centres" of economic activity include Salford, Trafford, Macclesfield, and Warrington. The remaining boroughs (with the exception of Bolton which is broadly in balance) are net exporters of labour" (Deloitte 2008:39). The map below indicates the strength of travel to work movements along within the city region:

Figure 1.10: Travel to Work Flows into/out-of and within the Manchester City Region



Source: Greater Manchester Transport Authority 2007

1.5 Regional Economic Structure and development

The greater Manchester economy has undergone transition from industrial prowess in traditional manufacturing in the 19th and early 20th centuries – in textiles and later chemical and electrical engineering – to its present position "seeking a post-industrial urban renaissance" (Cowie et al 2013:3). This transition towards a service-dominated economy is generating an economy polarized between the development of higher-value added knowledge-intensive business services – the bedrock of Manchester's knowledge economy in university research and creative industries, and its financial and business services and the lower value-added services concentrated in hospitality, leisure, retail and care. Outside London, Greater Manchester is now the UK's main centre for business, financial and professional services, employing 324,000 people (New Economy 2016). Greater Manchester is benefitting from the relocation of parts of the BBC out of London to Salford as part of the anchor institution strategy for

the Media City development and from location of shared service centres for large companies like Sainsbury's, Marks & Spencer and The Royal Bank of Scotland.

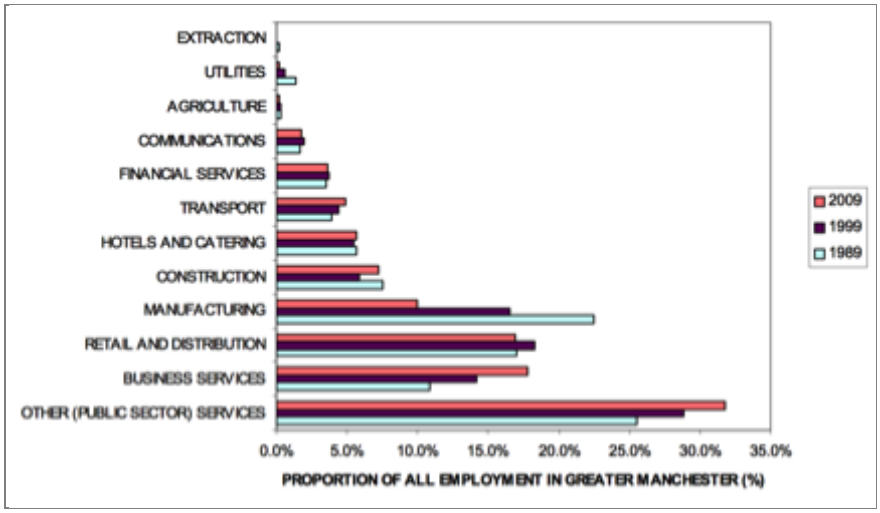
The 1.4 million people working in Greater Manchester work in around 105,000 businesses, which are broken down by size as follows (New Economy 2016: figures from ONS Business Register & Employment Survey):

- Micro, 0-9 employees: 86,100 businesses
- Small, 10-49 employees: 15,300 businesses
- Medium, 50-249 employees: 3,400 businesses
- Large, 250+ employees: 600 businesses

Overall, a third of all jobs are within large businesses spread across a wide variety of sectors, including 240k in finance and professional services; 199k in life sciences and healthcare; 185k in manufacturing; 85k in creative industries; and 57k in ICT (GMCA 2016:5). Greater Manchester has the largest student population in Europe (100,000), with its Universities accounting for £ 1.4 billion of income and 18k jobs (GMCA 2016:5).

Changes in industrial structure have resulted from a decrease in manufacturing and an increase in business services and "other public sector services", with other sectors remaining relatively consistent across this ten-year interval. While private services have grown, public services remain a substantive part of the GM economy.

Figure 1.11: Changing Sectoral Employment in Greater Manchester 1999-2009



Source: AGMA GMSHMA 2010:11

In 2008 Deloitte reported: "There has been a relative shift towards both high-end and low-end occupations at the expense of traditional mid-range occupations, such as administrative and skilled manual roles. This has worked to change the demand profile for housing within the Greater Manchester sub-region…as well as contributing to increasing socio-economic polarisation, which is particularly acute in the North Eastern HMA" (Deloitte 2008:4) and coexists with ethnic polarisation (Deloitte 2008:4)

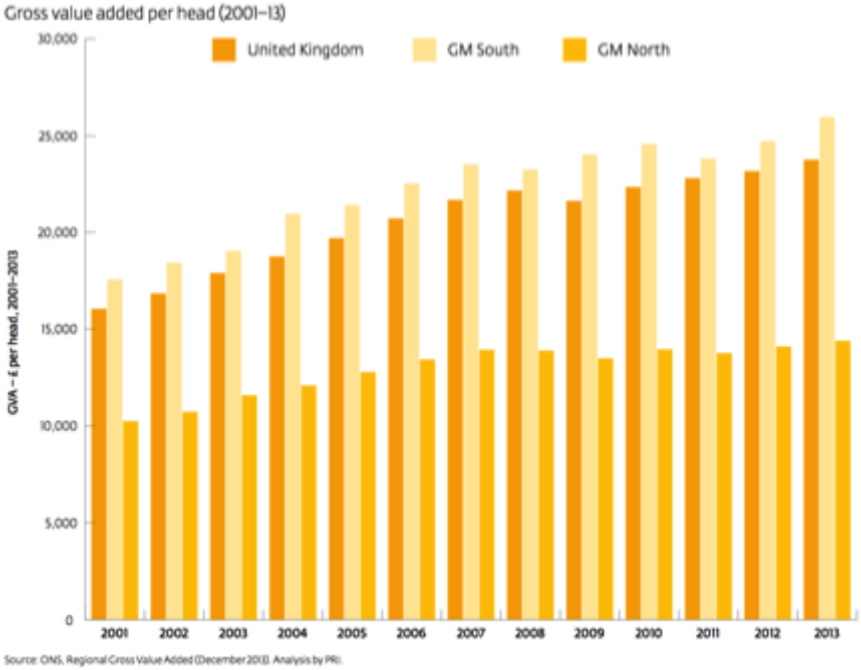
In 2013, Greater Manchester and the West Midlands city regions were the joint second largest economies in the UK after London – each contributing 4.3% of England's GVA compared

to London's 26% (ONS 2013). The competition between Manchester and Birmingham as England's second city is intense with some reports that "Recent growth has seen Manchester overtaking Birmingham as the UK's second city" (Hunt 2012:8) and their role as centres of economic agglomeration within their broader city-regions has grown in importance. However, there is an "uneven spatial development of the conurbation" that can be broadly split between "a more prosperous southern part transformed by the recent history of sustained economic growth and a northern part that has continued a longer-term trajectory of deprivation (Harding *et al.*, 2010)" (Cowie et al 2013:4).

GDP figures for Manchester are available only as GVA and are measured in the former (pre-2015) NUTS3 categories of "Greater Manchester North" and "Greater Manchester South". Greater Manchester's total annual GVA was £ 59.6 billion in 2015 (ONS) representing 3.6% of UK (D'Souza 2016). This is an increase from 2008 where GMCA cite GVA of £ 48 billion and 5% of the national economy (GMCA 2016:5) although AGMA valued this slightly higher at just over £ 50 billion but only 4% of the national economy (AGMA, 2010:1). These figures continue to vary slightly in estimation with New Economy suggesting in 2016 that "the Greater Manchester economy generates £ 56 billion of gross value added (GVA) on an annual basis" (New Economy 2016).

Figures for estimated GVA per capita available from ONS between 1997 and 2013 and taken from the Manchester City Council Annual State of the City Report 2015 show that GM South outperformed the national average in terms of GVA per head compared to the UK average, while GM North lags behind, reflecting and reinforcing existing geographical disparities.

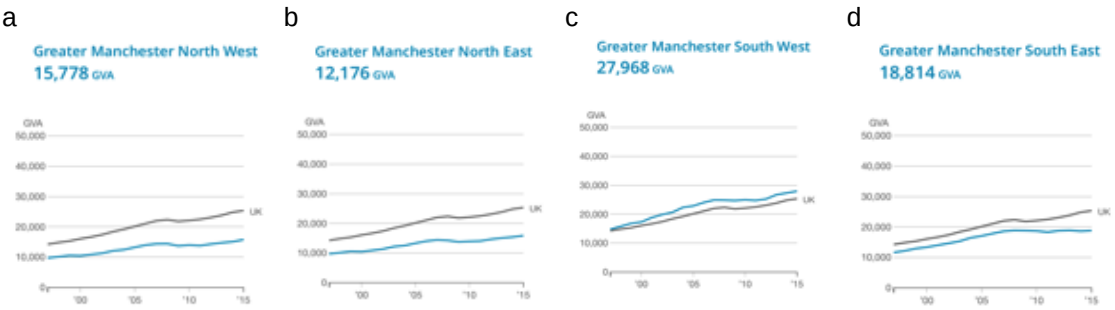
Figure 1.12: GVA per head – Greater Manchester North, Greater Manchester South and UK



Source: Manchester City Council 2015

While the North West region of the UK had the fastest annual growth in 2015 of 3.6% (ONS 2016), within Greater Manchester there was significant variation across the four quadrants clearly illustrating the north-south Manchester economic divide:

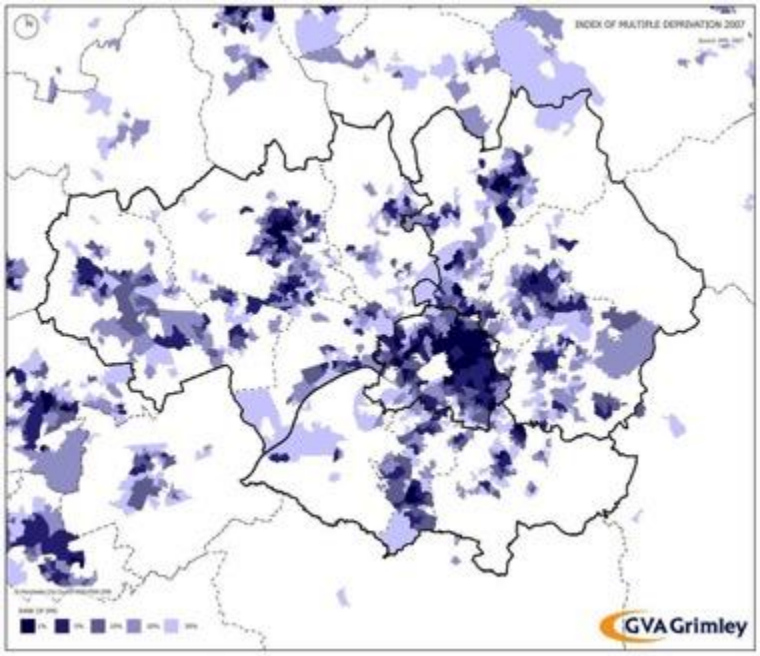
Figure 1.13: Greater Manchester GVA per head a) North West, b) North East, c) South West and d) South East



Source: ONS 2016

As well as the north-south divide within Greater Manchester, localized pockets of entrenched deprivation have persisted despite GM's recent city-centre based growth. Figure 1.14 below shows the index of multiple deprivation – a UK national ranking of socio-economic deprivation produced in 2007 to reflect income; employment; health and disability; education, skills and training; barriers to housing and services; crime; and living environment (Deloitte 2008:52). Darker areas show areas of higher multiple levels of deprivation:

Figure 1.14: Index of Multiple Deprivation in Greater Manchester – 2007



Source: Deloitte 2008:52

Table 1.8: Gross Value Added (Income Approach) by SIC07 industry at current basic prices at NUTS 3 (£ million)

NUTS level	NUTS code	Region name	SIC07 code	SIC07 Industry	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
NUTS3	UKD33	Manchester	A	Agriculture, forestry and fishing	2	2	2	2	2	2	2	2	2	2
NUTS3	UKD33	Manchester	BDE	Production	120	117	123	104	106	92	93	104	102	108
NUTS3	UKD33	Manchester	C	Manufacturing		623	658	696	666	655	646	629	637	621
NUTS3	UKD33	Manchester	F	Construction	183	207	206	227	230	252	251	311	333	345
NUTS3	UKD33	Manchester	GHI	Distribution; transport; accommodation and food	1,710	1,859	1,889	1,927	2,080	2,210	2,280	2,366	2,497	2,578
NUTS3	UKD33	Manchester	J	Information and communication	453	511	583	617	635	724	862	933	896	943
NUTS3	UKD33	Manchester	K	Financial and insurance activities	795	880	855	786	910	928	985	1,399	1,676	1,965
NUTS3	UKD33	Manchester	L	Real estate activities	508	578	594	591	685	762	807	785	907	1,085
NUTS3	UKD33	Manchester	MN	Business service activities	874	934	1,047	1,073	1,331	1,439	1,571	1,763	1,627	1,815
NUTS3	UKD33	Manchester	OPQ	Public administration; education; health	1,585	1,668	1,791	1,871	2,079	2,240	2,268	2,509	2,610	2,744
NUTS3	UKD33	Manchester	RST	Other services and household activities	201	217	246	285	312	340	358	377	424	415
NUTS3	UKD33	Manchester	All	All industries	7,057	7,595	7,993	8,179	9,035	9,645	10,124	11,179	11,710	12,621
NUTS3	UKD34	Greater Manches-ter South West	A	Agriculture, forestry and fishing	5	4	4	4	4	4	4	5	4	4
NUTS3	UKD34	Greater Manches-ter South West	BDE	Production	284	275	290	245	252	219	221	247	242	255
NUTS3	UKD34	Greater Manches-ter South West	C	Manufacturing	997	992	1,047	1,107	1,060	1,043	1,030	1,003	1,015	990
NUTS3	UKD34	Greater Manches-ter South West	F	Construction	419	476	474	523	532	583	578	717	766	794
NUTS3	UKD34	Greater Manches-ter South West	GHI	Distribution; transport; accommodation and food	1,368	1,482	1,510	1,538	1,645	1,742	1,794	1,859	1,956	2,018
NUTS3	UKD34	Greater Manches-ter South West	J	Information and communication	346	388	443	469	484	550	654	705	682	714
NUTS3	UKD34	Greater Manches-ter South West	K	Financial and insurance activities	307	339	332	306	354	363	386	544	649	759
NUTS3	UKD34	Greater Manches-ter South West	L	Real estate activities	757	813	839	815	912	967	1,058	1,058	1,126	1,263

NUTS level	NUTS code	Region name	SIC07 code	SIC07 Industry	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
NUTS3	UKD34	Greater Manchester South West	MN	Business service activities	827	879	990	1,016	1,232	1,325	1,439	1,618	1,510	1,682
NUTS3	UKD34	Greater Manchester South West	OPQ	Public administration; education; health	1,003	1,058	1,139	1,191	1,315	1,417	1,437	1,589	1,655	1,743
NUTS3	UKD34	Greater Manchester South West	RST	Other services and household activities	168	180	204	233	257	282	297	313	348	343
NUTS3	UKD34	Greater Manchester South West	All	All industries	6,480	6,886	7,273	7,448	8,045	8,495	8,900	9,657	9,953	10,563
NUTS3	UKD35	Greater Manchester South East	A	Agriculture, forestry and fishing	7	7	7	6	6	6	7	7	6	6
NUTS3	UKD35	Greater Manchester South East	BDE	Production	153	148	156	133	136	118	119	133	130	137
NUTS3	UKD35	Greater Manchester South East	C	Manufacturing	1,320	1,312	1,385	1,466	1,403	1,381	1,363	1,328	1,344	1,310
NUTS3	UKD35	Greater Manchester South East	F	Construction	405	456	454	499	504	555	557	684	737	761
NUTS3	UKD35	Greater Manchester South East	GHI	Distribution; transport; accommodation and food	1,210	1,309	1,340	1,362	1,434	1,512	1,552	1,607	1,685	1,738
NUTS3	UKD35	Greater Manchester South East	J	Information and communication	241	270	308	327	336	382	455	490	473	496
NUTS3	UKD35	Greater Manchester South East	K	Financial and insurance activities	176	194	190	175	202	206	219	309	370	433
NUTS3	UKD35	Greater Manchester South East	L	Real estate activities	792	775	818	802	838	833	953	969	1,031	1,110
NUTS3	UKD35	Greater Manchester South East	MN	Business service activities	471	506	566	583	685	737	797	896	845	937
NUTS3	UKD35	Greater Manchester South East	OPQ	Public administration; education; health	922	973	1,048	1,096	1,210	1,303	1,322	1,462	1,522	1,603
NUTS3	UKD35	Greater Manchester South East	RST	Other services and household activities	147	160	182	207	228	250	263	279	305	304
NUTS3	UKD35	Greater Manchester South East	All	All industries	5,844	6,111	6,454	6,654	6,982	7,282	7,607	8,165	8,447	8,836

NUTS level	NUTS code	Region name	SIC07 code	SIC07 Industry	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
NUTS3	UKD36	Greater Manchester North West	A	Agriculture, forestry and fishing	11	9	10	6	8	10	10	11	10	9
NUTS3	UKD36	Greater Manchester North West	BDE	Production	168	167	164	143	164	139	138	138	125	165
NUTS3	UKD36	Greater Manchester North West	C	Manufacturing	1,282	1,284	1,327	1,284	1,270	1,232	1,314	1,259	1,222	1,299
NUTS3	UKD36	Greater Manchester North West	F	Construction	473	508	483	517	552	641	644	769	795	822
NUTS3	UKD36	Greater Manchester North West	GHI	Distribution; transport; accommodation and food	1,169	1,251	1,347	1,297	1,419	1,470	1,543	1,541	1,679	1,718
NUTS3	UKD36	Greater Manchester North West	J	Information and communication	100	112	122	143	144	161	234	195	194	218
NUTS3	UKD36	Greater Manchester North West	K	Financial and insurance activities	126	145	142	118	113	151	167	212	258	295
NUTS3	UKD36	Greater Manchester North West	L	Real estate activities	731	726	729	708	704	707	828	876	953	1,104
NUTS3	UKD36	Greater Manchester North West	MN	Business service activities	375	407	431	421	414	470	527	575	600	683
NUTS3	UKD36	Greater Manchester North West	OPQ	Public administration; education; health	888	934	980	1,049	1,138	1,177	1,209	1,281	1,470	1,461
NUTS3	UKD36	Greater Manchester North West	RST	Other services and household activities	157	164	189	183	194	219	251	245	271	277
NUTS3	UKD36	Greater Manchester North West	All	All industries	5,479	5,707	5,925	5,870	6,118	6,378	6,865	7,102	7,576	8,051
NUTS3	UKD37	Greater Manchester North East	A	Agriculture, forestry and fishing	6	5	5	3	4	5	5	5	5	4
NUTS3	UKD37	Greater Manchester North East	BDE	Production	141	141	138	121	138	117	116	116	105	139
NUTS3	UKD37	Greater Manchester North East	C	Manufacturing	1,431	1,434	1,482	1,434	1,418	1,376	1,468	1,406	1,364	1,450
NUTS3	UKD37	Greater Manchester North East	F	Construction	416	447	426	457	490	570	571	684	707	731

NUTS level	NUTS code	Region name	SIC07 code	SIC07 Industry	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
NUTS3	UKD37	Greater Manchester North East	GHI	Distribution; transport; accommodation and food	1,275	1,362	1,470	1,410	1,549	1,603	1,681	1,679	1,827	1,868
NUTS3	UKD37	Greater Manchester North East	J	Information and communication	165	186	201	236	237	265	383	320	318	357
NUTS3	UKD37	Greater Manchester North East	K	Financial and insurance activities	76	88	87	72	69	93	103	130	157	180
NUTS3	UKD37	Greater Manchester North East	L	Real estate activities	752	749	764	723	724	760	837	907	973	1,109
NUTS3	UKD37	Greater Manchester North East	MN	Business service activities	403	436	464	449	437	493	552	599	625	707
NUTS3	UKD37	Greater Manchester North East	OPQ	Public administration; education; health	1,039	1,092	1,145	1,226	1,330	1,377	1,414	1,497	1,720	1,708
NUTS3	UKD37	Greater Manchester North East	RST	Other services and household activities	164	174	199	198	205	233	266	262	286	294
NUTS3	UKD37	Greater Manchester North East	All	All industries	5,868	6,113	6,381	6,330	6,602	6,892	7,396	7,604	8,087	8,547

Table 1.8: Gross Value Added (Income Approach) by SIC07 industry at current basic prices at NUTS 3 (£ million) [continued]

NUTS level	NUTS code	Region name	SIC07 code	SIC07 Industry	2007	2008	2009	2010	2011	2012	2013	2014	2015[3]
NUTS3	UKD33	Manchester	A	Agriculture, forestry and fishing	1	4	5	8	6	7	6	6	5
NUTS3	UKD33	Manchester	BDE	Production	109	71	56	46	52	63	129	130	145
NUTS3	UKD33	Manchester	C	Manufacturing	613	683	598	594	646	626	713	774	792
NUTS3	UKD33	Manchester	F	Construction	386	349	370	361	342	406	438	490	495
NUTS3	UKD33	Manchester	GHI	Distribution; transport; accommodation and food	2,729	2,617	2,866	3,046	2,909	3,011	3,309	3,312	3,595
NUTS3	UKD33	Manchester	J	Information and communication	1,007	970	918	873	901	848	772	976	1,074
NUTS3	UKD33	Manchester	K	Financial and insurance activities	2,060	1,939	2,199	2,067	1,916	1,905	2,020	1,745	1,929
NUTS3	UKD33	Manchester	L	Real estate activities	1,018	1,069	1,054	1,113	1,203	1,272	1,293	1,404	1,486
NUTS3	UKD33	Manchester	MN	Business service activities	1,881	1,898	1,767	1,770	1,842	2,170	2,538	2,636	2,669
NUTS3	UKD33	Manchester	OPQ	Public administration; education; health	2,983	3,060	3,221	3,349	3,269	3,405	3,541	3,912	4,054
NUTS3	UKD33	Manchester	RST	Other services and household activities	425	501	533	608	578	546	715	778	787
NUTS3	UKD33	Manchester	All	All industries	13,213	13,160	13,586	13,835	13,666	14,260	15,474	16,164	17,030
NUTS3	UKD34	Greater Manches-ter South West	A	Agriculture, forestry and fishing	3	5	4	5	5	4	6	6	6
NUTS3	UKD34	Greater Manches-ter South West	BDE	Production	293	300	274	278	264	359	461	445	416
NUTS3	UKD34	Greater Manches-ter South West	C	Manufacturing	975	1,047	984	927	903	906	939	1,057	1,080
NUTS3	UKD34	Greater Manches-ter South West	F	Construction	898	873	748	678	691	728	746	700	825
NUTS3	UKD34	Greater Manches-ter South West	GHI	Distribution; transport; accommodation and food	2,131	2,087	2,159	2,473	2,340	2,402	2,605	2,523	2,682
NUTS3	UKD34	Greater Manches-ter South West	J	Information and communication	767	748	772	731	840	797	819	970	1,049
NUTS3	UKD34	Greater Manches-ter South West	K	Financial and insurance activities	796	765	908	848	775	812	906	822	791
NUTS3	UKD34	Greater Manches-ter South West	L	Real estate activities	1,184	1,250	1,177	1,183	1,241	1,319	1,313	1,411	1,537

NUTS level	NUTS code	Region name	SIC07 code	SIC07 Industry	2007	2008	2009	2010	2011	2012	2013	2014	2015[3]
NUTS3	UKD34	Greater Manchester South West	MN	Business service activities	1,735	1,724	1,770	1,816	1,908	1,992	2,185	2,290	2,290
NUTS3	UKD34	Greater Manchester South West	OPQ	Public administration; education; health	1,896	1,916	1,938	1,970	1,974	1,974	2,010	2,132	2,125
NUTS3	UKD34	Greater Manchester South West	RST	Other services and household activities	351	412	438	504	483	457	552	616	594
NUTS3	UKD34	Greater Manchester South West	All	All industries	11,029	11,128	11,170	11,413	11,424	11,751	12,543	12,972	13,394
NUTS3	UKD35	Greater Manchester South East	A	Agriculture, forestry and fishing	4	7	4	4	4	3	5	5	4
NUTS3	UKD35	Greater Manchester South East	BDE	Production	158	210	459	523	485	550	563	526	532
NUTS3	UKD35	Greater Manchester South East	C	Manufacturing	1,291	1,420	1,285	1,182	1,190	1,132	1,086	1,222	1,249
NUTS3	UKD35	Greater Manchester South East	F	Construction	840	870	583	563	620	616	583	598	587
NUTS3	UKD35	Greater Manchester South East	GHI	Distribution; transport; accommodation and food	1,829	1,821	1,753	1,840	1,776	1,816	1,928	1,759	1,797
NUTS3	UKD35	Greater Manchester South East	J	Information and communication	531	453	490	427	479	436	393	441	467
NUTS3	UKD35	Greater Manchester South East	K	Financial and insurance activities	454	456	569	579	491	496	560	490	457
NUTS3	UKD35	Greater Manchester South East	L	Real estate activities	1,109	1,162	1,038	1,028	1,068	1,144	1,133	1,194	1,252
NUTS3	UKD35	Greater Manchester South East	MN	Business service activities	960	919	959	908	854	991	1,021	995	969
NUTS3	UKD35	Greater Manchester South East	OPQ	Public administration; education; health	1,744	1,720	1,883	1,897	1,862	1,915	1,823	1,742	1,812
NUTS3	UKD35	Greater Manchester South East	RST	Other services and household activities	307	361	377	422	396	366	458	488	477
NUTS3	UKD35	Greater Manchester South East	All	All industries	9,227	9,397	9,400	9,374	9,224	9,465	9,552	9,460	9,603

NUTS level	NUTS code	Region name	SIC07 code	SIC07 Industry	2007	2008	2009	2010	2011	2012	2013	2014	2015[3]
NUTS3	UKD36	Greater Manchester North West	A	Agriculture, forestry and fishing	7	8	7	9	8	10	10	10	9
NUTS3	UKD36	Greater Manchester North West	BDE	Production	151	168	199	153	168	132	139	120	148
NUTS3	UKD36	Greater Manchester North West	C	Manufacturing	1,261	1,261	1,051	1,131	1,159	1,285	1,277	1,341	1,373
NUTS3	UKD36	Greater Manchester North West	F	Construction	913	895	733	705	729	757	795	821	829
NUTS3	UKD36	Greater Manchester North West	GHI	Distribution; transport; accommodation and food	1,733	1,743	1,738	1,764	1,739	1,795	1,931	1,974	2,129
NUTS3	UKD36	Greater Manchester North West	J	Information and communication	249	221	225	263	296	270	275	310	348
NUTS3	UKD36	Greater Manchester North West	K	Financial and insurance activities	342	310	324	299	269	274	313	272	271
NUTS3	UKD36	Greater Manchester North West	L	Real estate activities	1,074	1,198	1,032	1,006	1,073	1,139	1,127	1,160	1,206
NUTS3	UKD36	Greater Manchester North West	MN	Business service activities	740	636	729	742	620	746	849	875	876
NUTS3	UKD36	Greater Manchester North West	OPQ	Public administration; education; health	1,589	1,673	1,742	1,850	1,823	1,789	1,781	1,840	1,956
NUTS3	UKD36	Greater Manchester North West	RST	Other services and household activities	266	298	289	369	340	366	361	368	381
NUTS3	UKD36	Greater Manchester North West	All	All industries	8,324	8,410	8,069	8,290	8,223	8,564	8,857	9,091	9,524
NUTS3	UKD37	Greater Manchester North East	A	Agriculture, forestry and fishing	3	6	7	7	7	6	8	8	7
NUTS3	UKD37	Greater Manchester North East	BDE	Production	127	182	151	165	181	225	277	247	255
NUTS3	UKD37	Greater Manchester North East	C	Manufacturing	1,407	1,387	1,194	1,308	1,406	1,411	1,453	1,526	1,563
NUTS3	UKD37	Greater Manchester North East	F	Construction	812	774	716	681	729	765	769	715	739

NUTS level	NUTS code	Region name	SIC07 code	SIC07 Industry	2007	2008	2009	2010	2011	2012	2013	2014	2015[3]
NUTS3	UKD37	Greater Manchester North East	GHI	Distribution; transport; accommodation and food	1,885	1,820	1,852	1,812	1,721	1,843	2,088	2,213	2,319
NUTS3	UKD37	Greater Manchester North East	J	Information and communication	407	340	345	376	430	418	378	391	407
NUTS3	UKD37	Greater Manchester North East	K	Financial and insurance activities	208	160	215	208	199	188	193	192	160
NUTS3	UKD37	Greater Manchester North East	L	Real estate activities	1,081	1,172	1,046	1,005	1,055	1,154	1,148	1,209	1,299
NUTS3	UKD37	Greater Manchester North East	MN	Business service activities	760	641	647	608	571	694	706	725	818
NUTS3	UKD37	Greater Manchester North East	OPQ	Public administration; education; health	1,858	1,965	2,014	2,084	2,097	2,144	2,104	2,135	2,163
NUTS3	UKD37	Greater Manchester North East	RST	Other services and household activities	281	310	301	376	353	296	320	331	325
NUTS3	UKD37	Greater Manchester North East	All	All industries	8,830	8,757	8,489	8,630	8,747	9,145	9,442	9,691	10,054

Despite relatively high levels of growth compared to the other UK regions, in terms of sectoral distribution of GVA, the Manchester Independent Economic Review suggested that, "by international comparison, GM's private sector is punching below its weight. Growth in VAT registrations since 1996 is below the national average, and less than half the rate of London... [and] Manchester's businesses are also unusually reliant on debt finance" (GMCA 2016:15). Table 1.8 further shows the breakdown of GVA share per sector measured by SIC07 industry code at NUTS 3 level between 1997 and 2015.

These sectoral GVA figures reflect a low rise in GVA between 1997 and 2015 in Manufacturing and a much higher rise in GVA among public administration related sectors:

Figure 1.15: GVA for manufacturing 1997-2015

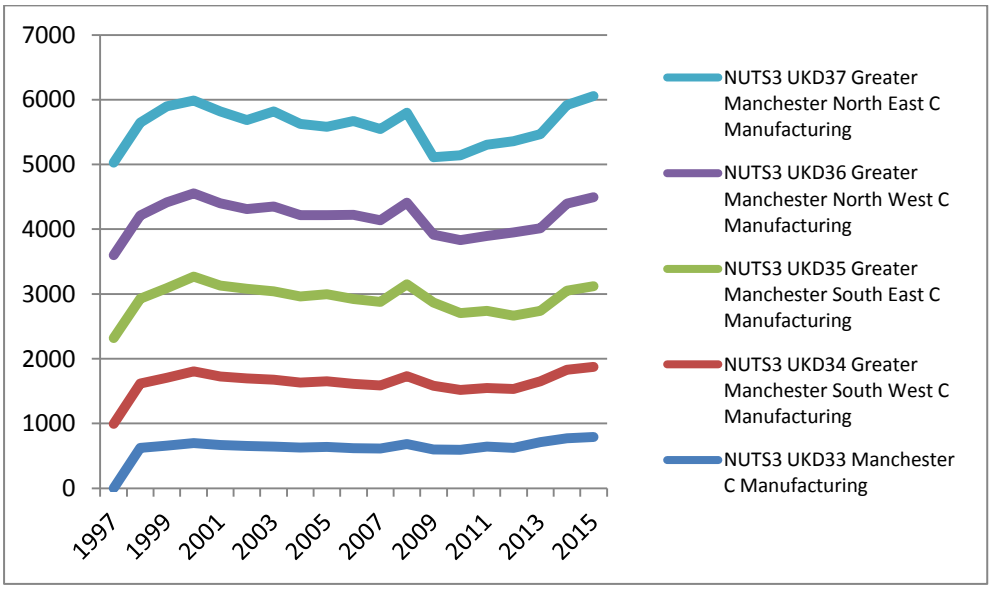
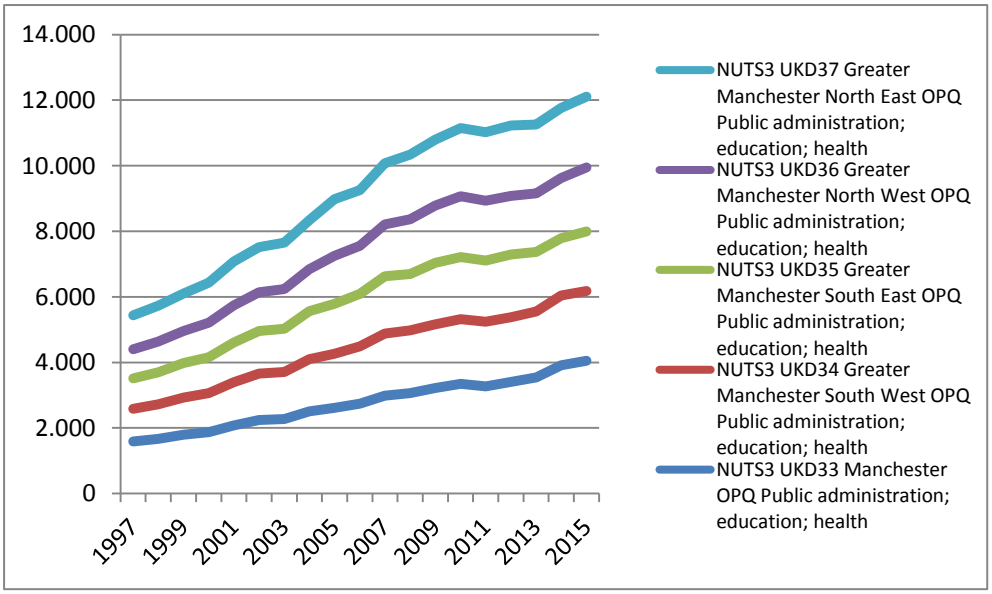
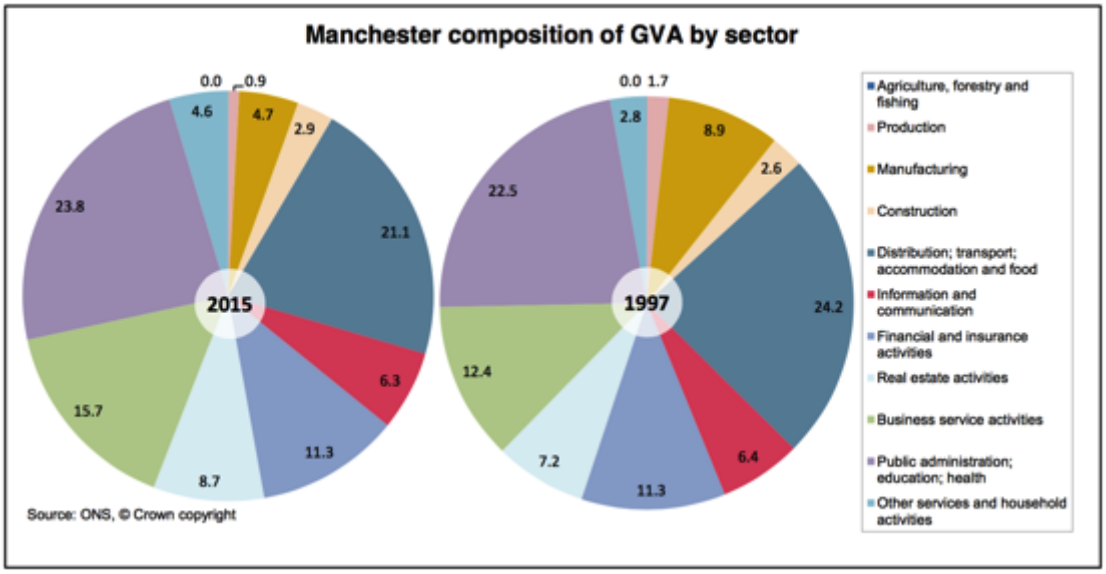


Figure 1.16: GVA for public administration



In an assessment of composition of GVA by sector for Manchester alone (not Greater Manchester), D'sousa gives the following sectoral breakdown:

Figure 1.17: Composition of GVA by Sector for Manchester City



Source: D'sousa 2016:4

Ironically given the UK Government's current aggressive stance towards public services, Public Administration, Education & Health is the sector with the largest GVA contribution in Manchester accounting for 23.8% of Manchester's total GVA and has experienced growth in contribution towards this total GVA from 22.5 in 1997. Other areas of increasing contribution to GVA are business services (12.4 – 15.7) other services and household activities (2.8-4.6) and real estate (7.2-8.7). In contrast, the contribution of manufacturing to GVA has fallen from 8.9% of the total in 1997 to 4.7% in 2015 and production has also fallen from 1.7% to 0.9% (D'sousa 2016:4).

The regional economic profile employment by structural business statistics (NACE Rev.2) by SIC code for 2004-2015 is shown in Table 1.9 below:

Table 1.9: Greater Manchester (NUTS2) % employment by SIC code 2007

	2004	2004 %	2005	2005 %	2006	2006 %	2007	2007 %	2008	2008 %	2009	2009 %
A Agriculture, forestry and fishing	900	0.1	1,300	0.1	5,300	0.4	1,700	0.1	3,300	0.3	2,100	0.2
B Mining and quarrying D Electricity, gas, steam and air conditioning supply E Water supply	15,600	1.3	14,500	1.2	18,100	1.5	17,700	1.5	18,500	1.6	13,700	1.2
C Manufacturing	168,700	14.4	160,600	13.6	160,200	13.3	172,500	14.3	163,500	13.7	128,600	10.9
F Construction	97,200	8.3	98,000	8.3	103,400	8.6	102,100	8.5	107,300	9.0	91,700	7.8
G Wholesale and retail trade I Accommodation and food service activities	231,300	19.7	237,700	20.1	234,400	19.4	227,700	18.9	227,400	19.1	236,400	20.1
H Transportation and storage J Information and communication	116,500	9.9	114,400	9.7	112,100	9.3	116,800	9.7	117,300	9.8	95,000	8.1
K Financial and insurance activities L Real estate activities M Professional, scientific and technical activities N Administrative and support service activities	152,200	13.0	156,600	13.2	172,000	14.2	174,200	14.5	166,300	13.9	172,300	14.7
O Public administration and defence P Education Q Human health and social work activities	327,800	27.9	336,600	28.5	341,400	28.3	328,600	27.3	319,000	26.7	364,500	31.0
R Arts, entertainment and recreation S Other service activities T Activities of households as employers U Activities of extraterritorial organisations/bodies	60,200	5.1	56,800	4.8	54,200	4.5	54,000	4.5	60,800	5.1	60,900	5.2

Source: Nomis 2017

Table 1.9: Greater Manchester (NUTS2) % employment by SIC code 2007 [continued]

	2010	2010 %	2011	2011 %	2012	2012 %	2013	2013 %	2014	2014 %	2015	2015 %
A Agriculture, forestry and fishing	2,100	0.2	1,600	0.1	800	0.1	900	0.1	2,700	0.2	3,400	0.3
B Mining and quarrying D Electricity, gas, steam and air conditioning supply E Water supply	14,800	1.2	15,300	1.3	15,500	1.3	19,000	1.6	15,600	1.3	15,800	1.3
C Manufacturing	131,800	11.1	121,300	10.3	124,300	10.4	127,800	10.6	120,100	9.7	121,500	9.6
F Construction	87,000	7.3	82,400	7.0	78,800	6.6	83,800	6.9	83,900	6.8	88,300	7.0
G Wholesale and retail trade I Accommodation and food service activities	230,400	19.4	240,500	20.3	245,700	20.5	242,500	20.1	250,600	20.2	245,300	19.4
H Transportation and storage J Information and communication	100,200	8.4	106,800	9.0	108,300	9.1	103,400	8.6	108,200	8.7	110,800	8.8
K Financial and insurance activities L Real estate activities M Professional, scientific and technical activities N Administrative and support service activities	176,400	14.9	178,200	15.1	184,000	15.4	205,300	17.0	207,100	16.7	220,300	17.4
O Public administration and defence P Education Q Human health and social work activities	373,900	31.5	373,100	31.6	368,300	30.8	358,100	29.6	373,900	30.2	382,400	30.2
R Arts, entertainment and recreation S Other service activities T Activities of households as employers U Activities of extraterritorial organisations/bodies	59,800	5.0	55,300	4.7	58,700	4.9	55,800	4.6	62,300	5.0	66,400	5.3

Source: Nomis 2017

The top 5 business sectors identified by New Economy are: Business, Financial & Professional Services, Health & Social Care, Creative & Digital, Education, Advanced Manufacturing and Sport (New Economy 2016). None of these are particularly energy intensive. The Greater Manchester Mini-Stern identifies only 4% of Greater Manchester's employment within energy intensive manufacturing (2008:6). Other non-manufacturing energy intensive industries include Manchester airport and land based transport. The report highlights sectors that are at higher risk from climate change legislation due to their importance to the regions current economic activity and high-energy usage and/or emissions. These are: Air Transport; Land Transport; Textile Finishing; Industrial Gases and Dyes; Man-made Fibres; Glass & Glass Products; Plastics & Synthetic Resins; Other Textiles; Textile Fibres; Articles of concrete and stone; Textile Weaving; Knitted products; and Paper and paperboard products (see Figure 1.18 below). This provides some information on which industries in the city region are both most energy intensive and most important to the Greater Manchester economy. A strategic economic issue is the focus on the airport as an economic driver especially in the GM South area.

Figure 1.18: High-energy intensive industry sectors identified to be "at risk" from climate change legislation within Greater Manchester

Source Deloitte 2008b: 28

2 Energy strategy, energy consumption and regional renewable energies

2.1 Regional highlights and challenges

In our view Greater Manchester is particularly interesting for two reasons. First, its designation as the UK's first city-region is interesting from a territorial governance perspective "as the first example of such administrative integration in the UK, and the only example of a statutory metropolitan government outside London" (Cowie et al 2013:5). This has led to "a new style of local government" and "radical devolution deals" (CCLES 2016:3). This innovation in governance is interesting from a low carbon development because it allows strategic working across administrative boundaries and organisations that is particularly suited to the challenges of low carbon development. What is interesting from a low carbon perspective is to test the claim laid out in the GM Low Carbon Implementation Plan 2016-2020 that "With more local control comes the enhanced ability to deliver" (CCLES 2016:3). Secondly, Greater Manchester has prioritised the low carbon economy as an area through which to develop and demonstrate its leadership at a UK level, and envisages this as wholly complementary to its strong economic growth ambitions. This makes Manchester city region an interesting place to test the claims that addressing climate change and economic growth ambitions can be met in parallel.

Greater Manchester has set itself the CO_2 emissions reduction target of 48% by 2020. This is considered a challenging target across the UK and there is currently a gap of 0.5 million tonnes between the expected reductions achieved by currently identified projects and the required target (CCLES 2016:4). Progress towards meeting this target to date includes installation of 120MW of renewable energy generation providing 360GWh of electricity per year including 28,000 PV installations through rent a roof schemes, community hydro projects in Stockport Rochdale and Oldham, heat generation schemes in Bury Manchester and Wigan and anaerobic digestion and energy from waste (GMCA 2016a: 7). Key achievements cited since publication of the Greater Manchester Climate Change Strategy 2012 include:

- The delivery of over 10,000 retrofit measures in Greater Manchester's Housing Stock; including a £ 6.1 million Green Deal Communities Programme; plus Salix funding to increase energy efficiency in GM's public buildings;
- Securing a £ 20 million project to trial new heating technologies linked by smart technology in 550 social homes;
- Being selected as one of three Local Authorities to work with Energy Systems Catapult on a significant smart systems and heat demonstrator by 2020;
- The deployment of almost 2,500 electric vehicles on Greater Manchester's roads and associated charging infrastructure; and
- Major expansions to the Metro link Tram network and £ 42 million to fund the city region's cycling strategy; (CCLES 2016:2)

Particular challenges for developing a low carbon economy are presented by managing increased electrification in the proposed decarbonisation of energy and transport, national pol-

icy around public sector cuts and Brexit, which affect delivery resources, and increasingly competing local economic priorities.

First, decarbonisation of energy usage and transportation through increased electrification increases electricity demand. However, Greater Manchester does not have high potential for large scale renewable electricity generation and so there is reliance on wider decarbonisation of the UK National Electricity Grid. Whilst overall robust and secure, UK generation capacity is decreasing (due to the decommissioning of old nuclear, gas and fossil fuel power stations) and aging distribution infrastructure needs to be adapted to cope with new connections, forms of management and two-way flow requirements (Greater Manchester Energy Group undated: 3). While reasonably robust, the local electricity grid will need to be adapted to more flexible forms of management to accommodate distributed generation, and known weaknesses will need strengthening. Increasing electricity demand through decarbonisation of energy and transport is compounded by increasing consumer demand associated with uptake of digital technologies and economic growth which also increases demand through increased population, buildings and processes:

> *"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" (Energy Technologies Institute 2016:25).*

Second, to date much of the activity towards a low carbon economy has been stimulated, coordinated and facilitated by public sector bodies and public sector funding. The declining ideological commitment to a strong public sector, the specific UK national programme of public sector austerity since 2011 and now the proposed exit from the European Union is impacting access to funding programmes through which this work has been delivered to date. As a result new modes of financing are being demanded for further development of the low carbon economy.

Third, compounding low carbon specific challenges, Greater Manchester has significant socio-economic challenges which compete for local priorities in this context of scare resources. As well as having extremely affluent areas, it is simultaneously the third most deprived Local Enterprise Partnership in the UK with "187 neighbourhoods…within the 5% most deprived LSOAs in England. …[and] over a quarter of all children living in Greater Manchester…living in poverty" (New Economy 2016:4*).* One specific impact of this on low carbon activity is that the recent economic climate, and austerity policies of the UK Government, mean that many working families are not in a position to take up home improvements through financing options made available through the Green Deal, accounting in part for the "lack of consumer demand and the limited uptake of the Green Deal" in the Greater Manchester area (Energy Technologies Institute 2016:31). Local authorities are increasingly reframing low carbon household retrofit in terms of addressing fuel poverty and whilst these two agendas

have previously been rhetorically well integrated, it was recognised on several occasions that in practice any carbon savings often drop out of programmes which deliver against important health and economic concerns (Interview 2,3,4,5,6). As well as competing social challenges, city-region ambitions for high levels of economic growth are outcompeting carbon reduction concerns in political decision making (Interview 8) and in key policy documents such as the Draft Spatial Framework.

2.2 Energy strategy of the region

The current and future energy strategy of Greater Manchester is set out in 3 main documents:

- The Greater Manchester Climate Change Strategy 2012-2020
- The Climate Change And Low Emissions Implementation Plan (2016-2020)
- and the Draft Greater Manchester Spatial Framework (2016)

The proclaimed focus and ambition of all three strategies is to marry pursuit of economic growth and regeneration with low carbon concerns. The Greater Manchester Climate Change Strategy 2012-2020 was formally adopted in 2011 and its development was led by the Association of Greater Manchester Authorities (AGMA), GM Local Enterprise Partnership (LEP), the Greater Manchester Combined Authority (GMCA) and all ten Local Authorities (Boroughs). It is governance and delivery is now co-ordinated by the GM Low Carbon Hub and its planned implementation and monitoring occurs through the Climate Change And Low Emissions Implementation Plan (2016-2020) and updated Climate Change And Low Emissions Implementation Plan (2016-2020). The Draft Greater Manchester Spatial Framework (2016) is being led by GMCA Spatial Planning Team, and is still under consultation.

The Greater Manchester Climate Change Strategy 2012-2020 set a 48% reduction in carbon emissions by 2020 from a 1990 baseline (GMCCS 2012). It focussed Greater Manchester's ambitions on climate change around "economic transformation, adaptation & developing a competitive advantage" (AGMA 2011:1). Framing responding to climate change through a discourse of Manchester's pioneering role in industrial innovation, it was suggested that "achieving a strong competitive edge in the new, global market for climate change solutions is our new and primary aim" (AGMA 2011:4). As well as carbon reduction, there is a strong focus on developing the low carbon and environmental goods and services sector – which was valued at £ 4.4 billion and "projected to grow at more than 4% over the next five years" at a time when economic growth had gained renewed focus under the coalition Government post the financial crisis of 2008). Key goals for addressing climate change until 2020 are to:

(a) Build a rapid transition to a low carbon economy
(b) Reduce carbon emissions by 48% by 2020 against a 1990 baseline
(c) Be prepared for and actively adapt to a rapidly changing climate; while creating future jobs and new industries in the "green" sector
(d) Ensure "carbon literacy" is embedded into the culture of organisations, lifestyles and behaviours.

While reducing carbon emissions through reducing energy consumption is a crosscutting concern across thematic workstreams (e.g. housing and transport), renewable energy generation is positioned as having a smaller overall contribution, in part due to GM's limited large scale renewable generation potential, and reliance national grid electricity:

> *"while the 'decarbonisation' of the electricity grid will be a national goal, our action in Greater Manchester on local generation, reducing energy use, smart grids and district heat networks will still contribute a 5% reduction in carbon emissions by 2020, again while offering opportunities to our low carbon industrial sector" (AGMA 2011:7)*

The policy was developed, and is owned by, the Association of Greater Manchester Authorities (AGMA), the Local Enterprise Partnership (LEP), the Greater Manchester Combined Authority (GMCA) and the ten District Councils and envisages a cross sectoral audience in which delivery will only be achieved by embedding targets and cultural change in the plans and operational activity of organisations and neighbourhoods throughout GM (AGMA GMCA GMLEP 2011).

In 2016, *The Climate Change And Low Emissions Implementation Plan (2016-2020)* was developed to update progress against the Greater Manchester Climate Change Strategy (2011) and to address the gap between carbon reductions identified in the policies and proposals of the existing Climate Change And Low Emissions Implementation Plan (2016-2020) and the target of 48% reduction by 2020 (CCLES 2016:5). This gap is small between *forecast resources* and target delivery, but described as *substantial* between secured resources and target delivery due to reliance on successful bidding to EU, UK and other discretionary funds (Local Enterprise Partnership Board 2016:3). The key goals of the 2016-2020 implementation plan are to:

(a) Cut carbon emissions by 48% below 1990 levels by 2020
(b) Grow a low carbon economy
(c) To rapidly adapt to a changing climate
(d) Embed low carbon behaviours
(e) Achieve air quality thresholds

The plan has been developed by The Low Carbon Hub in partnership with over 200 individuals and organisations as part of a wide-ranging consultation (GMCA 2016a). Its audience is the whole Greater Manchester city-region, aiming for a "whole place approach" and recognising that "our targets are challenging and cannot be achieved by Local Authorities working in isolation" (GMCA 2016a: 2).

Both documents focus on voluntary approaches to carbon reduction and encourage targets to be met by joint action across the public, private and voluntary sectors. As a result there is much emphasis placed on cultural and educational change. Early programmes of information awareness raising and advice to the general domestic population first available through the Energy Savings Trust and later the Greater Manchester Energy Saving Trust Advice Centre

were the victim of public sector funding cuts and so emphasis is now focussed on a Carbon Literacy programme, which involves peer led training run by Manchester Metropolitan University. Framing low carbon energy policy through an economic rationale involves framing the benefits of action and measurements of success also in economic terms. Greater Manchester's low carbon energy policies recurrently expressed potential benefits in financial, skills or health terms. For example, the State of the City Report (2015), champions the way that "Manchester's businesses are being supported to lower their carbon emissions and become more resource-efficient through the Green Growth programme [which] is also supporting the city's low-carbon businesses to grow, increasing their sales, number of employees, and by safeguarding jobs" (Manchester City Council 2015: 19). Low carbon is positioned not only as an opportunity for cost savings within existing businesses but also as an economic opportunity for inward investment in Greater Manchester. GMCA state: "It is proposed that the Government and Greater Manchester commit to develop Manchester's role as a Beacon for Inward Investment, similar to the Dutch model. This would have a focus on investment from India, China and Brazil, in a complementary capacity to London under the UK banner. The aim would be to generate net new jobs and growth in Greater Manchester and across the whole of the north." (GMCA 2016:17). In relation to energy policy specifically, one of the key actions of CCLEIP is to "Developed and published a suite of low carbon 'propositions' plans to drive inward investment" (CCLES 2016:8).

The *Draft Greater Manchester Spatial Framework (2016)* continues this framing of parallel pursuit on economic growth and low carbon. Currently at consultation stage, it represents the first metropolitan scale spatial plan since 1981. The Greater Manchester Spatial Framework (GMSF) aim is to outline "how Greater Manchester is planning to meet levels of growth well above baseline forecasts" (GMCA, 2016b:6). Its aim is to identify sites and strategic locations for development and to balance competition for land use across the Greater Manchester area in order to manage the target high levels of economic growth "so that Greater Manchester is a better place to live, work and visit…to make sure that investment and growth in houses and jobs happens but also benefits our residents … to plan for schools, green spaces, roads and health facilities alongside new homes, offices and factories. If we don't do this, it won't happen" (GMCA 2016b:4). The GMSF pledges a 60% reduction in carbon emissions compared to 1990 levels by 2035 (2016: Policy GM15) however it is relatively weak on specifying how this will be met and integrating this ambition across the whole Spatial Framework. The Framework does require a detailed carbon assessment for new development (GMCA 2012b:101), supports the delivery of renewable and low carbon energy schemes for all new development with particular attention to decentralised heating and cooling networks in the strategic development locations (2012:80), and considers the sequestration of carbon (GMCA 2016b:64; and 70). However, it has been criticised for lacking an ambitious and integrated approach to low carbon (Interview 6) as discussed further in section 3.5.

2.3 Regional and local energy infrastructure

Greater Manchester has several district heating networks already in operation and an active programme of heat network projects in development with active support through the GM Project Development Unit.

Examples of existing district heating schemes include:

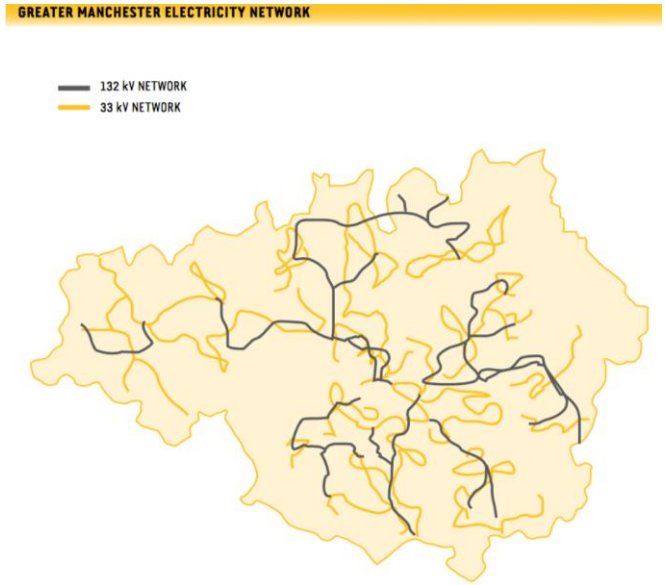
- Oldham gas district-heating scheme which is around 50 years old but serves 1,400 homes managed by the Housing Association, First Choice Homes (FCHO). (Greater Manchester Energy Commission 2011) This scheme is undergoing renewal by Vital Energi (Vital Energy 2016).
- Stockport has developed seven separate biomass district heating schemes heating between 2013 and 2014 covering over 2,000 social rented high rise flats, collectively making it the largest district heating system in the UK (re-heat 2016).

Examples of new schemes in development include:

- Manchester Civic Quarter Heat Network which is currently at procurement stage (Interview 4) and involves a cluster of Manchester City Council-owned or controlled buildings (including the Town Hall and Central Library) with potential for significant expansion to other heat off-takers and a private wires network (GMCA 2017b).
- Detailed techno-economic feasibility studies have been carried out for further opportunities at the Co-op/Hermes mixed-use NOMA development to the north of Manchester City Centre, an extension of the existing tri-generation network at Media City UK, a new network in Ashton under Lyne town centre and two proposals that have been under consideration since at least 2011 – heat recovery from electrical generation on Pilsworth landfill site in Bury, and supply of heat and power to civic and commercial buildings in Bolton town centre from the nearby existing Viridor GMWDA Raikes Lane Energy from Waste plant (GMCA 2017).
- There are further master-planning studies underway at: Piccadilly Station, Manchester; Salford Central (based upon significant planned commercial and residential development); Trafford Park Industrial Estate (Manchester Ship Canal Corridor from Carrington CHP) and Greater Manchester Regional Centre (GMCA 2017).

The North West Regional gas network is available across the Greater Manchester area, although 5% of the postcodes (3,316 postcodes) have never had a gas connection and can be considered off-grid. This is equivalent to around 35,000 domestic properties or 3% of homes (Energy Technologies Institute 2016:19). Greater Manchester has a 132kV and 33kV electricity distribution network as shown below:

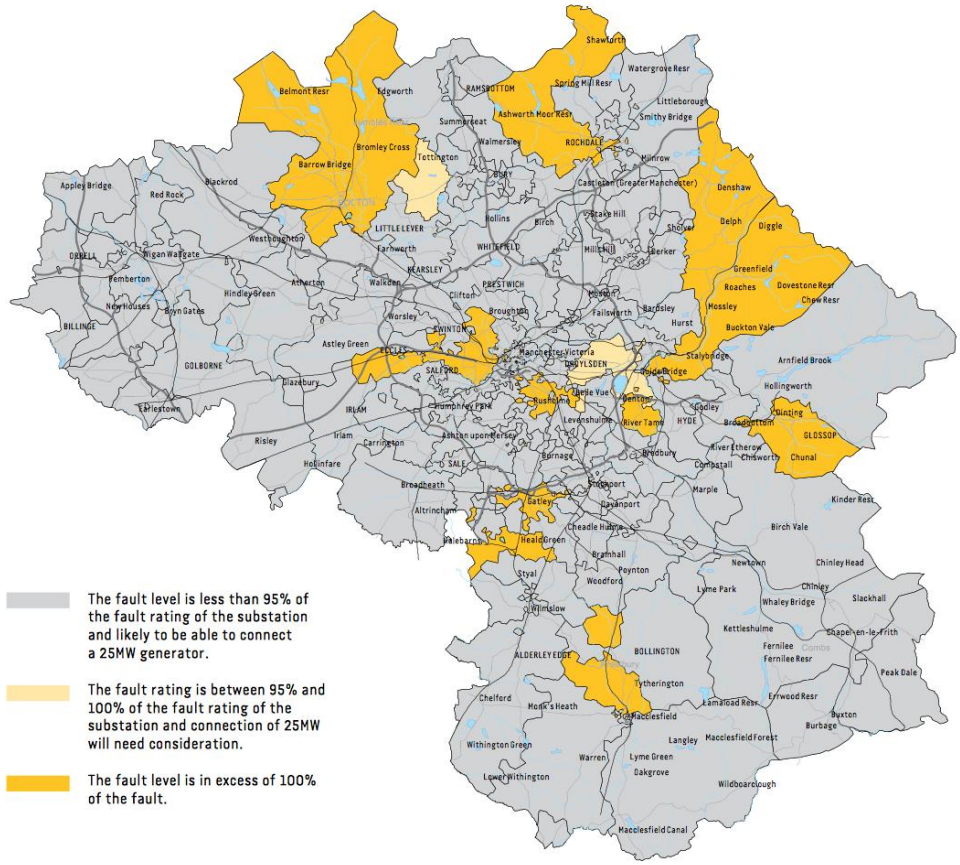
Figure 2.1: Greater Manchester's 132kV and 33kV electricity distribution network



Source: GMEP 2011:37

This network is generally considered robust (Energy Technologies Institute 2016: 23) but has the following restrictions in capacity for connecting new generation:

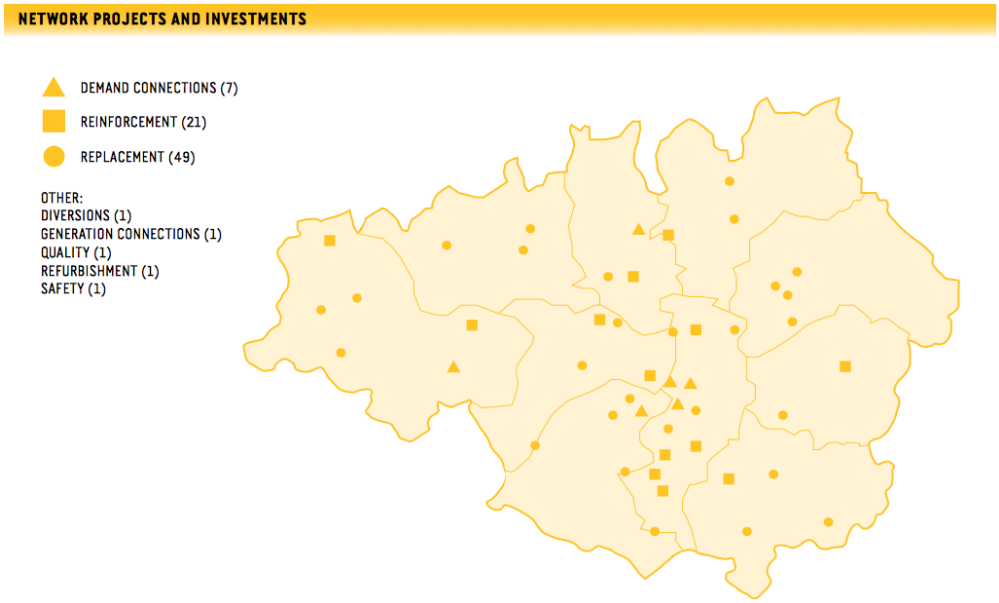
Figure 2.2: Areas in which connection capacity is approaching or exceeding the fault level



Source: GMEP 2011:38

The following map shows areas of significant investment in the electricity distribution network – highlighting upgrading work over a monetary value of £ 100,000:

Figure 2.3: Areas of significant investment in electricity network in Greater Manchester



Source: GMEP 2011:43

2.4 Patterns of energy consumption

In the Greater Manchester Spatial Energy Plan (2016) it is suggested that Greater Manchester uses a total of 51.6 TWh of energy per year – around 3% 0f the UK total (Energy Technologies Institute 2016:19, see also Low Carbon Hub Board 2016:2). This compares to figures in the GM Energy Programme for 2009 of 11.7 TWh of electricity and 25.8 TWh of gas and 20TWh of petroleum products (totalling 57.5TWh) (GMEP 2011:6). These figures include domestic, non-domestic and road transport consumption.

2.4.1 Domestic and non-domestic consumption

UK Government DBEIS Statistics show the domestic and non-domestic consumption of electricity and gas (excluding transport) for Greater Manchester to be a total of 32.3 GWh – made up of 11.5 GWh of electricity and 20.77 GWh of gas (DBEIS 2016). This data is is collected from MPAN data, linked to postcodes through Gemserve and then aggregated up to LSOA, MSOA/IGZ, local authority and English region and devolved administration levels (DBEIS 2016). Compiled summaries of domestic and non-domestic metered energy consumption data are available at NUTS1 and NUTS 4 levels. Aggregation of the ten local authority areas (NUTS4) that make up Great Manchester gives a total domestic and non-domestic consumption figure for Greater Manchester (NUTS 2) of 32.2566 GWh in 2015 made up of 11.5 GwH electricity and 20.767 GWh of gas. The following Table 2.1 shows the detailed breakdown at NUTS 4 level for domestic consumption – first of electricity and then gas:

Table 2.1: Sub-national electricity sales and average domestic consumption 2005-2015

NUTS4 Code	NUTS4 Area	2005		2006		2007		2008		2009		2010	
		Domestic Sales (GWh)	Average domestic consump-tion – Sales per consumer (kWh)	Domestic Sales (GWh)	Average domestic consump-tion – Sales per consumer (kWh)	Domestic Sales (GWh)	Average domestic consump-tion – Sales per consumer (kWh)	Domestic Sales (GWh)	Average domestic consump-tion – Sales per consumer (kWh)	Domestic Sales (GWh)	Average domestic consump-tion – Sales per consumer (kWh)	Domestic Sales (GWh)	Average domestic consump-tion – Sales per consumer (kWh)
UKD3201	Bolton	501	4,561	496	4,210	496	4,115	469	3,922	475	3,913	474	3,891
UKD3202	Bury	341	4,597	346	4,308	347	4,262	326	4,048	327	4,017	327	3,995
UKD3101	Manchester	816	4,270	844	4,059	860	4,021	828	3,885	836	3,888	847	3,916
UKD3203	Oldham	372	4,249	368	3,948	368	3,909	348	3,734	350	3,731	348	3,701
UKD3204	Rochdale	367	4,409	367	4,126	366	4,072	348	3,892	348	3,855	348	3,837
UKD3102	Salford	431	4,447	435	4,173	444	4,123	424	3,944	435	3,992	439	4,001
UKD3103	Stockport	552	4,712	548	4,368	546	4,305	519	4,128	521	4,114	520	4,092
UKD3104	Tameside	391	4,320	388	4,005	385	3,928	368	3,764	371	3,752	370	3,729
UKD3105	Trafford	424	4,708	429	4,461	426	4,393	403	4,198	407	4,198	409	4,198
UKD3205	Wigan	545	4,353	549	4,077	555	4,013	522	3,819	530	3,806	526	3,758
UKD3201	Bolton	2,141	19,635	2,078	18,873	2,033	18,156	1,949	17,361	1,776	15,703	1,724	15,193
UKD3202	Bury	1,558	20,686	1,504	19,836	1,462	19,155	1,408	18,427	1,276	16,653	1,242	16,165
UKD3101	Manchester	3,133	18,361	3,000	17,490	2,906	16,733	2,768	15,897	2,496	14,272	2,425	13,769
UKD3203	Oldham	1,747	20,246	1,673	19,303	1,627	18,612	1,570	17,926	1,418	16,157	1,369	15,554
UKD3204	Rochdale	1,639	19,626	1,591	18,824	1,545	18,136	1,483	17,379	1,339	15,551	1,298	15,036
UKD3102	Salford	1,653	18,395	1,592	17,605	1,549	16,911	1,486	16,227	1,356	14,671	1,316	14,205
UKD3103	Stockport	2,483	21,744	2,390	20,836	2,308	19,987	2,241	19,360	2,020	17,374	1,984	17,041
UKD3104	Tameside	1,732	18,860	1,663	18,025	1,616	17,321	1,562	16,641	1,411	14,962	1,373	14,533
UKD3105	Trafford	1,902	21,654	1,856	20,853	1,785	19,963	1,737	19,385	1,590	17,627	1,564	17,328
UKD3205	Wigan	2,351	18,551	2,285	17,872	2,228	17,136	2,146	16,374	1,953	14,795	1,904	14,362

Source: UK Government BEIS: December 2016 (online at: https://www.gov.uk/government/statistical-data-sets/regional-and-local-authority-electricity-consumption-statistics-2005-to-2011)

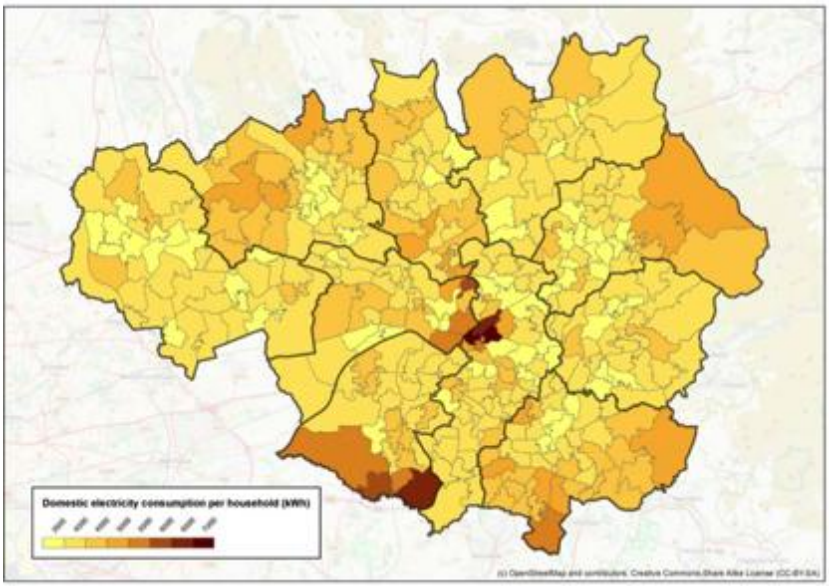
Table 2.1: Sub-national electricity sales and average domestic consumption 2005-2015 [continued]

NUTS4 Code	NUTS4 Area	2011		2012		2013		2014		2015	
		Domestic Sales (GWh)	Average domestic consumption – Sales per consumer (kWh)	Sales (GWh) Domestic consumers	Average kWh -All Domestic – Mean consumption	Sales (GWh) Domestic consumers – All domestic	Average kWh All domestic – Mean consumption	Sales (GWh) Domestic consumers – All domestic	Average kWh, All domestic – Mean consumption	Sales (GWh)Domestic consumers	Average kWh All domestic – Mean consumption
UKD3201	Bolton	473	3,868	464	3,793	459	3,743	459	3,743	477	3,716
UKD3202	Bury	326	3,974	319	3,884	314	3,819	313	3,819	327	3,789
UKD3101	Manchester	836	3,858	835	3,846	817	3,754	820	3,754	848	3,752
UKD3203	Oldham	346	3,688	339	3,605	338	3,578	338	3,578	356	3,555
UKD3204	Rochdale	346	3,810	336	3,695	334	3,655	334	3,655	352	3,627
UKD3102	Salford	435	3,957	427	3,868	422	3,804	422	3,804	441	3,808
UKD3103	Stockport	514	4,052	504	3,962	499	3,920	500	3,920	518	3,897
UKD3104	Tameside	369	3,709	360	3,611	358	3,572	358	3,572	374	3,539
UKD3105	Trafford	406	4,169	398	4,092	395	4,058	393	4,058	408	4,033
UKD3205	Wigan	521	3,722	510	3,637	506	3,602	507	3,602	529	3,583
UKD3201	Bolton	1,637	14,384	1,622	14,197	1,577	13,744	1,509	13,104	1,511	13,089
UKD3202	Bury	1,177	15,246	1,171	15,065	1,135	14,554	1,086	13,876	1,084	13,790
UKD3101	Manchester	2,269	12,763	2,226	12,405	2,166	12,031	2,082	11,545	2,079	11,477
UKD3203	Oldham	1,296	14,707	1,277	14,397	1,246	13,936	1,196	13,278	1,193	13,170
UKD3204	Rochdale	1,227	14,207	1,207	13,915	1,173	13,455	1,125	12,828	1,125	12,772
UKD3102	Salford	1,235	13,244	1,225	13,056	1,190	12,619	1,139	12,107	1,136	12,024
UKD3103	Stockport	1,860	15,924	1,870	15,890	1,817	15,407	1,744	14,754	1,734	14,628
UKD3104	Tameside	1,295	13,651	1,284	13,460	1,248	13,033	1,194	12,430	1,191	12,350
UKD3105	Trafford	1,461	16,149	1,478	16,286	1,440	15,835	1,383	15,213	1,369	14,997
UKD3205	Wigan	1,773	13,303	1,757	13,108	1,682	12,507	1,614	11,940	1,606	11,828

Source: UK Government BEIS: December 2016 (online at: https://www.gov.uk/government/statistical-data-sets/regional-and-local-authority-electricity-consumption-statistics-2005-to-2011)

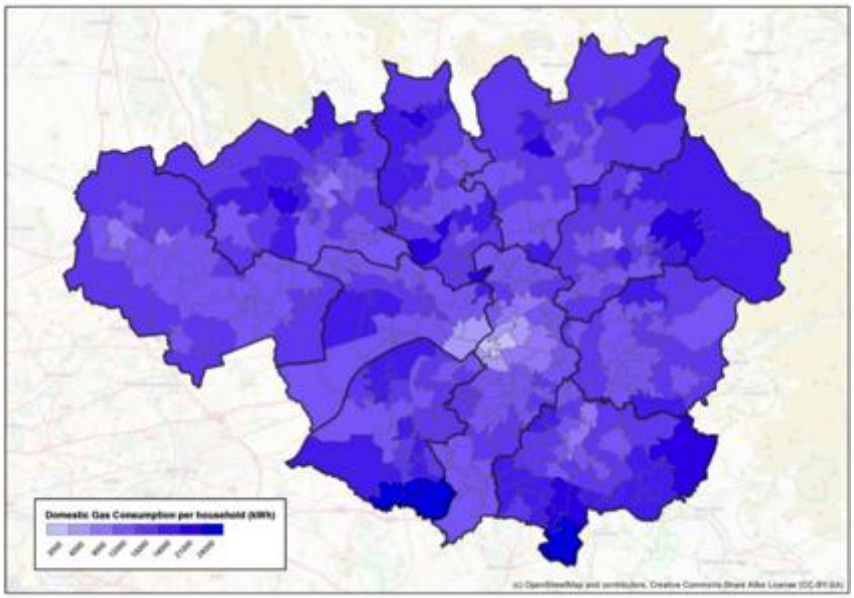
These figures represent averages and within local authority areas there is significant variation:

Figure 2.4: Variation in electricity consumption within local authority areas (NUTS 4)



Source: Catapult Energy Systems 2016:107

Figure 2.5: Variation in gas consumption within local authority areas (NUTS 4)



Source: Catapult Energy Systems 2016:108

There is acknowledgement of uncertainties around future demand for energy in GM under a changing climate, particularly around changes in energy profiling – with potential for increasingly warm spring and autumns reducing the heating demand requirement but conversely putting pressure on cooling in summer (MA interview).

2.4.2 Consumption By Industry sector

The UK Government compiles statistics on energy consumption by sector at UK level. Since 2011, these are made available through the DUKES tables and Energy Consumption UK (ECUK) reports. Non-domestic figures are not broken down by NUTS3 (or other sub-regional geographic areas), so figures are only available at a UK level and are measured in units of thousand tonnes of oil equivalent. The following four tables are extracts from the DUKES tables for 2016 showing energy consumption by sector at a UK level – both final consumption and fuels consumed for further electricity generation:

Table 2.2: Final Energy Consumption By Main Industrial Groups at UK Level 2011-2015

Thousand tonnes of oil equivalent

	2011	2012	2013	2014	2015
Iron and steel and non-ferrous metals					
Coal	51	49	52	53	44
Manufactured solid fuels *(2)*	281	343	445	451	384
Blast furnace gas	64	26	13	14r	11
Coke oven gas	59	43	62	55r	50
Natural gas	659	600	625	640r	632
Petroleum	4	5	4	6r	7
Electricity	931	723	708r	710r	696
Total iron and steel and non-ferrous metals	**2,050**	**1,789**	**1,908r**	**1,930r**	**1,823**
Chemicals					
Coal	50	49	55	65r	47
Natural gas	1,379	1,307	1,305r	1,251r	1,301
Petroleum	189	124	106r	103r	121
Electricity	1,517	1,500	1,421r	1,326r	1,342
Heat purchased from other sectors *(3)*	350	336	325r	281r	260
Total chemicals	**3,484**	**3,316**	**3,211r**	**3,026r**	**3,070**
Metal products, machinery and equipment					
Coal	48	46	49	64r	54
Natural gas	1,028	1,073	1,104r	1,084r	1,104
Petroleum	138	149	181r	175r	199
Electricity	1,619	1,577	1,574	1,501r	1,469
Heat purchased from other sectors *(3)*	-	-	-	-	-
Total metal products, machinery and equipment	**2,833**	**2,845**	**2,907r**	**2,823r**	**2,827**
Food, beverages and tobacco					
Coal	32	31	31	45r	38
Natural gas	1,764	1,734	1,771r	1,761r	1,765
Petroleum	141	126	129r	117r	106
Electricity	973	958	953	915r	923
Heat purchased from other sectors *(3)*	2	3	-r	-	-
Total food, beverages and tobacco	**2,912**	**2,851**	**2,884r**	**2,838r**	**2,832**

(1) Industrial categories used are described in Table 1l. Data excludes energy used to generate heat for all fuels except manufactured solid fuels and electricity.
(2) Includes tars, benzole, coke and breeze and other manufactured solid fuels
(3) Data equates to heat sold information in the energy balances.

Thousand tonnes of oil equivalent

	2011	2012	2013	2014	2015
Paper, printing and publishing					
Coal	71	80	70	93r	71
Natural gas	641	609	699r	668r	676
Petroleum	30	29	30r	28r	29
Electricity	938	934	929	923r	911
Heat purchased from other sectors *(3)*	1	1	-	-	-
Total paper, printing and publishing	**1,681**	**1,653**	**1,729r**	**1,712r**	**1,687**
Other industries					
Coal	941	957	1,173	1,282r	1,088
Natural gas	2,654	2,545	2,570r	2,621r	2,643
Petroleum	392	412	407r	421r	428
Electricity	2,824	2,750	2,749	2,601r	2,600
Heat purchased from other sectors *(3)*	417	426	411	432r	435
Total other industries	**7,228**	**7,090**	**7,311r**	**7,357r**	**7,195**
Unclassified					
Manufactured solid fuels *(2)*	42	49	74	46	12
Coke oven gas	-	-	-	-	-
Natural gas	2	2	1	1	1
Petroleum	3,604	3,824	3,199	3,209r	3,046
Bioenergy & waste	506	459	636r	776r	1,102
Total unclassified	**4,154**	**4,334**	**3,910r**	**4,031r**	**4,160**
Total					
Coal	1,194	1,212	1,430	1,603r	1,342
Manufactured solid fuels *(2)*	323	392	519	497	395
Blast furnace gas	64	26	13	14r	11
Coke oven gas	59	43	62	55r	50
Natural gas	8,127	7,870	8,075r	8,026r	8,123
Petroleum	4,500	4,669	4,056r	4,059r	3,935
Bioenergy & waste	506	459	636r	776r	1,102
Electricity	8,801	8,442	8,333r	7,976r	7,940
Heat purchased from other sectors *(3)*	769	766	736r	713r	695
Total	**24,344**	**23,879**	**23,860r**	**23,718r**	**23,594**

Source: UK Government Dukes tables 2016

Table 2.3: Energy Consumption for Electricity Generation (auto generation) By Main Industrial Groups

Thousand tonnes of oil equivalent
(except where shown otherwise)

	2011	2012	2013	2014	2015
Iron and steel and non-ferrous metals					
Coal (2)	651	521	-	-	-
Blast furnace gas	454	591	740	731r	641
Coke oven gas	196	182	172	154r	137
Natural gas	37	39	39	34r	43
Petroleum	7	7	7	7	16
Other (including renewables) (3)	60	63	58	62r	63
Total fuel input (4)	**1,404**	**1,402**	**1,016**	**989r**	**901**
Electricity generated by iron & steel and non-ferrous metals (5)	**429**	**370**	**185**	**335r**	**166**
(in GWh)	4,983	4,303	2,147r	3,896r	1,928
Electricity consumed by iron and steel and non-ferrous metals from own generation (6)	**349**	**187**	**166r**	**181r**	**163**
(in GWh)	4,065	2,170	1,931r	2,106r	1,892
Chemicals					
Coal	109	110	7r	7r	7
Natural gas	718	727	627r	454r	434
Petroleum	6	6	0r	0r	0
Other (including renewables) (3)	68	42	30r	29r	31
Total fuel input (4)	**900**	**885**	**664r**	**491r**	**472**
Electricity generated by chemicals (5)	**379**	**412**	**301r**	**206r**	**193**
(in GWh)	4,404	4,793	3,501r	2,391r	2,248
Electricity consumed by chemicals from own generation (6)	**239**	**242**	**161r**	**134r**	**148**
(in GWh	2,783	2,811	1,875r	1,557r	1,723
Metal products, machinery and equipment					
Coal	-	-	-	-	-
Natural gas	42	42	40r	27r	31
Petroleum	6	6	6	6	6
Other (including renewables) (3)	48	48	47r	63r	63
Total fuel input (4)	**96**	**95**	**93r**	**96**	**99**
Electricity generated by metal products, machinery and equipment (5)	**22**	**22**	**24**	**25r**	**25**
(in GWh)	251	256	279	286r	290
Electricity consumed by metal products, machinery and equipment from own generation (6)	**21**	**21**	**23**	**24r**	**24**
(in GWh)	241	245	267r	275r	278
Food, beverages and tobacco					
Coal	4	4	4	5	5
Natural gas	361	352	345	360r	366
Petroleum	4	3	3	2	2
Other (including renewables) (3)	6	10	3r	31r	30
Total fuel input (4)	**375**	**369**	**355r**	**397r**	**403**
Electricity generated by food, beverages and tobacco (5)	**186**	**187**	**187**	**198r**	**199**
(in GWh)	2,157	2,178	2,177	2,300r	2,317
Electricity consumed by food, beverages and tobacco from own generation (6)	**110**	**115**	**112**	**116r**	**119**
(in GWh)	1,277	1,339	1,301r	1,344r	1,379

(1) Industrial categories used are described in Table 1l.
(2) The power plant in this category was reclassified as a Major Power Producer in 2013 so no longer appears in the autogeneration figures
(3) Includes hydro electricity, solid and gaseous renewables and waste.
(4) Total fuels used for generation of electricity. Consistent with figures for fuels used by other generators in Table 5.4.

Thousand tonnes of oil equivalent
(except where shown otherwise)

	2011	2012	2013	2014	2015
Paper, printing and publishing					
Coal	30	26	10	-	-
Natural gas	368	417	301	272r	248
Petroleum	0	0	0	0	0
Other (including renewables) (3)	83	94	92r	240r	270
Total fuel input (4)	**480**	**538**	**403r**	**511r**	**517**
Electricity generated by paper, printing and publishing (5)	**195**	**210**	**187**	**207r**	**195**
(in GWh)	2,264	2,441	2,180	2,412r	2,272
Electricity consumed by paper, printing and publishing from own generation (6)	**126**	**141**	**137**	**161r**	**156**
(in GWh)	1,468	1,642	1,590r	1,878r	1,816
Other industries					
Coal	-	-	-	-	-
Coke oven gas	28	28	28	28	5
Natural gas	79	71	59	60r	58
Petroleum	6	6	2	3	3
Other (including renewables) (3)	1,918	1,924	1,942	1,932	1,894
Total fuel input (4)	**2,032**	**2,028**	**2,031**	**2,023r**	**1,961**
Electricity generated by other industries (5)	**116**	**119**	**125r**	**140r**	**168**
(in GWh)	1,347	1,380	1,448r	1,623r	1,952
Electricity consumed by other industries from own generation (6)	**103**	**106**	**114**	**130r**	**150**
(in GWh)	1,192	1,238	1,326r	1,506r	1,742
Total					
Coal	794	661	20r	12r	12
Blast furnace gas	454	591	740	731r	641
Coke oven gas	224	210	200	182r	142
Natural gas	1,605	1,647	1,411r	1,208r	1,180
Petroleum	28	27	19r	18r	28
Other (including renewables) (3)	2,182	2,181	2,172r	2,356r	2,351
Total fuel input (4)	**5,287**	**5,317**	**4,561r**	**4,507r**	**4,354**
Electricity generated (5)	**1,325**	**1,320**	**1,009r**	**1,110r**	**946**
(in GWh)	15,408	15,351	11,732r	12,909r	11,006
Electricity consumed from own generation (6)	**948**	**812**	**713r**	**745r**	**759**
(in GWh)	11,025	9,445	8,291r	8,667r	8,830

(5) Combined heat and power (CHP) generation (i.e. electrical output from Table 7.8) plus non-chp generation, so that the total electricity generated is consistent with the "other generators" figures in Table 5.6.
(6) This is the electricity consumed by the industrial sector from its own generation and is consistent with the other generators final users figures used within the electricity balances (Tables 5.1 and 5.2). These figures are less than the total generated because some of the electricity is sold to the public distribution system and other users.
(7) The figures presented here are consistent with other figures presented elsewhere in this publication as detailed at (4), (5), and (6) above but are further dissaggregated. Overall totals covering all autogenerators can be derived by adding in figures for transport, services and the fuel industries. These can be summarised as follows:

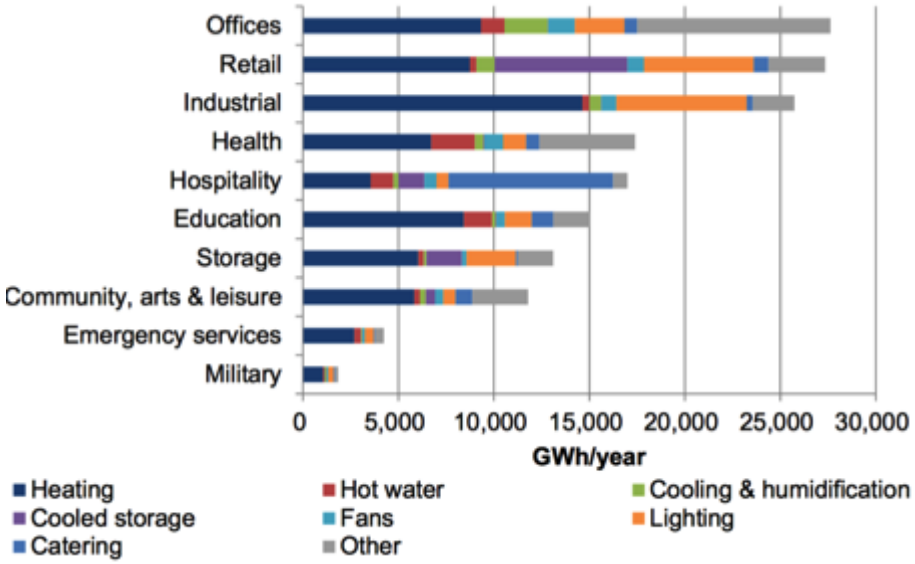
Thousand tonnes of oil equivalent

Fuel input	**2011**	**2012**	**2013**	**2014**	**2015**
All industry	5,287	5,317	4,561r	4,507r	4,354
Fuel industries	1,732	1,981	1,799	2,043r	2,338
Transport, Commerce and Administration	284	367	379r	409r	399
Services	1,381	814	1,143r	1,506r	2,276
Total fuel input	**8,684**	**8,478**	**7,882r**	**8,465r**	**9,367**
Electricity generated	**3,006**	**3,036**	**2,893r**	**3,358r**	**3,728**
Electricity consumed	**1,554**	**1,489**	**1,503r**	**1,585r**	**1,880**
					GWh
Electricity generated	**34,960**	**35,309**	**33,647r**	**39,050r**	**43,353**
Electricity consumed	**18.079**	**17.318**	**17.484r**	**18.428r**	**21.863**

Source: UK Government Dukes tables 2016

In addition, DBEIS collect information on the breakdown of energy use within particular sectoral groups – a summary is shown in Figure 2.6 below:

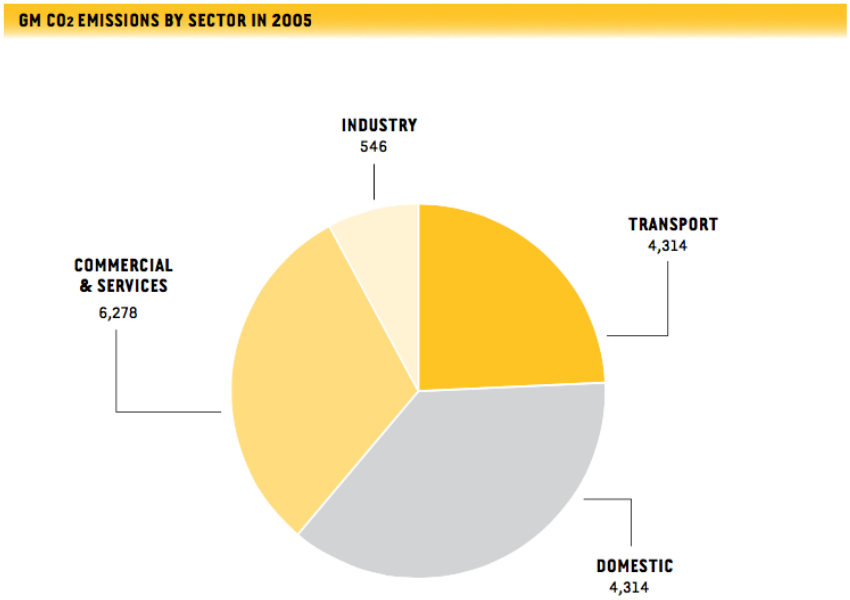
Figure 2.6: Energy Consumption by sector and energy end use 2014-15 UK level



Source: DBEIS 2016b: 98

At the Greater Manchester scale, most energy consumption by industry sector statistics are expressed as CO_2 emissions rather than direct consumption units. For example in 2016 New Economy reported that Greater Manchester's direct carbon emissions were 15.3 million tonnes in 2013 of which "industry and commercial use account for 37% of carbon emissions, with 35% from the domestic sector, 27% from transport and 1% from land use, land change or forestry" (New Economy 2016). Greater Manchester Energy Group's report "Connected: The Greater Manchester Energy Plan" quantifies these figures for four broad sectors in million tonnes of CO_2 as follows:

Figure 2.7: Greater Manchester CO_2 emissions by sector in 2005



Source: GMEP 2011:14

2.4.3 Consumption in Public Buildings

Out of 2,053 public buildings with a DEC (Display Energy Certificate) in Greater Manchester, 48% achieve a D rating or better" (Catapult Energy Systems 2016:21).

2.4.4 Share of energy carriers by sector

UK Department for Business release an annual Energy Trends Report identifying changes in the source, use and supply, of energy over the preceding few years (variable 3-6). The % share of energy carriers at a UK level between 2011 and 2016 has been compiled from statistics presented in DBEIS 2016b: 12 – this is not available by sector:

Table 2.4: % share of Energy carrier at a UK level between 2011 and 2016

Year	2011	2012	2013	2014	2015
Energy carrier					
Coal	8.38%	8.65%	6.95%	6.43%	4.34%
Gas	32.99%	31.73%	31.71%	32.39%	31.81%
Petroleum	41.44%	39.80%	38.66%	38.47%	39.76%
Bioenergy	4.44%	5.55%	6.69%	7.31%	7.95%
Electricity (Nuclear)	11.36%	12.40%	13.38%	12.24%	12.45%
Electricity (wind solar and hydro)	1.35%	1.86%	2.62%	3.17%	3.74%
Total	99.96%	99.99%	100.01%	100.01%	100.05%

Source: DBEIS 2016b: 12

2.5 Regional potential of renewable energy

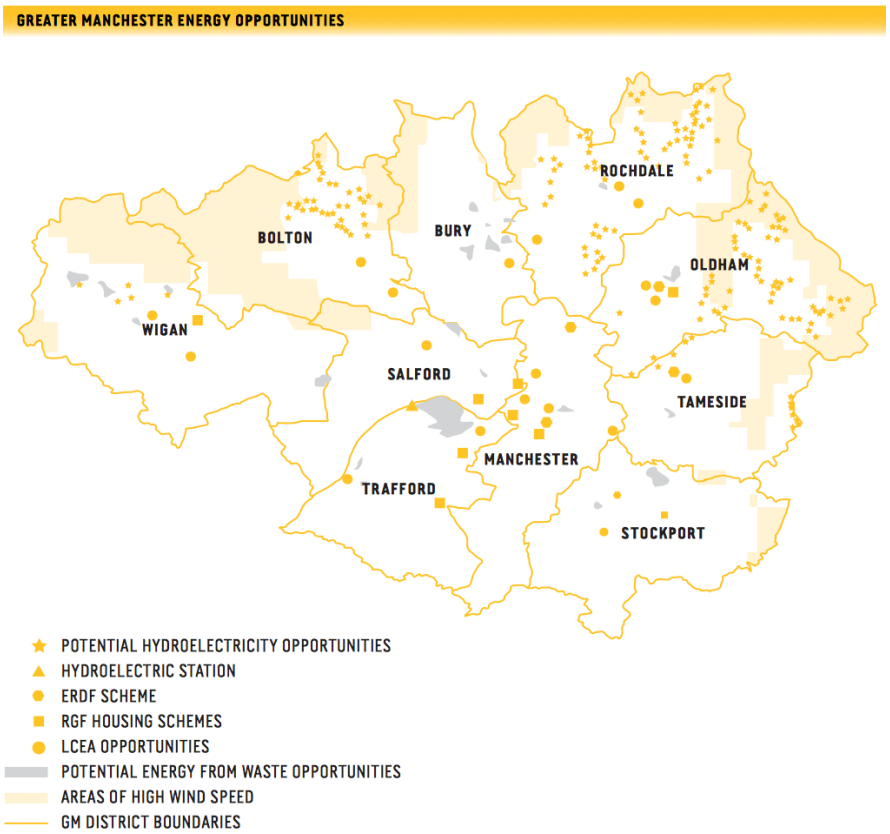
There have been two significant assessments of renewable energy potential within the greater Manchester region over the last seven years – the North West Development Agency Appraisal of Renewable and Low Carbon Energy Capacity in the former North West region (2010) and the Energy Technology Institute Greater Manchester Spatial Energy Plan Evidence Base (2016). Although the NWDA report focus is the whole North West Region it gives some specific figures for Greater Manchester.

The NWDA appraisal focussed on renewable and low carbon energy capacity in the former North West region (not including offshore, marine or tidal) and identified a potential accessible renewable energy resource of 6,871 MW within Greater Manchester broken down by type: 79% from micro-generation (54% from heat pumps), 19% from community wind, 13% ground source heat pumps, 6% solar hot water heating, 6% PV, 1% municipal waste and 1% C&I waste (New Economy 2013:70). This contributed towards a North West regional figure of just over 40GW (NDWA 2010:11). While this was deemed sufficient to meet the NW Renewable Energy Strategy targets of 30% electricity to be from renewable sources by 2020 it was identified that "there were considerable challenges, constraints and uncertainties which might make deployment of the resources by 2020 difficult" (GMEP 2011:22). In particular, Greater Manchester's combined solar PV and solar thermal resource of 880MW and combined ground

and air source heat pump resource of 4,529MW were highlighted (NWDA 2010:ii). In addition, to data showing strong potential from landfill, sewage and AD gas, NWDA identified potential for small-scale hydro (12.8MW), biomass (9.2 MW electricity and 10.5 MW Heat), and commercial wind (1265 MW via 506 turbines within Greater Manchester), with little small-scale wind potential within the predominantly urban area (NWDA 2010:16).

From this assessment, the Greater Manchester Energy Plan specifically maps the following sites as offering potential for future generation:

Figure 2.8: Potential Low Carbon Generation Opportunities identified in 2005

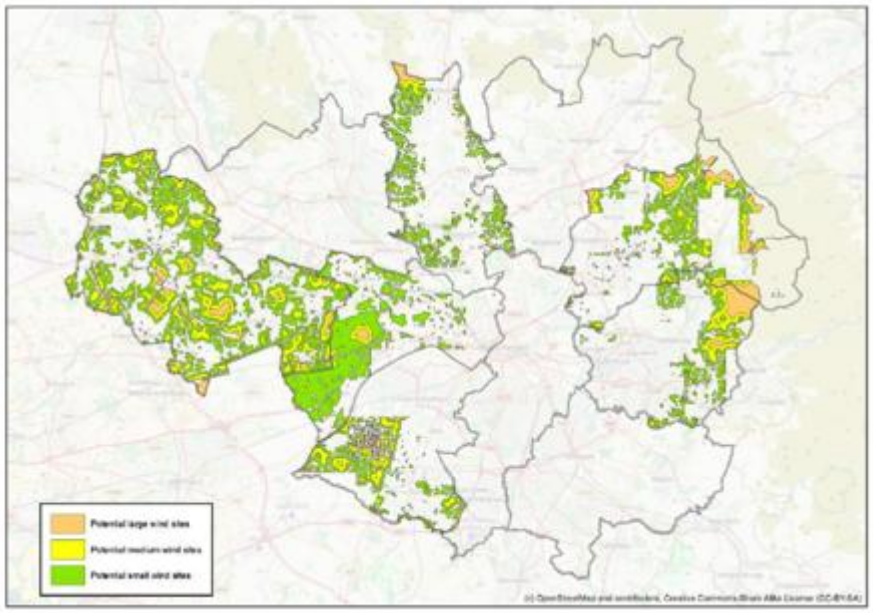


Source: GMEP 2011

In 2016 as part of the Energy Technologies Institute (ETI) Smart Systems and Heat Programme a Spatial Energy Plan was commissioned for Greater Manchester Combined Authority 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" (ETI 2016:13). It is difficult to compare these two assessments directly because the NWDA (2010) report cited figures in MW whereas the ETI (2016) report used GWh so conversion for comparison is required. Further the ETI report often uses secondary measures such as percentage of existing consumption, or tonnes of carbon emissions, making direct comparison difficult. However, the Energy Technology Institute suggest that up to 1,030 GWh/yr. (9% of existing electricity consumption) and up to 68% of existing gas demand could (technically) be generated by renewable energy sources within Greater Manchester region (ETI 2016:26). The identified mix has not substantially changed with observation that "The majority of regional

renewable electricity generation in GM is from Landfill, sewage and AD gas (74%)" ETI 2016:23) with capacity to meet heat demand through ground source and air source heat pumps (12,400 TWh/yr. or 50% of current GM domestic and non-domestic heat consumption), from solar thermal (2,770 GWh/yr. or 13% of current gas demand) and biomass heat (1,173 GWh/yr. or 5% of current gas demand) sourced from 10,000 tonnes of biomass available within the GM boundary and a wider regional supply chain of 325,000 tonnes (ETI 2016:26). Technical capacity for electricity provision was identified from solar PV (7.3% of current GM electricity consumption), hydro (0.04% GM electricity demand or 4.4 GWh/yr.) and wind – principally in Bury and Oldham (where a potential of 140 GWh/yr. further extends the existing 2.2GWh/yr. generation capacity in the Greater Manchester area) (ETI 2016:26). Potential wind generation sites are identified in Figure 2.9 below:

Figure 2.9: Map showing potential sites for wind deployment – Small = less than 50kW, Medium = up to 550kW, Large = up to 2MW



Source: ETI 2016:135

2.5.1 Low Carbon Energy Potential

In addition to strictly renewable sources of energy district heating is identified as offering potential for a range of both low carbon and renewable technologies (ETI 2016:27). Such district heating may either be powered by high efficiency gas systems or by recovering surplus waste heat from industry, power stations and waste incinerators. In 2010 assessment of low carbon energy generation potential – CHP, trigeneration and district heating – gave a further potential for Greater Manchester of 9016 MW (NWDA 2010:v). In 2016 it was suggested that mine water heat extraction within Greater Manchester has the technical potential to provide 176 MWth/yr, and there is potential for recovering power station heat of 6,000 GWh/yr and industrial waste heat of 1,000 GWh/yr from across the whole North West region (ETI 2016:27). District heating total potential across the North West region offered 37,000 GWh/yr "with a

cost-effective potential of 4,000 GWh/yr23 under current market and regulatory arrangements" (ETI 2016:27). Within this Greater Manchester has identified "feasible opportunities for approximately 35 individual District Heating Networks with technical potential to reduce GM carbon emissions by 413 $ktCO_2$ (3%)" (ETI 2016:27).

Table 2.5: Quantitative figures of Accessible Renewable Energy Resource by technology at NUTS 2 in 2010

Table 1: Accessible renewable energy resource by technology group, sub-categories and sub region (at 2020)

Technology group	Total energy (MW)	Sub-categories	Electricity (MW)	Heat (MW)	TOTAL (MW)	Cheshire	Cumbria	Greater Manchester	Lancashire	Merseyside
Wind	**24,456**	Wind – commercial	23,587		**23,587**	4,806	10,399	1,265	6,497	619
		Wind – small scale	669		**669**	235	220	0	201	13
Biomass	**1,118**	Plant Biomass – Managed woodland	20		**20**	2	13	1	3	1
		Managed woodland (HEAT)		122	**122**	12	81	6	9	4
		Energy crops	11		**11**	3	3	1	3	2
		Energy crops (HEAT)		60	**60**	16	15	4	15	10
		Waste wood	39		**39**	7	12	7	10	4
		Agricultural arisings (straw)	11		**11**	4	2	1	3	1
		Animal Biomass (Wet Organic Waste)	206		**206**	49	99	7	49	2
		Animal Biomass (Poultry Litter)	9		**9**	3	3	1	2	0
		Municipal Solid Waste (MSW)	211		**211**	33	17	77	43	41
		Commercial & Industrial Waste (C&IW)	135		**135**	22	9	56	26	22
		Landfill gas	68		**68**	32	3	8	14	11
		Sewage gas	28		**28**	6	0	16	4	3
		Co-firing of biomass	198		**198**	198	0	0	0	0
Hydro	**77**	Small scale hydropower	77		**77**	4	47	13	10	3
Microgen.	**14,671**	Solar Photovoltaics (PV)	1,158		**1,158**	153	90	440	238	237
		Solar Water Heating (SWH)		1,158	**1,158**	153	90	440	238	237
		Ground Source Heat Pump		2,471	**2,471**	344	207	906	511	503
		Air Source Heat Pump		9,884	**9,884**	1,376	829	3,623	2,043	2,013
TOTALS			26,426	13,695	40,122	7,459	12,139	6,871	9,929	3,725
Percentage (%)						**18.6%**	**30.3%**	**17.1%**	**24.7%**	**9.3%**

Source: NWDA Report 2010:iii

Table 2.6: Identified Capacity from selected technologies from ETI Evidence Base Report for GM Spatial Strategy

	Solar PV	**Solar Thermal**	**Heat Pumps (Ground and Air source)**	**Water source Heat Pumps**	**Wind**	**Hydro**	**Biomass**	**Mine Water**
Electricity	1090MW 917 GWh 8% current electricity consumption in GM				60MW 141 GWh/yr. (1.1% of total GM 2015 electricity consumption)	256 kW 4.4 GWh (0.04% GM electricity demand)		
Heat		600MW (domestic) (2770 GWh Equivalent to 13% of gas demand or 5.4% of total annual energy demand in GM)	8GW (10.7 TWh per year as a theoretical maximum if heat pumps provide heating to 50% of all properties. However could increase annual electricity consumption by 30%).	25MW (Manchester Ship Canal and River Irwell)			1,173 GWh (5% of 2014 total gas demand)	176 MWth/yr. (less than 0.5% of total 2005 gas demand)

Source: ETI 2016

2.5.2 Summary

There is currently a gap of around 0.5m tonnes between currently identified projects and the 2020 target of 4 million tonnes of carbon reduction in Greater Manchester's Climate Change Strategy for 2012-2020 (GMCA 2016:4). Analysis by the Tyndall Centre suggests that 2.9 million tonnes of savings will be delivered by 2020 if all of the existing and planned actions in Section 5 of the Plan are fully implemented. However these figures represent technical capacity and both the NWDA (2010) and ETI (2016) reports identify challenges around economic viability, transmission constraints, supply chain constraints and planning constraints – all of which mean that this technical capacity may not be realised. A large proportion of potential renewable energy generation capacity across the North West region identified in the NWDA assessment comes from onshore wind (40GW) but this involves significant planning challenges constraints and uncertainties for development by 2020. The plan assumes that "A further 1 mtCO_2 of cuts can be estimated associated with background (largely national) activities on buses, goods vehicles for transport, emissions savings on the electricity and heat used, which are importing from National Grid, improvements in commercial sector and other sectors such as agriculture. This leaves at least 0.5 million tonnes of savings to be identified between now and 2020 beyond the proposed programme, plus additional potential savings to account for short term growth in the population and economy" (GMCA 2016:5).

As introduced in section 2.1, there is also considerable uncertainty around future energy demand – with energy efficiency and the 2008 economic recession weakening demand but ambitions for growth increasing demand. Greater Manchester is planning for growth in the numbers of businesses and homes requiring energy. Increasing electrification of major sectors, and increased electricity demand from the use of heat pumps and electric vehicles also increases electricity demand (GMEP 2011:19). Increases in electricity consumption from electrification of transport could add 0.5 MWh per year to the electricity consumption of each GM household by 2035 and electrification of heat through reliance on heat pumps could increase electricity consumption by 30% (ETI 2016:26). Decentralisation of electricity generation within GM will also place increasing pressure on electricity infrastructure networks (ETI 2016:27). The NDWA assumed a level demand between 2008 and 2020 with increasing energy efficiency and decarbonisation of electricity supply considered important to allow for economic growth (NWDA 2010:8). However, the UK as a whole estimates a doubling of demand by 2050 (GMEP 2011:27) and on this basis GM suggests it is now working closely with the DNO to look at the impact on the electricity network of these forecast changes and the possibilities for energy storage (Interview 1).While the local electricity network is generally very robust, "if we quickly move to electrification of transport and electrification of heat, our network will need to find other mechanisms to strengthen, particularly in certain areas…its ability to deal with that capacity" (Interview 1). Hope and confidence is being placed in development of a smart-grid and in energy storage beyond electricity (Interview 1).

Given that "Greater Manchester has the potential to deliver something like 9% of its electricity demand in the future, locally, but 68% of its heat demand" (Interview 1) attention is shifting to

renewable heat. However where significant emphasis was placed on biomass even as recently as the 2016 LCEES Plan, this has rapidly changed over the last six months to question the relation between biomass and air-quality and question the sustainability of biomass overall (Interview 1). Concern over biomass "wasn't in my mind when this was written [indicating the LCEES], and so there is a challenge in my mind there about heat and how we are going to be able to generate heat….biomass is a challenge for us, I don't know what we're going to do about that yet" (Interview 1). Attention is shifting to technical trials of new smart heating models to understanding heat demand and consumer experiences and develop algorithms for use in the UK National Energy Systems Catapult "Smart Systems and Heat (SSH) programme" (GMCA 2016c) and in developing (gas) district heat networks such as Manchester Civic Quarter Heat (Energy) Network (CQHN) – for further detail see section 2.3a.

2.6 Use of renewable energy in the region

Figures for Greater Manchester's existing installed renewable energy generation vary slightly but include:

- 120MW renewable energy generation (GMCA 2016a: 7),
- 29MW installed renewable heat and 140MW renewable electricity (ETI 2016:23)
- 219 MW (Green Alliance 2016).

Solar PV is the best documented technology. UK Government Department for Energy and Climate Change (2007-2016) collected statistics for the number of installations of Domestic Solar PV between 2010 and 2016. Figures are available for the ten Local Authority areas (at NUTS 4) – selecting the third quarter of each year enables data to be included for 2016 as forth quarter data for 2016 is not yet online at the time of writing:

Table 2.7: Number of Solar PV Installations – September 2010-2016

	Number of Installations						
LA (NUTS 4)	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Bolton	6	110	702	1,012	1,327	1,663	1,897
Bury	8	106	366	541	745	960	1,115
Manchester	22	101	2,074	2,593	2,861	3,703	6,205
Oldham	8	53	352	533	960	1,300	1,538
Rochdale	8	78	604	1,177	1,573	1,877	2,094
Salford	11	112	503	697	912	465	2,832
Stockport	13	420	2,616	2,955	3,187	3,465	3,974
Tameside	5	53	376	586	1,055	3,737	4,074
Trafford	13	122	514	636	818	992	1,130
Wigan	8	108	1,819	2,469	2,946	3,396	3,701
Total for Greater Manchester (NUTS 2)	102	1,263	9,926	13,199	16,384	23,558	28,560

Source: DECC 2017

Unfortunately, similar data is not collected for solar thermal, geothermal energy or biomass, where fragments of data need to be pieced together. For example in biomass the Barton Renewable Energy Plant biomass plant (20MW) was consented in 2016 and there are a number

of smaller scale biomass schemes across GM, such as the 7 high-rise biomass district heating schemes by Stockport Homes totalling 4.2MW and the 2x 2MW biomass boilers at University Hospital of South Manchester – see section 6. In addition, ETI suggest, "there is currently 6.8 MWe of accredited combined heat and power (CHP) installed across the 10 districts"(Energy Technologies Institute 2016:24) although it doesn't specify how much of this is biomass fuelled.

Greater Manchester has little large-scale wind energy generation except for Scout Moor Wind farm, (142.5GWh) (GMEP 2011:7) and hydropower schemes in Stockport and on the Manchester Ship Canal (GMEP 2011:29). Some data for small-scale generation is available for onshore wind and hydro through those registering for Feed-In Tariffs in 2016. The number and capacity of wind and hydro installations registering for Feed In Tariffs is shown for Local Authority areas – NUTS4. See Table 2.8 below:

Table 2.8: Number of Wind Installations registered for Feed In Tariffs

LA (NUTS 4)	**Number of Installations (and total kW in brackets) in 3rd quarter – Sept 2016**	**Number of Installations (and kW in brackets) in 3rd quarter – Sept 2016**
Bolton	2 (11kW)	-
Bury	4 (297kW)	2 (175 kW)
Manchester	-	-
Oldham	10 (150kW)	-
Rochdale	12 (682kW)	-
Salford	-	-
Stockport	1 (5kW)	1 (74 kW)
Tameside	-	1 (15 kW)
Trafford	-	1 (5 kW)
Wigan	3 (37kW)	-
Total Greater Manchester (NUTS 2)	32 (1182 kW)	5 (269 kW)

Source: DBEIS 2016c

In terms of the renewable part of waste, GM has seen construction of several projects by Greater Manchester Waste Disposal Authority for four anaerobic digestion plants (8MW) a combined heat and power scheme (83MW electricity and 5MW heat) and four landfill and other energy from waste schemes (combined total of 300MWh) established through PFI contracts. In addition Davyhulme Biogas Schemes converts bio methane (a bi-product of wastewater treatment) via anaerobic digestion into fuel for the local gas pipeline network and a fleet of sludge tankers, steam for the site and gas to 500 homes (10MW). There is no reliable data on direct consumption from renewable generation "however it is anticipated to be less than 0.5% of total demand" (GMEP 2011:12).

3 Governance and important regional policies

Since 2011, public sector governance has taken the form of a two-tier structure: Greater Manchester Combined Authority (city-region scale – NUTS 2) and its ten constituent local authorities – each with metropolitan borough status (NUTS 4). Greater Manchester Combined Authority (GMCA) holds responsibility for transport, planning and economic development (as strategic cross-boundary considerations) whereas the Metropolitan Boroughs retain local decision-making power over all other local authority functions. The city-region is also subject to policy drivers from national and European policy drivers, and the legacy of former North West regional scale priorities. The structure of this section has been adopted slightly from the template, first presenting the changing city-region governance context (3.1) and then focussing specific attention to the governance of low carbon at the city-region scale (3.2). The involvement of different actors is discussed in 3.3 together with specific experiences of working with the private sector, and then the role of membership in European Networks and Programmes in 3.4. Finally 3.5 discussed indicative effects of this city region governance framework and the specific advantages of collaboration.

3.1 Greater Manchester City-Region Governance System

Inauguration of the Greater Manchester Combined Authority in 2011 builds on a strong history of collaborative governance across the geographic footprint of Greater Manchester metropolitan area. Historically, there was a two-tier local authority structure between 1974 and 1986 comprising Greater Manchester County Council and ten district local authorities. After abolition of Greater Manchester County Council in 1986, voluntary collaboration at a Greater Manchester scale continued between 1986 and 2011 through the Association of Greater Manchester Authorities (AGMA) especially around strategic considerations (Gibbs, Jonas and While, 2002).

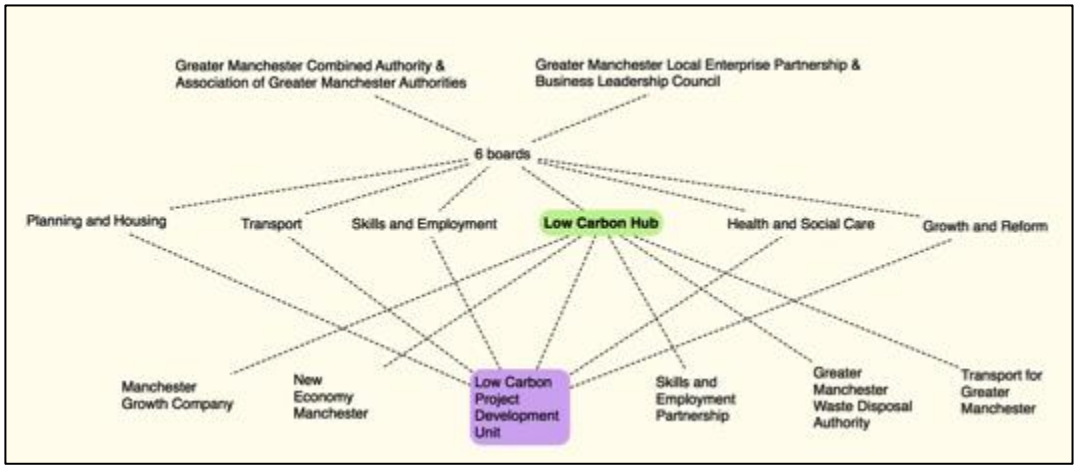
In Greater Manchester the term “city – region” needs to be demarcated from that of “region”, which has a specific history in the UK. Between 1999 and 2012 the UK had nine designated regions, each with their own governance structure: a Government Office for the Regions, an indirectly elected Regional Chamber, and a Regional Development Agency (RDA) that was designed to lead economic development and provide a link between local business needs and government policies (NWDA, 2009). As part of the North West region, a much larger area than the current Greater Manchester city-region that included Liverpool and Merseyside to the west and Lancashire and Cumbria to the north, Greater Manchester was under the North West Development Agency (NWDA). All the RDAs developed Regional Strategies and a Regional Strategy for the North West of England was published in 2008. The NWDA actively worked with the other Northern RDAs – One North East and Yorkshire Forward –to address the economic North-South imbalance of the UK through a jointly developed initiative called “The Northern Way”, which championed city-regions as vehicles for closing the north south economic divide (Hunt 2012: 16-17). As the UK’s second city, Manchester held a strong posi-

tion within the North West Region prompting Greater Manchester metropolitan area to understand itself as a key economic hub in addressing the wider UK North-South divide. However, in 2011, the new coalition Government and section 109 of the Localism Bill (DCLG 2011, 2013) abolished this regional scale of public sector governance, including all nine RDAs. The functions of RDAs across the UK were replaced with Local Economic Partnerships (LEPs), private sector partnerships designed to continue and increase the link between local business needs and both national and local government policies.

It was in this recent context that Greater Manchester was the first UK city outside London to establish a formal structure for metropolitan governance at the scale of Greater Manchester city-region – Greater Manchester Combined Authority (GMCA). It has been suggested that for stakeholders, the regional scale was seen to operate better at the Greater Manchester city-region level than the former North West regional scale as: "the GMCA boundaries are based on sound principles of functional economic areas…based on travel to work areas and economic output" (Cowie et al 2013:9). As part of this City-Region negotiation, Greater Manchester was the first of eight cities in the UK to enter into of a "City Deal" with central UK Government. This City Deal promises a package of enhanced powers, responsibilities and resources in various policy areas including transport, economic development and health and social care in return for active contributions to economic growth, reform of public services, and reducing the costs of service provision (see 3.32 for more detailed discussion).

The current GMCA occupies the same territorial boundaries as the former Greater Manchester County Council and exists alongside AGMA: where AGMA is a voluntary association made-up of elected representatives providing a policy scrutiny role for GMCA policies (AGMA 2012), GMCA is the constituted legal body staffed by officers (Interview 1). This formalises previously informal co-operation between public sector bodies and co-operation between public and private sectors through the LEP and Business Leadership Council. For example, Greater Manchester's Local Enterprise Partnership (GMLEP) established 2011, and the Business Leadership Council established in 2008, act as strategic advisors to Greater Manchester Combined Authority (GMCA) and decisions made by GMCA are cleared by the LEP (GMCA 2016), whilst political leadership for GMLEP is secured through GMCA who also serve as the accountable body for LEP funding (GMCA 2016). As such, relations between GMCA and the GMLEP are closely interwoven. It was suggested that: "these two, unlike many areas across the country, these two work hand in glove, they have some similarity in membership, to ensure cross-over, and they have the same agenda. I don't mean the same agenda for meetings, I mean they have an ultimate, they share the same aspirations…we have one combined agenda, so there is very little tension between those two" (Interview 1). This shared leadership between AGMA-GMCA and the GMLEP through the six commissions/boards are represented in Figure 3.1 below:

Figure 3.1: Schematic showing governance relationships through GMCA's 6 Boards



Despite establishment in 2011, the GMCA to date has operated through a very thin infrastructural make-up, relying on very few directly employed staff (some suggest as little as two) but instead on secondments from the 10 LAs, the private sector, and appointments made through the various supporting organisations or subsidiary bodies (represented at the bottom of the diagram above) each with a slightly different legal relationship with GMCA itself but upon which GMCA-AGMA relies for delivery (Interview 4 and 5). Most of these supporting organisations are either part of GMCA or affiliates of GMCA. For example, New Economy is a wholly owned subsidiary of AGMA/GMCA and although based in Manchester Growth Company remains a different entity (Interview 1). The Skills and Employment Partnership (SEP) also sits under the umbrella of Manchester Growth Company, but is a voluntary collaboration between employers, colleges and training providers, funding agencies and local authorities that reports to GMCA and subcontracts activities funded through the ESF programme to Manchester Growth Company to deliver. Transport for Greater Manchester (TfGM) and Greater Manchester Waste Disposal Authority (GMWDA) are both primarily owned by GMCA but due to their size both have their own office independent space and staff (Interviews 4 and 5). While Manchester Growth Company provides a large proportion of the office space for current GMCA staff, some teams are based elsewhere (for example in Manchester City Council Offices). With the election of a GM Mayor in May 2017, the GMCA (minus TfGM and GMWDA) will be brought together under one legal and physical roof for the first time (Interview 4 and 5). As shown on the diagram, each supporting body may be active in delivering projects that contribute towards one or more of the thematic boards of GMCA-AGMA (as indicated in the case of the LCPDU). Likewise, the Low Carbon Hub as one such thematic board will draw from activities delivered by several of the supporting/subsidiary organisations.

3.2 Low carbon Governance

Within this general city-region governance structure, policy responses to addressing climate change and transition towards a low carbon economy (outlined in section 2.2) are led and co-ordinated through the GMCA Low Carbon Hub. The Low Carbon Hub is working towards a target of 48% reduction in carbon dioxide emissions by 2020 based on a 1990 baseline. This target was inherited from the Greater Manchester Climate Change Strategy (2011). In addition to this central carbon reduction target, the Low Carbon Hub has 5 headline goals which are being addressed through fived themed and two crosscutting work programmes each with its own key goals and an annual work programme (Interview 1):

(1) transport
(2) energy
(3) buildings
(4) natural capital (which includes adaptation and environmental quality concerns)
(5) consumption and production

and two underlying economically driven themes:

(6) low carbon and environmental services sector growth
(7) skills development.

Activities and progress undertaken by a range of public private and third sector partners to meet these goals are currently collated and reported through two Low Carbon Hub action plans – the first running from 2012-16, and the second running from 2016-20. Delivery is overseen by the Low Carbon Hub Board, which meets four times a year and is made up of representatives from the public private and voluntary sector. The Low Carbon Hub Board reports to AGMA/GMCA as one of its six boards (formally AGMA commissions) as outlined in 3.1.

Like the GMCA as a whole, the Low Carbon Hub is a light structure (around 10-12 people) that co-ordinates existing people and resources funded by a variety of mechanisms and makes them work better: “its an engagement mechanism, a governance mechanism to try to get people to work more collaboratively” (Interview 1). Operating on “a bit of a shoestring” and through “goodwill of the local authorities who are financing the resource base” (Interview 8) activities under each theme are delivered by a range of organisations working in partnership from across the public private and voluntary sector.

The Low Carbon Hub itself co-ordinates these partnership activities through specific themed groups which lead delivery on each of the crosscutting work programmes. The remit of these activities is wider than either carbon reduction or low carbon economy and is more accurately focussed on environmental sustainability (Interview 1). This likely reflect the way in which the newly established Low Carbon Hub transitioned the former Environment Commission thematic group of AGMA into the Low Carbon Hub – building from the former five themes under the AGMA Environment Commission of Buildings, Energy, Transport, Sustainable, Production and Consumption, and the Green and Blue (natural) environment (GMEP 2011:89-90). The addition of the two crosscutting themes in the Low Carbon Hub’s work programme (compared

to that of the former AGMA Environment Commission) can be seen to reflect the increasing national policy focus on economic growth and the strong role of the LEP and Business Leadership Council both in the governance of GMCA/AGMA and in the Low Carbon Hub Board itself. In addition to the Low Carbon Hub GMCA supports low carbon project specific delivery through the Project Development Unit currently housed within the Core Investment Team but soon to transfer to the Low Carbon Hub (Interview 2). The PDU support delivery of large programmes particularly around heat networks and street lighting working with private sector partners and the ten local authorities.

Figure 3.2: Low Carbon Hub Thematic Governance Structure

Source AGMA/R4GG undated: 5

Current focus on low carbon governance seen through the Low Carbon Hub has built upon a longer series of activities through which Greater Manchester had sought to position itself as a leader in the transition to a Low Carbon Economy. Hodson et al (forthcoming) identify two distinct phases of low carbon transition – that characterising 2006-11 and that post 2011-present. Here, the influence of the regional governance context of AGMA and the NWDA, as well as constructive alignment with national policy programmes in the earlier phase can be clearly identified.

The NWDA previously played a strong role in establishing low carbon energy strongly on Greater Manchester's policy agenda – providing leadership for the Energy Theme of the Northern Way to lead "a clear and deliverable ambition for the North of England to become the low carbon powerhouse for the UK" (Environmental Economy of North West England 2012). In pursuit of this aim, the NWDA established the Northwest Energy Council in 2003 bringing together key regional energy sector players from academia and the private and public sector to provide strategic guidance (Environmental Economy of North West England 2012). AGMA played a similarly strong role. In 2008 AGMA commissioned a Greater Manchester Energy Master plan (undertaken by Urbed) to provide strategic evidence for LDF Core Strategy (ADE 2017: online), commissioned a Mini-Stern for Manchester – undertaken by Deloitte (Deloitte, 2008) and in 2009 established Manchester's Climate Change Agency

(MCCA). MCCA then co-ordinated and developed the bid for Greater Manchester to become the UKs 4th (of eight) Low Carbon Economic Area (LCEAs) focusing on low carbon buildings.

The Low Carbon Economic Area Programme (2009-2015) was part of the Government's Low Carbon Industrial Strategy and UK National Low Carbon Transition Plan, but the specific interest in retrofit and attracting private sector low carbon investment to Manchester city-region was developed through a draft prospectus produced by consultants Ernst and Young under commission from AGMA (Hodson et al 2013:1417). This reflected early ambitions for the city-region to become a leader in housing retrofit and to develop a strong low carbon retrofit supply chain (AGMA, 2010). Manchester's LCEA promise was to reduce 6 million tonnes of CO_2 emissions from 2010 to 2015; create an additional £ 650 million Gross Value Added (GVA); support 34,800 jobs; and help to address worklessness (Sustainability West Midlands 2010:6). MCA also facilitated access to resources from the Homes and Communities Agency, DCLG and DECC for large scale housing retrofit programmes, innovative financing schemes such as "green mortgages" to help private householders invest in energy efficiency, major energy infrastructure projects including combined heat and power (CHP) centres, smart grids, biomass, smart metering and low carbon energy generation and actions to develop low carbon skills, planning policy and procurement (Sustainability West Midlands 2010:5). Combined this portfolio of activities established low carbon energy as a strategic niche for the new city region. Hodson et al suggest: "From around 2008 there was a meshing, by Greater Manchester elites, of a strategy of promoting an entrepreneurial economic agenda with efforts to build a low carbon agenda in Greater Manchester" (forthcoming:9). In this process, the LCEA Programme and the Manchester Mini Stern were key moments through which Greater Manchester established its ambition to become a "world leading city-region transforming to a low carbon economy" (O'Doherty 2010).

Consequently, GMCA prioritised energy and low carbon concerns very early in its establishment. The AGMA/GMCA Environment Commission was one of the first thematic commissions to meet in 2009 and the Energy Group (a partnership group meeting bimonthly to provide a sounding board for government policy) was established shortly afterwards (GMEP 2011:88). The Greater Manchester Climate Change Strategy was published by AGMA/GMCA in 2011 (the first year of GMCA's establishment), and the Energy Group produced the Greater Manchester Energy Plan also in 2011 initiating Hodson et al's second phase: 2011-present.

3.3 Involvement of Actors

As described above a range of different actors are involved in the governance of low carbon. This sub-section describes how different actors are engaged, which are decisive to implementation, and discusses particular experiences and learning from involving the private sector.

3.3.1 The changing role of Local authorities and the role for GMCA in the governing energy and low carbon economy

The last ten years has seen a marked ideological shift away from local authorities being perceived as central to delivering climate change activity in the UK. During the first decade of the 2000s, local authorities were seen to play an important role in local energy governance and focus on decentralisation under Blair's labour Government had reinstated local authorities as holding a central role in delivering outcomes based policy (Fudge and Wade 2012:10-12). The Comprehensive Spending Review of 2007 had established performance indicators around which Local Authorities were perceived to have influence: one of which was National Indicator 186: the percentage reduction of CO_2 emissions per capita in Local Authority areas (against a 2005 baseline) and all ten local authorities within Greater Manchester led delivery of low carbon projects within their own boundaries. In the 2009 UK Low Carbon Transition Plan, "the role of local authorities as a "vanguard" of local and community action on climate change is noted 33 times" (Fudge et al 2012:15) and in 2010 the UK Government DCLG/DECC worked with eleven pioneering local authorities (including Greater Manchester) on a Local Carbon Frameworks Pilot Programme that sought to explore further the leadership role for local authorities in wide scale local carbon reduction. Through this programme Greater Manchester secured funding and network support to share learning from a portfolio of locally identified projects including A Carbon Metrics Framework, a Housing Retrofit Programme, an Energy Action and Investment Framework and a Low Carbon Investment Appraisal (CAG Consultants 2011: 104).

However since 2011, with the change in UK Government to a Conservative-Liberal Democrat Coalition, a number of factors have weakened this role. Firstly, severe cuts to public services through UK National Austerity Programmes have impacted local authority capacities and resources to deliver. Cowie et al previously reported that "the city-region has been hard-hit by recent public spending cuts…with an estimated £ 10 billion to be removed from the economy in the four years between 2011 and 2015 (Talbot and Talbot, 2011)" (Cowie et al 2013:4). With a focus on maintaining front-line services, local authority climate change policy teams have been dramatically scaled back and their capacity to demonstrate leadership therefore undermined (Interview 6). This has continued and it was suggested during interviews that "whereas even sort of a year or two ago there was a reasonable level of energy officer resource there across the local authorities…its slowly fallen away" (Interview 4). Climate change projects often also relied on time allocated informally by other staff through goodwill but with fewer officers in other delivery areas too, increased pressures restrict the ability of those who are left to accommodate wider altruistic projects (Interview 6). Secondly, weakening of priority towards climate change in UK national government policy, widespread cuts to non-departmental public bodies such as the Environment Agency, Natural England and Forestry Commission (that have weakened the strength of low carbon and renewable energy discourses within local policy making), and abolishing of the National Indicator Performance Framework through which reporting on carbon emissions took place, has generated a lack of

mandate for local authorities to prioritise climate change policy goals. In Greater Manchester, discussions painted a despondent picture of how these changes had affected their ability to deliver projects and programmes. From the position of being the only remaining officers from former teams that had been disbanded, two of the interviewees described feeling like lonely voices struggling to keep their portfolios on the policy agenda (Interview 3 and 6). Thirdly, specifically in the context of domestic retrofit, with the easy wins now completed, "the harder knuts to crack … need more resources, and have longer payback" which further challenge delivery (Interview 6). Finally, ideological withdrawal of the state has simultaneously weakened wider governance powers of local authorities to intervene in market based decisions – for example through planning regulation, building control and imposing infrastructure levies on developers (further discussed in section 3.51). Thus despite a Memorandum of Understanding signed in 2011 between DECC and the Local Government Group to recognise the "pivotal role councils have in tackling climate change" (DECC-LGG 2011:3), the compound effect of these changes sees local governments no longer perceived, nor demonstrably able to offer local leadership on climate and energy delivery.

In this context faith and hope are vested in GMCA's ability to lead momentum on climate change as a strategic policy area, and to set a strong policy framework into which local authorities could position and develop their individual contributions (Interview 6). In contrast to these national changes, GMCA is committed through the Low Carbon Hub and the LCPDU to supporting all ten LAs in their climate change and energy activities. Framing of low carbon ambitions and renewable energy activities in economic terms, has enabled GMCA to continue to advocate for the governance of climate change and energy under its formal remit for regeneration, transport and economic development. With the long history of voluntary cooperation between municipalities, there is a clear desire to work together at a Greater Manchester scale on strategic concerns with networks of support – both with other LA climate change/energy officers and the LCH and PDU emphasised as important sources of support (Interview 6). "If we were just sat here on our own, what a horrible nightmare vision…I think x is quite part of the GM project, it sees itself as part of the GM project" (Interview 6). This collaboration and support has enabled work on low carbon projects within GM's local authorities to continue despite the challenges posed by national policy changes.

Overall, seven of the ten Greater Manchester local authorities have committed to eliminating fossil fuels by 2050 as part of a 100% clean energy pledge (GMCA 2016:4) and although "there is a wide variation in installed renewable capacity across GM districts" (Energy Technologies Institute 2016:24) GMCA suggest that all authorities have shown clear leadership over particular low carbon technologies and programmes – each with a different local focus (GMCA 2016:18). For example, in 2011-2012 Stockport Homes installed solar panels to 1,924 domestic properties through Prudential Borrowing of £ 10 million, saving 5,000 tonnes CO_2 and giving a household average financial saving of £ 158 per year on their electricity bills (SMBC 2015) and Rochdale Council also followed suite in 2014 installing 600kW PV arrays at a cost of £ 550,000 generating an estimated 550MWh/year and saving 290 tonnes of CO_2"

(GMCA 2016: 8). However, if any council stands out as a frontrunner, it is Manchester City Council. In 2005, Manchester City Council developed Manchester Energy Strategy 2005-2010 providing a baseline of current energy use, generation and identified opportunities (2005:8). In many ways this strategy was an early pioneer of the emphasis on competitive advantage that characterised later city-region policies. Emphasis was placed on the benefits for businesses both in terms of savings possible through energy efficiency improvements, and suggestions that "our competitiveness in European markets could be affected by our inefficiency particularly if mainland Europe is more energy efficient than us" (2005:6). In 2008 Manchester was one of 3 cities selected by UK Government to share £ 250,000 funding and support from the Carbon Trust and Energy Savings Trust under the Low Carbon Cities Programme (LCCP) to develop joined up city wide carbon reduction plans, involving Local Authorities, the NHS, housing and private sector organisations (Sustainability West Midlands 2010:5). In 2010 MCC outlined its vision to become a "leading low carbon council" (2010:6) and established a series of demonstration projects – including on district heating, and implemented carbon proofing of all future council decisions and planning policy (2010:6). In 2016 it outlined in the Manchester Climate Change Strategy 2017-50 produced by The Manchester Climate Change Agency its intentions for the city to be run entirely on green energy within the next 35 years (van den Bent-Kelly, 2016). There has been some success in wider integration of these policy concerns into *Our Manchester* – the city's strategy for 2016-25, which, as well as an ambition to be zero carbon by 2050 aims for a sustainable economy and jobs fed by carbon literate local talent"(2016: unpaginated).

The changing role for public sector in governing energy and low carbon economy

Low carbon projects face increasing competition in the prioritisation of resources at both city region and local scale where "people-focussed" outcomes inevitably attract more political attention meaning low carbon slips down the policy agenda (Interview 8). Several stakeholders interviewed described a discursive change over the last couple of years in which whilst concern over carbon is still on agenda, it is now often positioned as secondary benefit to arguments grounded in people focussed outcomes like fuel poverty or in revenue gain (Interviews 3, 4, 5 and 8). On one hand this is resulting in retraction back to familiar ground (Interview 3). Climate change activities within local authorities have strong historical connections with housing – based on the retrofit focus. With the challenge of fuel poverty in Greater Manchester perceived to be worsening and household spending on gas and electricity in 2010 having increased by 20% since 2007 (New Economy 2013:68), this has created to a shift in framing retrofit activities in terms of fuel poverty rather than carbon reduction – "when you've got less resources to spend…it's an easier case to make" (Interview 6). The implications for understanding carbon reduction through fuel poverty are discussed further in section 6.1.

On the other it is prompting ventures into new modes of governance. The PDU describe moving away from articulating projects with local authorities around carbon emissions savings potential as the key local authority key driver and instead foregrounding the potential for con-

verting capital funding and assets into revenue streams in order to replace or compensate for funding lost from central government:

> *"we are very focussed on using these types of projects to meet carbon targets and we're very aware of those…[however] whereas 4 or 5 years ago, local authority officers would have approached projects primarily as carbon saving, whether by deliberately or unintentionally, our approach is now the commercial side, and particularly for local authority projects, its all about taking capital and turning it into revenue streams to support the revenue budgets that are being pushed down, and what we find, or what we consider in those instances is if the project is commercially viable, if its designed right, then all the carbon benefits will flow out anyway, so if you have a pecking order of what the drivers are for the project over the years, carbon has sort of moved down to the bottom of the list, even though its still there, it is important, but it's the commercial performance that drives whether the scheme goes ahead – whether that's public or private sector" (Interview 5).*

Local authorities are being encouraged to operate through private sector models of self – financing that extend and deepen the extent to which the role of local authorities have already been positioned as consumers, stimulating the market through local government procurement since the mid 2000s as exemplied by GMCA: "Changing the way that we procure as a local authority can have a market impact … we're a big player in the market and we can stimulate markets that way" (Interview 1). Emphasis on the role of public sector in stimulating markets through procurement and creating a conducive culture for business investment was a strong feature of Deloitte's recommendations through the Manchester Mini Stern (Hodson et al forthcoming). The role for GMCA in low carbon governance is also envisaged primarily through stimulating voluntary behaviour change (both among local residents and local businesses). This is grounded in both perceived importance of behaviour change as the necessary counterpart to technological innovation(Interview 1), and perceived need to reduce public sector regulation of the market. In fact such traditional regulatory functions of local authorities were problematised at GMCA, both ideologically and in the context of resource scarcity for enforcement:

> *"you can put policies and regulations in place that would have an impact on potential markets, however, you can put as many regulations in place as you like, but if its contentious changes then you have to enforce it, and you know enforcement is both costly and politically difficult. Do we really want to live in a police state where everything is enforced down to the n'th degree? Most people would say no, so then you've got to try and find a way to make regulations work without having to have a hard stick at the end of it – and that's not easy… there are other reasons why I think regulation is, I wouldn't say the last resort, but not the one you immediately jump to, stimulating change in other ways is eminantly more preferable." (Interview 1)*

Greater Manchester does not therefore "currently resource or prioritise the enforcement of existing targets or use of regulation" (Local Enterprise Partnership Board 2016:6). Instead, the smart cities agenda as seen as offering particular promise for mainstreaming carbon reduc-

tion activities – motivating uptake through alternative configurations of interest: "there are hooks around the smart agenda, that people will be interested in for one reason, but will also deliver carbon reduction or energy efficiency, or waste reduction. I think the smart agenda might encourage people to do things, to behave differently not because they want to be good environmentalists, but because *they are going to get a benefit out of it*, it'll be indirect impact rather than direct impact" (Interview 1 emphasis added).

In an era of declining public funding sources and in the context of Brexit restricting access to European funding, the Low Carbon Hub is also increasingly looking to what it refers to as "Innovative finance models" to fund low carbon activity. These innovative finance models are in the early stages of exploration, but include:

(a) Exploring utilising the Earn Back Model under the City Deal to capture business rates

Greater Manchester is participating in a trial programme with UK Government called the Earn Back Model under the City Deal where GM is incentivised to prioritise investment decisions on the basis of net GVA impacts through the possibility of receiving a larger proportion of tax revenue if growth is generated, than would otherwise be the case under business rate retention. Prudential Borrowing against revenues and government grants are used to finance the £ 1.2 billion investment programme, and if additional GVA is created relative to a baseline (using a formula, linked to changes in rateable values over time). the Earn Back Model promises recapturing of business rate income to provide a revenue stream to GM of around £ 900 million over the 30-year period of the City Deal (Leaders Blog 2014). Thus far, the Memorandum of Understanding between GMCA and the UK Government governing the earn back scheme has not contained an explicit low carbon focus. In 2015 the Low Carbon Board resolved to explore when this could be reviewed and rather weakly noted that "existing devolution measure do provide greater flexibility in how we direct or transport, housing and skills funding which could include greater opportunities for low carbon" (Low Carbon Hub Board 2015e) with some funding earmarked for public transport investments including a Metro link extension to Trafford Park that contribute to low carbon policy goals. The PDU suggest they would like to look at how things like the earn back model be replicable for heat networks (Interview 4). During 2016 on-going discussions with DECC and then DBEIS have developed a closer working relationship but as yet no firm commitment over financing low carbon programmes has been reached (Low Carbon Board 2016). It was suggested that its "a little bit too political for us to try to put anything in this time round, but if an intervention is made, next time we come to look at how business rates are calculated, or what the payback period might be in any type of intervention, you could see how business rates could be used to incentivise in a way that is cost neutral" (Interview 1).

(b) Using Property Levy's attached to homes to finance retrofit

A property levy transfers the cost of energy efficiency retrofit to the individual private homeowner without them paying up-front for the cost. Instead Green Bonds offer householders "a

loan…payable on the sale or death of the resident"(Interview 1). Housing levies for home insulation have been trialled at small scale in GM but require scaling up to address the wider affordability of retrofit challenge and address the question of justifying a low or even zero per cent loan (Interview 1).

(c) Pipe-Co Models of investment

The PDU are also exploring a financing model for heat networks in which the LA operated ESCO model is turned on its head and investment and management of the pipework of a heat network is separated out from the heating generation and sales and managed as a utility in itself. Here a LA could just invest in the pipework being "involved in any of the commercial risk of actually supplying the heat to customers…and the local authority would perhaps get an income from that…that's an innovative commercial model that might apply to some of our projects" (Interview 5). This model encourages the private sector to pick up the riskier but more financially rewarding part of the investment profile without the heavy infrastructural costs, whilst the LA covers these without the risk of commercial service provision: "You're just splitting a project from a whole ESCO into: generation, distribution and supply; and obviously the risk profiles and the investor profiles for those three are quite different" (Interview 5).

These innovative finance models increasingly move away from public sector grant based investment to thinking about ways to fund low carbon activities through private investment whilst moving beyond the challenges of immediate commercial viability. In each case of innovative financing there is an associated shift in thinking that accompanies each model that foregrounds private sector rationalities. By foregrounding private benefit, Property Levys and Pipe-Co models seek to pursue strategic goals by re-balancing risk and reward in ways more amenable to investor decisions. In the case of the Earn back model, as GMCA describe, the possibility of GM financial benefit in times of resource shortage is being used to focus investment decisions around economic growth measured through GVA: "Earn Back provides an additional incentive for GM to prioritise local government spending to maximise GVA growth….this will create a genuinely revolving Fund which rewards GM for delivering growth" GMCA 2016:8). Whilst offering the potential for immediate financing of low carbon, the long term tensions between economic growth and carbon reduction/sustainability concerns (discussed further in section 3.51) remain unaddressed.

The need for such models is being positioned within a discourse of moving beyond funded demonstrator projects to "mainstreaming" which is clearly being understood through market uptake:

> *"we're getting to the stage in Manchester where, we've done the demonstrators, we still like to do the projects that allow us to test something new, even though its risky, but we're now trying to find ways that we can mainstream this activity, and to do that you need to be able to develop and deliver innovative finance models… how do we embed this, how do we get the innovative finance, how do we get this type of activity scaled up" (Interview 1).*

It is through reliance on market uptake (which in turn was suggested to depend on both cost and simplicity of technologies) that sustainability of such programmes is being constructed as a situation in which "there's no need for a specialist programme, because it's embedded in the way that we do business in the future" (Interview 1). While pilot programmes such as the Green Deal Communities Programme are seen as important for demonstrating what is technically possible, but result in solutions that are too expensive for market delivery.

> *"the truth is the Green Deal Communities Programme … it was almost a £ 10 million programme, but it treated, it treated very well, but it treated 1500 homes or 1600 homes, for nearly £ 10 million! … it was an expensive programme. And out of the 1.1 million homes in Greater Manchester…really what we need to be interested in if we want to make a substantial change to this agenda, is how do you get scale, and how do you afford scale, and I'm afraid I don't know that, but its what we're thinking about" (Interview 1)*

Encouraging local authorities to understand their role as market consumers, to veer away from regulation to voluntary action, to move towards self-financing programmes and to become architects of innovative forms of private sector project financing reconfigures the role of local authorities – away from regulation and redistribution of taxation drawing from notions of the public good, towards understanding their role in private sector terms. The implications for addressing low carbon are further discussed in section 3.5 below.

3.3.2 The role of the voluntary sector, local communities, NGOs, private households and educational institutions?

There is significant evidence of local voluntary and community action across GM and it is suggested that "the voluntary and community sector has played a prominent role in Manchester's work on climate change to date, particularly in motivating behaviour change at the local level" (Manchester City Council 2009:33). Examples include MEAN Environmental Education in schools, The Environment Network for Manchester (EN4M), Action for Sustainable Living (AfSL), Friends of the Earth, Merci, Red Rose Forest, Groundwork, RSPB, Carbon Co-op, church groups and Hulme Community Garden Centre, who have delivered more than 300 projects between 2010 and 2012 alone (Manchester a Certain Future Stakeholder Steering Group 2013). Eames highlights the way that these bottom up initiatives weave dominant policy frameworks with individual motivations and beliefs and particular constructions of community interest (Eames et al 2014).

Forms of collaboration between NGOs, local communities, higher education institutes, and private households are difficult to generalise with local communities and private households tending to collaborate on a project basis while NGOs and higher education institutes find opportunities for collaboration around specific projects and through strategic networks or consultations – for example, Steady State Manchester to the CCLEES (available online: Steady Sate Manchester 2016). The ability to constitute a recognised and respected voice again differs widely between and within these categories. Most budgets enabling collaboration come

from specific higher education or community led funding bids. One example is Carbon Co-Op (examined further in section 6.3) – a collaboration of private householders who have worked to share their experiences around the whole house retrofits funded through the Green Deal and support others in retrofit activity (Coop/Urbed 2015).

Despite the presence of this activity, Cowie et al have previously suggested that the community and voluntary sector are not well represented at the GMCA level. They suggest from previous interviews that stakeholders feel this reflects issues of scale in which community and third sectors do not operate at the scale of the city region and so are best engaged at a local level through the local authorities (Cowie et al 2013:12). This was confirmed in conversations with stakeholders who suggests that the support offered through the GMCA PDU tending to be focussed on projects of a bigger scale – currently street lighting and heat networks – that are "probably a bit too big for community groups" (Interview 6). Also, community groups tend to come to Local Authorities for support and collaboration around schools, community centres or social housing because local authorities often own the buildings (Interview 6). While local authorities are keen to remain responsive to opportunities to support community action in this way, their ability to do so proactively has been affected hard by cuts in funding for neighbourhood community support (Interview 6). Nevertheless, since 2010 several climate and energy related initiatives at city region level have sought to better involve voluntary sector and local communities. In 2010 Manchester A Certain Future Steering Group was formed bringing together 28 individuals to co-ordinate delivery of an action plan for Manchester that represented the views and interests of stakeholders across the city. Co-ordinated by Manchester City Council the steering group sought to involve and facilitate leadership and scrutiny of progress by organisations and communities across Manchester city. The Manchester A Certain Future Action Plan was developed in advance of the UN Summit on Climate Change in Copenhagen (December 2009) and contributed to Manchester's Community Strategy "The Manchester Way" (Inteli-inteligênciaeminovação 2014). In 2016 the Our Manchester Forum (previously Manchester Leader's Forum) brought together 40 senior leaders from across the city's public, private, community and academic sectors to produce Our Manchester Strategy (Manchester City Council 2016).There is now representation of NGOs (Wildlife Trust for Lancashire Greater Manchester & North Merseyside) and higher educational institutions (Pro-Vice-Chancellor for Research & Enterprise at the University of Salford) on the Low Carbon Hub Board and although individual voluntary organisations don't have a seat on the LCH board, there are regular LCH spotlights on particular initiatives (Interview 8).

3.3.3 Involvement of private sector partners

Governance of energy by GMCA relies strongly on partnership working with the private sector and the public-private nature of low carbon governance is reflected in both the wider governance structure of GMCA and the Low Carbon Hub and the specific involvement of private sector actors in delivery programmes. Five distinct ways of involving private sector actors can be identified:

(a) Involvement of private sector actors in governance

Involvement of private sector actors in low carbon governance occurs explicitly through direct engagement with private sector actors (on boards, projects, partnerships and advisory groups) and increasingly less explicitly, through the intermingling of public-private governance in ways in which demarcation between public and private actors become more difficult to ascertain.

Explicitly, Greater Manchester involves private sector actors in governance decisions at the highest levels through the Business Leadership Council and the GMLEP that operate separately but concurrently in the region – with the nature of business networks meaning that members know each other (Cowie et al 2013). The Business Leadership Council acts "as both a check and balance on the GMCA's policies" and also conducts "development of policy in its own right" (Cowie et al 2013:13). The Local Enterprise Partnership comprises a board made up of seven business leaders and the chairs and vice chairs of the GMCA (Cowie et al 2013) and is "a key component of Greater Manchester's governance arrangements, providing a forum to have a single conversation with business leaders" (GMCA 2016:6). The LEP aims to promote economic growth by creating partnerships between local government and business (Cowie et al 2013:3) focusing on nine areas for influence, one of which is the Low Carbon Economy (AGMA 2017b). This positions the private sector with an influential voice in the general priority setting within GMCA – for example through the Greater Manchester Strategy (AGMA 2017) – as well as in specific thematic working groups such as the AGMA Energy Group (GMEP 2011:90). Individual private sector companies are also specifically involved in the governance of low carbon activity through the Low Carbon Hub Board, which involves representatives from the BBC, Siemens, Viridor, Arup and Electricity North West among others (Low Carbon Hub 2015) although these tend to be private sector partners with a specific interest in low carbon behaviour change (Interview 8) and the Low Carbon Hub champions its strong partnerships with the private sector (e.g. Electricity Northwest, United Utilities, Coop, Bruntwood, Arup, Peel Energy, and Manchester Airport (GMCA 2016).

More indirectly, the boundaries between public and private governance are becoming less distinct. For example The Energy Technologies Institute which advises and provides baselinie intelligence reports on low carbon to GMCA is "a public-private partnership between global energy, engineering companies and the UK Government" (ETI 2016:13). This generates both public and private ambitions within organisations that become increasingly difficult to separate out. In the case of ETI the ambition is both "to act as a conduit between Academia, Industry

and the Government to accelerate the development of future low carbon technologies" and "is focussing on targeted commercial investments in the various technology programmes across heat, power, transport and the infrastructure" (ETI 2016:13). The ETI has recently provided the Greater Manchester Spatial Energy Plan Evidence Base Report that will feed into the Greater Manchester Spatial Framework. This illustrates what Raco has called the hybrid nature of urban governance in which "the traditional distinction in the English planning system between a public and a private interest has been dissolved and replaced by new institutional entanglements, objectives and priorities, in which the commercial interests of private companies have become aligned with public interest in the name of regulatory and contractual governance" (2016:161-2). Fudge et al suggest that this intermingling of public-private governance is characteristic of changes in governance across the UK especially apparent in climate change and renewable energy where decarbonisation policy has seen a plurality of approaches that mix neo-classical economic approaches with interventionist strategies through the local scale for action (2012:8-9).

(b) Involvement of private sector actors in low carbon delivery programmes

As well as involvement of private sector in strategy setting, the private sector plays an important role in delivering low carbon projects – particularly renewable energy programmes. Firstly, the Low Carbon Hub ambitions to increase renewable energy provision within GM to 1 TWh/year of electricity generation and 2-3 TWh/year of heat generation by 2020 (AGMA/R4GG undated) often rely on commercial projects to develop generation. Secondly, since privatisation of the energy utilities in the late 1980s, neither Greater Manchester Combined Authority nor its ten local authorities have direct powers, duties or accountability over energy infrastructure (GMEP 2011:55). This depends instead on close working with the North West Distributed Network Operator to negotiate a local grid infrastructure that can accept increased distributed energy generation with different load and generation profiles. Electricity North West Limited has undertaken a £ 500 million programme of network improvements between 2011-2015 (GMEP 2011:87), including £ 270 million in 2013 for transforming the distribution system and energy balancing and £ 52 million on energy innovation projects reducing energy losses and increasing the ability of the grid to take new connections (CCLES 2016:4). Thirdly, although many large-scale and cross- cutting low carbon projects (such as the Greater Manchester Green Deal Communities Programme) are public sector initiated and co-ordinated, private sector partners are usually involved as delivery partners and often also contributers of funders. Minutes of the Local Enterprise Partnership Board reflect the importance of levering in significant additional funding to deliver the actions identified in the CCLES (2016:2). The involvement of these private actors varies from being suppliers of technology and infrastructure systems to playing stronger leadership roles in project development and management. Here, the private sector is seen to offer practical means necessary for project implementation. This includes knowledge (technical and engineering knowledge as well as financial and legal considerations – MCC 2013:18), provision of technical solutions/equipment, and financing.

(c) Involving private sector in carbon reduction as energy and material consumers

Recognising the contribution of business activity to carbon emissions, there is widespread recognition of the role the private sector needs to play in reducing energy use and carbon emissions across its own sectoral operations (MCC 2013:9). This has led to a number of initiatives promoting and supporting low carbon and energy efficiency business action. For example, the "ENWORKS" programme in Greater Manchester (see more detail in 6.2), the Chambers of Commerce Carbon Reduction Group, and support for businesses through the nationally run Carbon Trust – now a not-for-dividend private company set up by UK Government with public funding in 2001 to provide specialist support to help business and the public sector cut carbon emissions, save energy and commercialise low carbon technologies. While support is available, the Low Carbon Hub Board Minutes note that the role of commercial buildings and private landlords in carbon reduction in particular needs to be further addressed (Low Carbon Hub Board 2015c). In some cases carbon reduction initiatives are led by the private sector. This tends to be building and company specific projects – for example within regeneration of Salford Keys – although it was also suggested that the private sector were offering proactive forward thinking around carbon literacy, which when communicated from the BBC held more glamour than from the Local Authority (Interview 6).

(d) Involving the private sector in low carbon through the pursuit of economic growth

The low carbon energy economic sector is considered an area of high potential for realising economic growth. As well as avoiding risks of doing nothing outlined in the 2008 Greater Manchester Mini Stern Review (which suggested that Manchester's economy could lose £ 20 billion by 2020 if it fails to shift to a low carbon economy), it was suggested in 2010 that the North West low carbon and environmental goods and services sector has a market value of £ 10,777 million, of which Greater Manchester represents around 40% (GMEP 2011:62). In 2012/13 GMCA identified that "the Low Carbon Environmental Good and Services Sector in GM was the third largest in the UK… employed 37,000 people …and has annual sales of over £ 5 billion, showing annual growth of around 4% with particular growth in the renewable energy sector at 5.6%" (GMCA 2016). The presence of a strong low carbon business sector and supply chain is seen to contribute to Greater Manchester's ambitions for economic growth – increasing the number of businesses and jobs (through which growth is measured). At present "this represents approximately 2% of the GM business base but the potential for future growth is huge" (Manchester City Council 2013:11). This proved a great catalyst for lobbying with the private sector and the Local Enterprise Partnership (LEP) board agreed to position low carbon growth as one of its objectives.

(e) Involving the private sector in low carbon behaviour change

The private sector is increasingly seen to be important in both funding and delivering energy behaviour change campaigns to domestic energy consumers (Low Carbon Economic Area Initiative 2011:27). This has particularly been through Energy Distribution Company led en-

ergy efficiency programmes funded through ECO, and through The Energy Savings Trust (a not-for-profit organisation funded by UK Government and the private sector) to deliver demand reduction programmes aimed at individual consumers (GMEP 2011:89-90).

3.3.4 Particular Experiences of involving the private sector for unlocking low-carbon investments?

Greater Manchester offers a range of experiences of initiatives that seek to unlock low carbon investment from the private sector – some traditional, some more innovative. Some of these examples are covered in more detail in the case studies presented in section 6, but this section outlines the range of different strategies taken to stimulating private sector investment in low carbon and highlights what becomes financed and which actors are key for implementation. Eaxmpes are presented according to the following type of financing model:

(1) Co-financing: Matching Public and Private Sector Funds
(2) Encouraging direct private sector investment in their own businesses
(3) Levering private sector funds through loans
(4) Attracting inward investment
(5) Regulated Investment through infrastructure levies
(6) Community privately financed projects.

(1) Co-financing – Matching Public and Private Sector Funds

The majority of funding for large cross-sector low carbon programmes particularly in housing transport and energy infrastructure – are public sector led and draw from European sources such as Horizon 2020, Elena or ERDF that are designed to require match funding or leverage from private sector and/or UK National funds. In cases where UK National Government has been able to be used to match European funds, there has sometimes been no private sector finance levered at all. For instance, Transport for Greater Manchester and UK Government Office for Low Emission Vehicles – OLEV's provision of 167 electric vehicle charging infrastructure stations utilised 50% Ticket 2 Kyoto (T2K INTERREG grant with further public sector grants from the North West Development Agency's (NWDA). However, in the context of reduced central government funding, and no RDA held readymade match for European funds, the Greater Manchester Third Local Transport Plan 2011-16 explicitly emphasises the need to work "through private sector-led investment strategies...bringing public and private resources together to deliver much-needed infrastructure" (TFGM 2011:14).

An important application of this type of funding model has been to enable experimental trial programmes in which private sector actors gain a test bed for product development prior to commercial implementation and public sector bodies are able to develop low carbon solutions considered at the forefront of technological expertise. One example is GMCA's 2014 partnership with Japan's public research and development management organisation "New Energy and Industrial Technology Development Organisation" (NEDO) and associated private sector partners on the *NEDO Smart Community Demonstration Project*- one of the UK's largest trials

of retrofit air source heat pumps. This is described as "one of the most significant heat pump and demand side response trials in the world" (GMCA 2016c) and worth somewhere between £ 20 million (GMCA 2016d) and £ 30 million (GMCCLES 2016). The project has involved fitting 300 social housing properties in Bury, Manchester, and Wigan with air source heat pumps and smart energy monitoring equipment (GMCA 2016d) and aims to "to support the shift from gas to electric heating by combining low-carbon heat pump technology, demand response and aggregation and examine its impact on the network and benefits to customers" (GMCA 2016c). While led by public sector partners – DECC (UK), NEDO (Japan), GMCA and GM ALMOs – Northwards Housing, Sixtown Housing and Wigan and Leigh Homes (see http://www.gmsmartenergy.co.uk) – who have been instrumental to the project taking place, private sector partners Daikin, Electricity North West, Hitachi and Mizuo are supplying and installing generation and energy management equipment, and Warmer Energy Services are acting as delivery agent for the programme. These types of programmes are seen to unlock future private investment by building investor confidence, and developing market readiness of technology. A particular example where public-private partnerships are cited to have worked well is the brownfield regeneration of Salford keys, although it was suggested this had taken 30 years to achieve (Interview 7) and as part of the Manchester regional centre already provided strong investment potential.

(2) Encouraging direct private sector investment in their own businesses

The Low Carbon Network includes many examples of private sector businesses investing in improving the efficiency and lowering the carbon emissions within their own businesses. This includes Abbey Logistics Group (Transport sector) who improved fuel/energy/water efficiency to save £ 641,000 and 1,700 tonnes of CO_2e per year and Mölnlycke Health Care (Textiles sector) who improved energy/material efficiency to saving £ 172,000 and 429 tonnes of CO_2e per year (see – http://www.green-growth.org.uk/case-studies). The Greater Manchester Energy Plan also gives examples of major private sector investment including a portfolio of property improvements being undertaken by Bruntwood and Peel (including energy networks at Mediacity, trigeneration facilities at Granada studios) and biomass energy generation and efficiency investments in the Co-operative Group's NOMA headquarters (source: GMEP 2011:87). Often public sector support programmes are often decisive in encouraging and supporting private companies to invest – drawing from the co-financing model above to secure private sector investment. Examples include the ENWorks programme (further detailed in section 6.2). A second example of a public sector support programme directly focussed on unlocking this private capital investment is the work of the GM Low Carbon Project Development Unit.

The PDU supports the commercial development of both public and private sector projects by providing tailored revenue support to take projects "along the development curve…particularly with a focus on the transition from feasibility, to commercialisation, to market engagement, procurement and delivery" (Interview 5). The PDU is funded by European Elena and EIB

funding and comes with strict leverage targets that require a 1:20 return on public funding in terms of private investment of over whole portfolio of projects supported (Interview 5). The initiative arose from a precedent set by Greater London Authority in accessing EIB funding (Interview 4) and mirroring the model of Greater Manchester's Investment Framework, which prioritises a pipeline of projects according to GVA impact – aligning core economic funds from central government, ERDF, the North West Evergreen Fund and private sector funding to support their delivery (GMCA 2016:10). It also in many ways replaces the support in identifying and assisting the delivery of projects such as reducing the carbon footprint of town halls and public buildings provided through the NWDA funded Manchester is my Planet Programme between 2005 and 2010 (see Sustainability West Midlands 2010:5). A similar Pipeline of around sixty Low Carbon Investment projects was identified, initially as part of exploring a joint venture company between GMCA and the UK Green Investment Bank: Greater Manchester Green Developments Ltd (GMCA 2016:19). The idea was that "the private sector was then invited to invest in an Investment Fund, rather than individual projects" (Innovation Seeds undated) enabling Investment Pipeline manager to channel funds exclusively into the high priority projects – a key interventionist approach. However, during the second phase, in which, twenty projects were shortlisted as priority for advanced coaching in 2013, the formal joint venture was abandoned amid challenges to the structure, governance and legality of the Joint Venture and insistence on funding development work on "commercial terms" (AGMA/R4GG undated: 6). In a report to the scrutiny committee it was suggested the initiative failed because the GIB "wanted Greater Manchester to loan money at a higher rate than available in the market" (GMCA (2015c). While the trial had provided Manchester with the capabilities to move forward with the investment pipeline it could do so on its own through the creation of the Low Carbon Project Development Unit enabled through ELENA funding of € 2.7 million (GMCA 2015, AGMA/R4GG undated: 6, Innovation Seeds undated).

The PDU pipeline focuses on three priority work stream areas: street lighting, heat networks and Non Domestic Energy Efficiency and on projects with strong commercial potential (Interview 5). Criteria for prioritising projects came from consultancy work that sought to develop quantifiable measure of which projects more suited to be taken forwards these were the investment rate of return, the carbon emissions savings potential and the strategic fit in terms of planning and softer drivers (Interview 5). It was suggested that: "Because of leverage target, we've looked at those that are more deliverable and commercially attractive rather than strategically fantastic or good carbon savings" (Interview 4). Using UK Government feasibility funding has allowed identification of which projects have the most commercial potential, which has helped Elena funding to be held back for projects that are more certain to actually go forwards which has helped with meeting the leverage targets: "we're not spending the money we're contractually obliged to deliver leverage against on projects that we can spend sixty grand doing a feasibility study that says actually there's no opportunity here…we can reign that spend in until we know, we can target …that's been very helpful" (AT Interview). As well as directly funded support programmes, establishment of a "Low Carbon Network" of busi-

nesses also supports the unlocking of low-carbon private investments by "rais[ing] the profile of businesses in the low carbon and environmental goods and services sector and improv[ing] the visibility of local supply chains…to enable companies to be better connected to new business opportunities …from new tender opportunities to changes in government policy" (GMCA 2016:23).

(3) Levering private sector funds through loans

As well as supporting projects through the PDU, GMCA are in the process of establishing a Low Carbon Investment Fund, which, when operational later in 2017, will use £ 15 million ERDF funding to leverage low carbon investment by the private sector through a revolving loan (Low Carbon Hub 2016. Interview 5). This model is only for private sector projects up to 50% CapEx to a maximum of £ 3 million over a period of up to 15 years (due to ERDF regulations). Here the emphasis is on carbon savings and over the whole fund there is a commitment to achieve 10,000 tonnes carbon saving (Interview 5). The model is once again based on experience of the Greater Manchester Core Investment Fund, which uses public sector sources – Regional Growth Fund, ERDF, Growing Places Fund, GM Loan Fund, and NW Evergreen (JESSICA) funds – to offer a debt-funding programme to support development of commercial property and infrastructure projects. While, the fund will operate as a revolving loan fund with the private sector repaying loans in full with interest, management of the fund relies in the first instance on funding for staffing coming from ELENA. In future years it is suggested this will be financed from fees on low carbon loans (GMCA 2016d). This is increasingly perceived as a future direction for financing low carbon investment in Greater Manchester. The Low Carbon Fund will run in parallel to the BEIS Heat Network Investment Project (HNIP) which is a UK national programme of £ 320 million over 5 years. As HNIP can be matched with European funds (subject to state aid) it is envisaged as match funding for some of the Low Carbon Fund projects (Interview 5).

(4) Attracting inward investment

Greater Manchester's inward investment agency MIDAS seeks to unlock low-carbon investments into the city-region by championing the strengths and advantages Greater Manchester offers. This service is conducted for all types of business but the Low Carbon Goods and Services sector is seen as a priority sector for attracting investment and developing clusters of technological innovation. One example championed by Midas is Europe's largest ever PFI waste management deal with Viridor (Midas 2016). This is a Public Private Partnership in which the public sector has entered into a partnership with the private sector for service delivery. It was signed in 2009 and covers material waste collection, recovery and disposal worth £ 3.8 billion over 25 years (£ 4.7 billion, when landfill and the Authority's own costs are added) (GMWDA 2014). The contract involves 5 Mechanical Biological Treatment (MBT) and 4 Anaerobic Digestion (AD) plants generating 15,000 (MWh) electricity, plus a mechanised sorting plant at Arkwright Street in Oldham. The MBT supplies Refused Derived Fuel (RDF) that cannot be recycled for use in a Combined Heat and Power (CHP) generation facility at Ineos

Chlor (a major North West chemicals producer) to provide energy 29 MW electrical power and 26 tonnes per hour of steam for its plant at Runcorn, Cheshire. In addition the Energy-from-Waste (EFW) facility at Bolton generates green energy for around 7,000 homes (GMWDA 2014). Collectively these schemes contribute a significant proportion of Greater Manchester's low carbon energy generation capacity. The finance arrangement was complex with a mix of capital contributions by GMWDA (over £ 103 million made up of 8% investment 4% debt); investment from the European Investment Bank 23%, direct investment from The Pennon Group, Viridor's parent company, equity investments from John Laing Investments and Ineos Chlor (19%), investment enabled through Viridor Laing from the Bank of Ireland, Sumitomo Mitsui Banking Corporation, Banco Bilbao Vizcaya Argentaria, and the Lloyds Banking Group (collectively 31%); and £ 124.5 million PFI credits because the scheme is a government backed Private Finance Initiative Contract (GMWDA 2014).

(5) Regulated Investment through infrastructure levies

Nationally, the spatial planning system has been a crucial mechanism for leveraging private investment in infrastructure where cumulative impacts of development impact existing infrastructure provision. This has been undertaken through the Community Infrastructure Levy or Section 106 agreements which were described as "essential to support new developments" within the Greater Manchester LTP (2011:56). Local planning authorities are decisive for securing S106 contributions from developers through private negotiations that must be base on prescribing the nature of development (e.g. proportions of affordable housing), compensating for loss or damage created by a development (for example, loss of open space) or mitigating a development's impact (for example, through school expansion or increased public transport provision). An example of S106 being used to finance low carbon activities in Greater Manchester is their use within the Greater Manchester Sustainable Transport Fund to support cycling and walking infrastructure. Implementation is dependent on a strong local planning authority but hard bargaining with developers is often problematised as compromising development. The challenges facing spatial planning are discussed in greater detail in section 3.3 below.

One further important example of a regulated lubrication of private sector funding of low carbon has been ECO (formally Cert and CESP). ECO draws upon the UK Government's legal obligation on energy suppliers and electricity generators to reduce carbon emissions among domestic consumers in specific low-income areas of Britain. This private funding secured through regulation has been used to fund the Greater Manchester Green Deal Communities Housing Retrofit Scheme (see detailed case study section 6) as well as other retrofit programmes such as the partnership between Stockport Homes and British Gas to develop Stockport Biomass Heat Network in 2013-14 using CESP funding to provide nine multi-storey blocks and over 600 homes with heating and hot water cumulatively become the largest biomass-heating network in the UK (Carbon Plan 2017).

(6) Community private financed projects.

Community scale renewable energy installations have increasingly turned to private financing in the form of householder or community shares. For example, the Archimedes screw hydro-generation plant in Stockport is owned by a community group who financed the scheme through shares and a 10-year loan from Stockport Council's Green Regeneration Fund at 7% interest rate (SMBC 2012) – for more see section 6.3. A similar scheme in Oldham was part financed by a £ 243,000 EU grant under the Rural Carbon Challenge fund through DEFRA and matched by community share raising of £ 230,000 (Saddleworth Community Hydro 2016). Although small scale, these initiatives represent a move away from reliance on public grants and instead reliance on private investment models to realise community energy schemes. Here, affluent community investors are decisive for securing match funding to top up reduced availability public sector grants and loans. Greater detail is provided in the case study profiled in 6.3.

Summary

In all these financing models, public sector funding programmes (European and National) and local public actors (such as GMCA and AGMA) stand out as decisive actors for implementation in projects that go beyond immediate commercial viability. Despite the emphasis on the economic value of the low carbon and energy efficiency sector to Greater Manchester's economy, private sector investment in large-scale cross-cutting programmes is rarely being market driven meaning that to date public sector funding sources are remaining central in unlocking low carbon investment. The only projects amenable to such market uptake have to date been in the case of business' own energy efficiency programmes or product developments. When asked the extent to which the market had taken up the challenges of low carbon, it was suggested "That's an interesting question. I think we've got an awful lot more to do on that agenda…very much so" (Interview 8).

3.3.5 Learning and recommendations from involvement of private sector partners

The following points of learning have been collated from a range of programmes involving private sector partners:

- *Need to Increase National Standards* – A key challenge in working with the private sector through the Green Deal Communities Programme was the fluctuations in national policy that create fluctuations in industry recruitment. While AGMA claimed that a "'bank' of technical expertise and solutions across Greater Manchester" was built up by installers to address commonly encountered technical challenges" (AGMA (undated:8), it was suggested during interviews that a particular challenge had been that rather than building skills capacity over time the private sector deliver partners would recruit untrained or newly trained to deliver programmes, who would then lose their jobs when programmes can to an end and when more money became available the circle would start again: "because of this I don't think the sector really drives innovation, quality, high level standards, I think all of that is a real issue" (Interview 3). While the Bomfield Review

2017 aims to put the onus onto industry, this is seen to rely on national standards, which are low – especially with external wall insulation – meaning: "I think the whole industry needs to be looked at…Its good that industry's part of it, but I think industry needs a lot more support…[and] certain parts of the industry like the smaller companies will struggle … its perhaps the larger ones who will be able to respond" (Interview 3).

- *Economies of expertise vs. tailoring solutions* –economies of scale in research and evidencing good practice can be achieved by working collaboratively (Environmental Economy of North West England 2012) and the reskilling of industry claimed by AGMA above was perceived through shared learning. However, at the same time residents participating in the Community Green Deal whole house retrofit programme highlighted a tendency for private sector trades to pursue one size fits all approaches such that "larger contractors that currently deliver area based programmes and social housing contracts … may not be best placed to deliver whole house approaches on individual homes….the nature of whole house retrofit means that every household is different, requiring the co-ordination of several different trades at once" (COOP/URBED 2015:18). Also homeowner expectations are different. "If people are paying for things themselves they want more choice over materials" (Interview 6).
- *Need to negotiate flexibility into PFI contracts* – The PFI experience with Viridor-Laing is described by some as a success and others as disastrous, and the agreement was increasingly threatened in 2016 as a result of spiralling costs of waste collection forcing authorities to reduce collection frequencies in the face of local authority budgetary cuts (Perchant 2016, Times 2016). Many Las have also entered into long PFI contract arrangements for street lighting, but this has presented difficulties in then negotiating energy reduction replacements. Whilst some successful negotiations have taken place across GM setting a precedent (Interview 5), for other LAs street lighting energy reduction programmes have been difficult to negotiate "because they're in a PFI, and its quite difficult to come in at a later date, mid-way through the PFI and encourage the partner on something they're not contractually obliged to do" (Interview 4).
- *Engagement of local commercial operators early aids delivery* – The Manchester DCLG/DECC funded Local Carbon Framework Programme found that the engagement of commercial operators in strategic discussions…has been tremendously positive in turning The Energy Group from an officer "talking-shop" into a strategic delivery group as long as due diligence is carried out for all procurement processes (CAG Consultants 2011:117).
- *Need to frame activity in economic language* – Sustainability West Midlands emphasise the need to involve partners from all service areas (including strong senior level leadership) and to ensure that ideas around the low carbon economy are firmly embedded into economic development activities and major regeneration investments. The need to emphasise the economic imperatives and opportunities in relation to businesses, jobs, addressing worklessness and raising skills (Sustainability West Midlands 2010:7) and the need to emphasise economic benefits of reducing costs and risks (Environmental Economy of North West England 2012).
- *Need to use shared funding to spread risk* – Experience gained from developing the Low Carbon Pipeline of Projects emphasised the role of using investment in a portfolio to enable strategic intervention to prioritise projects that may otherwise not attract investment such as supporting technology adopters with small or high-risk projects (Innovation seeds, undated) and in the Pipe-Co model illustrates potential to share the risk profile among the different types of investors differently.
- *Clear but flexible approaches to leadership and governance* – In 2010 an independent evaluation of the NWDA Climate Change Action Plan (CCAP) emphasised that clear and

decisive leadership was important, but at the same time flexibility to revise specific roles and governance arrangements over time was required when working with a broad partnership of stakeholders (Environmental Economy of North West England 2012).

- *Policy Consistency* – There needs to be consistency between regional national activity and local levels
- *Regions 4 Green Growth Recommendations* – Finally, in 2012-14 Manchester participated in the Regions 4 Green Growth EU funded programme as part of which, other participating regions performed a peer review of each other's strategies for "Maximising the value chain from low carbon investments". A series of recommendations were made to Manchester as presented in Table 3.1 below:

Table 3.1: Recommendations of RFGG Peer Review team and Agreed Actions (AGMA/R4GG undated: Appendix 1 p 31-34).

		Recommendations	**Mitigation Actions**
ORGANISATIONAL	O1	Make sure that the complex governance structure does not hinder how projects will be carried forward.	Initiate a dedicated Project Development Unit (PDU) within GM Core Investment Team to drive forward investment and capital project delivery.
	O2	Improve the technical and engineering competencies of the general management level in Local Authorities.	Appoint a dedicated Investment Director for the PDU with technical/engineering expertise to support Local Authorities in defining and delivering projects
	O3	Balance the ambitions with the human resources available.	Ensure LCH work programmes are realistic with respect to the resources available to deliver.
	O4	Make a stronger strategic partnership with the Universities to foster innovation transfer (example from Noord-Brabant) and identify key challenges that are not covered yet.	Establish a Low Carbon research forum for all GM Universities with a focus on longer term innovations ☐Encourage universities to bid for H2020 Eco- Innovation funding
PROJECS	P5	Establish a clear set of criteria for project selection.	Create a project gateway process which recognises the nature of low carbon investments
	P6	Implement the monitoring system – KPIs.	Establish a set of KPIs which monitor the progress of the each LCH work stream. Utilise research on carbon wedges to focus attention on attaining 48% carbon reduction target and achieving economic growth and build these into on-going monitoring of performance
	P7	Include in the procurement process criteria related to the compensation of carbon emissions generated during the contract execution, which will encourage using local resources (example from Noord-Brabant about road building procurement).	Include low carbon metrics criteria in procurements undertaken on behalf of the Low carbon Hub
	P8	Use public building retrofit as pilots for innovative solutions in low carbon technology (example from Valencia).	Consider opportunity for a hydrogen fuel cell demonstrator in buildings ☐Explore potential for EU funding to create public sector building demonstrators
FINANCIAL	F9	Develop the ESCO business model and introduce an official ESCO registry with criteria in order to ensure the client's trust (example from Lazio).	Develop the concept of and Energy Enterprise for GM. Assess the need for an ESCO model and registry to support low carbon project delivery
	F10	Nominate one person from each of the 10 LA to be responsible for energy purchasing forming a group in charge of energy procurement and make a start for a collective contract.	Investigate the potential for collective energy purchasing as part of the Energy Enterprise concept. If viable, consider best governance for collective purchasing contract.

	Recommendations		Mitigation Actions
	F11	Promote Green Public Procurement and extend it to all public purchases (example from Lazio). Consider the Oldham procurement mechanisms as a good practice to be replicated	Assess the potential for including social value evaluation criteria in all GM procurements
COMMUNICATIONS	C12	Make it easier for the businesses to find information regarding technology and funding by creating an Information Point in the Low Carbon Hub structures.	Provide GM businesses with information on technologies available in local supply chain Engage with wider private sector/commercial interests on availability of investment/funding
	C13	Engage representatives of citizens into the Hub.	Enhance web based communications mechanisms; Engage citizens in development of Climate Change Implementation Plan Refresh to 2020
	C14	Facilitate the creation of sectoral clusters and associations.	Deliver a Low Carbon sector development programme in Greater Manchester to build on existing strength. Identify opportunities to support sectoral clusters through Enworks and wider Growth Hub activities.
	C15	Facilitate the creation of a showroom for professionals with technical solutions in the house-retrofitting sector (example from Rotterdam).	Include the potential for demonstrators within the GM EU Investment Strategy. Develop a show house for ASHP as part of the NED project. Establish a wider show room for low carbon technologies

3.4 Membership in European and UK low carbon programs and initiatives

Greater Manchester is a signatory to the following international commitments:

- *Global Covenant of Mayors* –requiring Greater Manchester to set targets aligned with or exceeding an 80% emissions reduction by 2050, and to achieve a 40% reduction between 2005 and 2030 (GM has delivered cc 26% between 1990 and 2013). The commitment also requires comprehensive action planning, monitoring and reporting using the Carbon Disclosure Protocol and GPC greenhouse gas emissions reporting protocol (GMCA 2016a: 19).
- *Under2MOU* – which requires cities to commit to achieving emissions reductions of at least 80% by 2050, and/or achieving total emissions per capita of a maximum 2 tonnes per person by 2050 (GM's 2013 performance is 5.6 tonnes per capita) (GMCA 2016a: 19). Although not legally binding, this MOU demonstrates clear and lasting commitment to reduce emissions in the decades to come and was noted by the GMCA in 2015." GMCA 2016b).
- *Euro Cities* – offers members a platform for sharing knowledge and exchanging ideas across six thematic forums including Environment and through this involvement Manchester signed the Eurocities Declaration on Climate Change.
- *Celcius Smart Cities Programme*, led by GLA but an FP7 European Programme focussed on knowledge information and experience sharing between cities through online seminars (Interview 4)
- *EU RESIN* – Climate Resilient Cities and Infrastructures – an interdisciplinary, practice-based research project investigating climate resilience in European cities and developing practical and applicable tools to support climate adaptation strategies (Interview 8)
- *EU Eco*-Cities Pilot (Interview 8)
- *UNISDR's "Resilient Cities: My City is getting ready"* campaign (GM CCLES 2016:11).

Greater Manchester is not a member of Climate Alliance or Energy Cities and is not a formal member of ICLEI although some learning from the climate resilience RESIN project (Man-

chester Metropolitan University) will be transferred to second tier ICLEI cities through the ICLEI network and there is some ICLEI engagement with the Carbon Literacy Project.

Greater Manchester is also a member of the following UK city networks:

- *Low Carbon Cities Programme* (http://www.lowcarboncities.co.uk) to develop a citywide target for carbon emissions reductions and deliver them through joined-up action involving a wide range of public and private sector bodies.
- *The Core Cities group* – developing and sharing best practice on climate change. Including signing the "Nottingham Declaration" in 2007 (see http://www.corecities.com/dev07/Publications/Climate%20change%20declaration.pdf) and jointly with the Government setting out how the Core Cities will work with each other and the Government to tackle climate change. (Manchester City Council 2009).

It is suggested by stakeholders that signature of the Covenant of Mayors operated symbolically (Interview 6). For local authorities signing was driven both politically and from Chief Executive level. It was suggested Bloomberg's involvement as UN Secretary-General Special Envoy for Cities and Climate Change and the letter sent to City Mayors had had a big impression (Interview 6). However, whilst being a signatory is often cited in policy documentation – including the Greater Manchester Spatial Framework – and it was suggested this should give greater clout and justification for taking action, doubt was expressed about the effect this had in day to day practice (Interview 6 and 8). "I think politically GM and Manchester like to be seen as heavily involved and leading, I know the Covenant of Mayors gets picked up quite a lot, again the challenge is always how do you match that political ambition to what is delivered on the ground" (Interview 5). In terms of the difference made by signing the Covenant of Mayors to the draft Spatial Planning Framework it was suggested "in terms of this, to be honest I don't think it's made any difference, because it's a high level aspiration, but for us what does it mean then?" (Interview 7). This is a question the spatial planning team are constantly asking of the Low Carbon Hub. It was suggested politically that signatory agreements like the Covenant of Mayors provide useful frameworks, but activity in GM was reportedly not dictated by such frameworks but instead about the willingness of institutions and individuals within GM "we don't need to be convinced by international arrangements" (Interview 8). Nevertheless, being part of the Covenant of Mayors has required increased data collection at the Greater Manchester level, and led to Greater Manchester commissioning Anthesis consultants to develop a new data framework for GM to become compliant with the Covenant of Mayors reporting protocol (Low Carbon Board 2016a).

3.5 Effectiveness of the Regional policy Framework

The summary of regional low carbon and energy policies (presented in 2.2) and the regional governance of low carbon (presented in 3.1- 4) create the regional policy framework through which low carbon concerns are addressed at a city-region level. The effectiveness of these regional policies depends to a large extent on successful integration of low carbon strategies

within wider regional policies and the effects of regional policies on carbon reduction delivered "on the ground".

3.5.1 Successful Integration of low carbon within wider regional policy

Important wider regional policies include:

- GM City Deal 2011 (renewed 2015)
- Stronger Together: Greater Manchester Strategy 2013-2020
- Growth and Reform Plan 2014
- GM Draft Spatial Framework (2016)

City Deal

In 2015 Greater Manchester signed a renewed City Deal between GMCA, GMLEP and UK Government Cabinet Office of the Deputy Prime Minister. The City Deal responds to the argument that "Greater Manchester has developed a clear understanding of the drivers of its economy, its strengths and challenges and the levers it needs in order to achieve its growth potential" (GMCA 2016) – all it needs is control over the finances to deliver it. Low carbon is a relatively minor part of the agreement, with Greater Manchester committing to establishing the Local Carbon Hub, provide strong private sector partnership support and explore a 50/50 Joint venture Company with UK Green Investments and central Government committing in return to "support GM to achieve a 48% carbon reduction target by 2020 by giving GM consideration in any national policies and programmes, offering ad hoc support in bidding for appropriate EU monies relating to sustainability and highlighting the success of low carbon investment in the city …provide contacts and guidance on how to apply for investment from government policies and schemes…and UK Green Investments will commit resources and expertise to the 50/50 JV" (GMCA 2016:19). Hodson et al (forthcoming)highlight the way that the City Deal has produced a vision of Greater Manchester that focuses on accelerating economic growth in ways that do not prioritise carbon issues but instead frame economic restructuring through transport infrastructure.

Growth and Reform Plan 2014

The Growth and Reform Plan 2014 was jointly published by the GMCA and GMLEP with the ambition to "fuse together our strong plans for reforming public services with a continued drive for growth and prosperity. Our objective is to sustain progress whilst eliminating the gap between the taxes we raise and the resources we expend on public services" (GMCA 2017a: 6). At a discursive level it reasonably successfully integrates ambitions of the aforementioned low carbon strategies through a series of ambitious high level statements that seek to align low carbon with high standards of living and decouple carbon emissions from pursuit of economic growth, such as:

> *"We will be known for a good quality of life, low carbon economy and a commitment to sustainable development alongside an outstanding natural environment"(2017a: 9)*

> *"We will continue to promote energy efficiency investment measures to eliminate fuel poverty and make our houses healthy, warm, affordable and fit for purpose in a Low carbon economy" (GMCA 2017a: 16)*
> *"We will prepare an integrated infrastructure plan by mapping the investment needed against 'growth' locations to support resilient, low carbon growth" (GMCA 2017a: 16)*
> *"We are committed to exploring ways to pioneer a smart approach to low carbon city management" (GMCA 2017a: 21) and*
> *"Seizing the growth potential of a low carbon economy and increased resource efficiency. The importance of securing a rapid transition to a low carbon economy has long been recognised. We know that cities that move swiftly to adapt to a changing climate will be more competitive, less vulnerable and better prepared to seize the benefits of a low carbon economy….Successful cities will be those that are able to increase standards of living while reducing the consumption of non-renewable resources and minimising waste….We will develop Greater Manchester as a 'low carbon hub' to achieve the target of reducing our carbon emissions by 48% by 2020 (from 1990 levels). We will work to improve the energy performance of new and existing buildings, businesses and households and support growth in Greater Manchester's low carbon goods and services sector. We will also ensure that the city region is resilient to the changes in our climate" (GMCA 2017a: 19).*

This discourse of aligning low carbon with high standards of living and decoupling carbon emissions from pursuit of economic growth is tested more directly through implementation of this vision through the Draft GM Spatial Framework (GMSF).

Draft GM Spatial Framework

As section 2.2 introduced, the perceived role of GMSF is to outline how the promise of growth negotiated through the City Deal and outlined in the Greater Manchester Strategy might happen. This vision for accelerated growth establishes a vision for GM as more successful than other areas of the UK "in a context of relatively low economic growth in western national states since the financial crisis of 2007/8" (Hodson et al forthcoming:11). Hodson et al suggest this relies on assumptions "that through purposive interventions, Greater Manchester can buck this trend and produce growth 'above baseline conditions' of £ 5 billion by 2035, underpinned by population growth of 294,800, creating an additional 199,700 jobs and requiring 227,200 net new homes" (Hodson et al forthcoming:11). The enormity of this challenge has meant that the role of spatial planning to "bring together the different policies …and looks at what they mean … in a spatial context" has therefore been focussed around "So what is our patterns of growth in the future, and what do you need to do to make it happen" (Interview 7). This focus on growth is also joined to public service reform for which the GMSF is seen as a central mechanism to deliver: "The two pillars are growth and reform: reform of public services…create the jobs that they need to access, the jobs and then reduce the dependency on the public service" (Interview 7). To this end "everything we're doing is around, there's about a £ 5 million gap between the money GM spends collectively and the amount of tax it generates, so what we're doing is closing the gap…getting people into work, who aren't currently working… creating the right jobs and quality of life that attracts people to get the jobs, if you

get the right people in with the skills, then you attract the businesses in" (Interview 7). In this context it was the fear of past population loss and economic decline that drives the appeal and promise of growth:

> *"if you're not going forwards then you're going backwards, and people don't want to go back to the seventies and eighties where you're losing population…because you're not creating jobs…if you're growing…you will attract more people if you're creating jobs because people want to live there, and people follow jobs, but if you're doing that they need to live somewhere and they need to move around, and there will be impacts on things like congestion and air quality, and green space, that's the fact of a city isn't it… for me, from a carbon perspective, it's better for that to be in a city than a rural area, from a sustainability, yeah" (Interview 7)*

The GMSF approach to low carbon, as one policy area among many to be reflected, has been to develop high level broad principles to act as an enabling framework which can then be developed in greater detail either through individual LA local plans or through site specific master planning (Interview 7). At present reflecting low carbon commitments is seen as a discrete task: "We've got a policy there where reducing carbon emissions is reflected, we've got a target of 60% by 2015, which is linked to the 80% by 2050" (Interview 7). Policies to address the target focus on following the energy hierarchy in new developments retrofit, minimising travel, encouraging walking cycling, and carbon storage by habitats. A clear point of controversy in the plan is around the decision to revoke greenbelt protections in favour of increasing development (Interview 7). The biggest challenge recurrently expressed was understanding what the various carbon reduction commitments and targets, developed across different scales and time periods to that of the spatial framework, mean in practical terms for the GM city-region between 2018 and 2035 (Interview 7). Interpreting what delivering reductions in carbon means for GM however goes beyond what the quantitative target reduction cited within the Spatial Framework should be and confronts a more significant tension in integrating activity across the spatial framework and reconciling competing emphases – not least between pursuit of economic growth and low carbon which the draft Spatial Framework seeks to achieve in parallel (Interview 7).

There was widespread concern over the extent to which the draft GMSF would actually implement low carbon activity. One interviewee suggested:

> *"I don't think there's any of us working in low carbon who think its strong enough…it's that sort of going for growth, how do you go for growth and not restrict things, so I do think there are tensions between our ambitions for a low carbon Greater Manchester and the Greater Manchester growth…it's a thirty year document and it's not strong enough, and it's not that people haven't put forward their views, I suppose that needs to be a decision for politicians, because those views have been put forward" (Interview 6)*

Another suggested:

> *"it's been challenging, we have been feeding into the development of the Spatial Framework, low carbon is a cross GM issue, therefore it should be all over the spatial framework…[however] it's been quite challenging from a planning perspective to kind of agree what sorts of policies there should be" (Interview 4).*

Energy infrastructure is largely positioned as beyond the necessary scope of the plan because the local electricity Distributed Network Operator suggests that there are no supply problems for Greater Manchester and a connection to the gas or electricity grids can be provided, albeit sometimes at any cost (Interview 7). Further, given Greater Manchester's limited generation capacity, it was suggested that the city couldn't be self sufficient in any case and grid electricity, generated nationally, was seen as the most efficient way of delivering energy:

> *"where are we going to generate energy from? We've already got a few wind turbines on the hills, everyone doesn't like them, we can't have any more on there, the largest portion of electricity we get at the moment is from anaerobic digestion units – from landfill sites, a little bit of hydro but it's not doing very much, PV just ticking over a little bit, but the vast majority is going to come from National Grid somewhere, whether its offshore Scotland or its nuclear, so from our side we'll never be self sufficient in energy, and if demand is going up and up, and all the targets say we need more electric vehicles, need more trams – they're electric, we need more rail connection they're electric with electrification of lines to move away from diesel, how are you going to generate that, and it's a city, so it's never going to be self sufficient… why would we be concerned about where the electricity comes from?" (Interview 7)*

A Greater Manchester Energy Spatial Strategy Evidence Base was produced by Energy Technologies Institute to contribute towards the energy strategy of the draft GM Spatial Planning Framework, but the report was received late in the writing process and although it was cited in justification on several occasions "we used the evidence base that ETI Catapult did for the Low Carbon team, that wasn't one of the recommendations they picked up" (Interview 7) it was admitted the team didn't have much time to read it (Interview 7).

Discussions with the spatial planning team revealed a team of two under pressure, rushing to get a joint local plan in place to avoid penalties incurred by some LAs within GM not having a current local plan and falling foul of allocating housing numbers necessary to meet the ambitions for growth outlined. Despite the rush to get a strategy in place, this will be revised under the newly elected Mayor, Low Carbon officers continue to feed into the process (Interview 1 and 4), and there was a forthcoming meeting between the Spatial Planning team and ETI scheduled. It was admitted that there needs to be more specificity and spatiality in plans and to this end the concept of low carbon wedge thinking being developed by the Low Carbon Hub and ETI was suggested to be helpful, however, the main responsibility for this specificity was devolved to the local authority level. With a strategic framework only "providing an enabling framework" (Interview 7) it was suggested local authorities each with different possibili-

ties for contributing to the low carbon economy will be best placed to know what's best in their area (Interview 7).

The role of the Spatial Framework in contributing to low carbon strategy of the GMCA shied away from the significance of forward planning in carbon reduction, preferring to emphasise carbon reduction as principally a matter for retrofitting programmes and building control standards (Interview 7). It was suggested the impact spatial planning would have is quite minor and as a small proportion of overall buildings already built has a lower impact on carbon than what's already there (Interview 7). It was suggested that people "want to put everything in planning because its more difficult to do the retrofit, so that's seen to be an easy win isn't it" (Interview 7). With low carbon framed as a building control concern, the importance of the role of spatial planning was downplayed. It was inferred that the building product improvements over the last ten years meant "how much towards to zero do you need to be…what is planning's role is that…in the same way a plan can't build a home, a plan can't retrofit the entire home stock of Greater Manchester…rather than getting hung up on the building fabric itself, which you could say isn't really a planning issue is it, this is a strategic spatial strategy not a building control design manual" (Interview 7). However as discussions progressed it became apparent that it was the lack of central Government guidance in the NPPF that meant it was the lack of a legal framework through which a more stringent approach could be reinforced that was at stake:

> *"the building regulations have improved so much anyway…but that's come and gone hasn't it so, one side of the team are saying you need to include all of this stuff here, but on what legal basis would you include all that, yeah so that's the tension" (Interview 7)*

The same difficulty also came to the fore through a discussion about the presence of an allowable solution policy (as in the Greater London Plan) that would enable demand of a payment from any development that can't meet the energy hierarchy to be zero carbon which can fund activity such as retrofit elsewhere in the city region. It was suggested that Greater London had established such a policy under the previous Government but as the present Government has "done away with the allowable solution concept …how would we legally put it in place" (Interview 7). Whilst it was emphasised that with the legal framework stripped away spatial planning "seemed to be in a better place six, seven years ago" (Interview 7).

> *Those involved in low carbon policy interviewed, both at GMCA and local authority level, expressed concern that low carbon spatial planning needs to be addressed at the GM scale and therefore be led by the GMSF (Interviews 1,6, 4).*

> *"My feeling is it should be in the GMSF…it should be stronger at GM level…because we'll end up with different standards across the ten boroughs…so very much I think they need to revisit that" (Interview 6).*

The hope of those leading low carbon activity is that having a GM wide policy creates a "level playing field" (Interview 1) which "gives the planning authorities the hook to say 'ah yes but we've got to, our planning control has to be in accordance with the GM planning control" (Interview 1). This reduces the strategy of developers to play local authorities off against each other such that if LA put in place more stringent low carbon requirements than a neighbouring authority "developers will say – if you're going to put those controls in we'll go to Manchester or we'll go to Salford" (Interview 1): "The spatial framework allows us the opportunity to be able to, on behalf of the ten authorities, put in caveats and controls that will apply across the ten local authorities that will hopefully – we're not quite there yet – but will hopefully elevate building standards" (Interview 1). However whilst some local authorities have been very explicit in saying they want a GM wide policy the current decision has been to push it back to the local plans" (Interview 4).

Despite challenges, ETI identify that regional and local governments could require higher standards of energy efficiency than the national building regulations because "The Planning & Energy Act 2008 still supports the ability of Local Authorities to set local requirements for renewable energy from new development" (Energy Technologies Institute 2016:30). However, GMCA Spatial Planning team appeared more sensitive both to the likelihood of all ten Local Authorities agreeing to a strong low carbon framework without veto (interview 4) and to the way in which private sector developers used the language of viability (meaning a lack of profit) to object to the multiple social and environmental concerns that the local authority might raise in relation to a development

> *"if you're building a development, who builds? The state doesn't does it, generally speaking, so it's a private developer looking to build something to sell – a business, so if you say right, well we need to address the flooding, and we need to address brownfield land, we want some money for affordable housing, we want some money for this and that, they say – well given what I'm selling it for, it's just not viable, I can't afford it" (Interview 7)*

This was seen within spatial planning less as a tactic of the developers than "just a fact of market reality isn't it" (Interview 7). From a GMCA spatial planning perspective "the Government fears actually going beyond that [building regulations] it is excessive, if you add more barriers and burdens to developers it will impact on housing delivery, so they took that view, that delivery is more important than squabbling actually about what's the final bit of carbon at the end" (Interview 7). However others were more sceptical of these claims suggesting:

> *"developers will play that card with planning professionals, but I'm not sure that its true, and I think the planning professionals know that, if a business wants to locate in Manchester, they'll locate in Manchester, locating in Liverpool doesn't quite do it for them, because it's not Manchester…perhaps Leeds… but I would argue that that's more words than reality, I can't prove that though" (Interview 1)*

Activity is therefore focused on getting projects on the ground because:

> *"that makes enforcing those sorts of planning obligations, or whatever you want to call them a bit easier, Manchester has already got policies related to district heating which says, if there's an existing heat network nearby you should strongly consider connecting, well at the minute it's easy for a developer to say well there isn't one. So it's about getting a few projects delivered so that our conversations with our planning colleagues, who we're trying to persuade that they actually need to be a bit more strict in enforcing this sort of stuff becomes a slightly different conversation" (Interview 5).*

During conversations with the Spatial Planning team a very different role for spatial planning emerged than might have been encountered ten-fifteen years ago. Growth is seen as central to driving infrastructure investment because "that's how transport is funded here isn't it, its funded because there's got to be the growth that's going to generate the sales to get a return back on the capital, not because you're going to put a line in here because there's wider social-economic benefits" (Interview 7). It was perceived that Scandinavia, Germany and the Netherlands could demonstrate high levels of low carbon achievement because of public land ownership that contrasted to the UK where "here you're talking very much about a free-market Laissez faire approach where you're trying to manage that" (Interview 7). When asked about tension between carbon and economic growth one interviewee suggested "a good example of what you're trying to tease out there is the GM Spatial Framework" (Interview 8). Another suggested: "it's the million dollar question isn't it …there is this, as there is everywhere I suppose there is this struggle between investment and low carbon, how far can you push one before the other starts to pull away" (Interview 5).

Addressing these pressures for delivering growth, reforming public services towards a model of low public regulation foregrounds the extent to which the market is being allowed to dictate the terms of spatial planning at GM level. The pragmatic focus of the draft spatial framework was framed as reconciling the gap between land supply and housing numbers to allow for uneven distribution of housing across the ten LA areas (Interview 7). While on one hand it there was some recognition that "it's not developing growth for growth's sake, it's how you share that prosperity for Greater Manchester" (Interview 7), a GMCA-wide plan was seen to add value by allowing a market led approach to development. It enables you to "look at where does the market want to be and how do you make sure you have enough to respond to the market in the future…some areas will have a lower figure, some will have a higher figure" (Interview 7). This emphasis on development-led planning, which "allows us to plan our infrastructure investment plan in line with the development" (Interview 7) is in part demanded through receipt of the Housing Investment Fund – a loan that demands a 5-year payback. Such a short payback encourages approaches to housing that enable development where market wants rather than on brownfield which would need longer – circa 20 year payback periods (Interview 7). Politically, it was recognised that levering in private funding – especially through real estate and accommodation – had achieved success but was focussed in CBDs where investors want to invest. This created an interesting tension in several interviews (par-

ticularly during moments agreed to be kept "off the record") in which the narrative of private sector led development were maintained whilst recognising its inimical effects on local social prosperity and achievement of low carbon ambitions. One on-the record account describes the effects on social prosperity:

> *"but ultimately who is that making money for…its not necessarily the local economy or local society…behind a lot of these investments are pension funds and hedge funds they're taking out 7,8,9% profit before any of this works, what we get as a consequence is accommodation that a lot of people in Greater Manchester can't afford…but all of this is...supported by the National Planning Policy Framework that allows developers to make between 15 and 20% profit before they even need to consider contributions to infrastructure, public realm, everything else and you'll hear it time and time again, developers turning round to local authorities and saying this is not economically viable, therefore I can't make these contributions to you. So there are huge tensions in terms of the growth and how it benefits the people of a place" (Interview 8).*

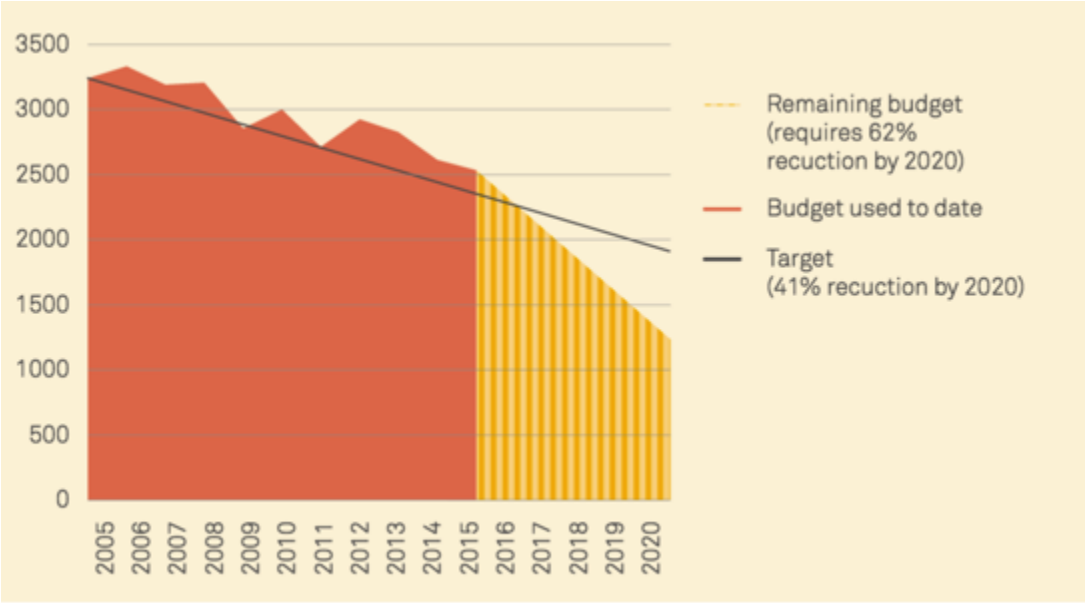
To date, pressures for growth and neoliberal governance are preventing a clear and strong low carbon framework within the GMSF creating a situation in which "we're going for low carbon, but not really" (Interview 6). Without this framework, Local Authority officers suggest there s a real risk that low carbon slips out of the GMSF as "the local plan is assuming it will be covered at GMSF level, and GMSF are assuming it will be covered at local plan level" (Interview 6).

Lack of regulation is explicitly presented as a challenge to delivery of the targets and ambitions set out in the GM Climate Change and Low Emissions Strategies: Whole Place Implementation Plan for Greater Manchester (2016-20): this "makes a material difference to our performance, particularly around new and existing buildings, but also on transport, vehicle selection and licensing" (2016:6). Whilst a market approach to mainstreaming is being adopted by the Low Carbon Hub, it was simultaneously recognised that "if you want to get mass change, if you want to move from the demonstrator, the pilot, up to the mainstream, then …sometimes I think regulation might be the way forward" (Interview 1). However, the combined authority does not "currently appraise the carbon implications and risks of our policies and programmes, investments and plans in a transparent and consistent way" (Local Enterprise Partnership Board 2016:6). As one interviewee suggests "well its not regulated at the moment so, the policy is there, but [its] what we said before about the conflict between regeneration and development and encouraging low carbon solutions" (Interview 5). GMCA recognised this tension in their scrutiny of the Low Carbon Hub where it was stated that it was a "challenge to connect low carbon to the wider GM growth and reform agendas" (GMCA 2015c: report 7p3). In the GMSF "The issue is not that carbon emissions are ignored in the Framework….[but] there is already a struggle to meet carbon targets. Even optimistic scenarios fall some way short. The Framework promotes growth significantly above baseline. This suggests carbon emissions reductions will be even more difficult to achieve and that carbon emissions reduction, as an agenda, is becoming more squeezed" (Hodson et al forthcoming:12).

3.5.2 Effects of regional policies on quantitative measures of carbon reduction

In 2016, New Economy Manchester released figures based on DECC statistics, suggesting Greater Manchester's direct carbon emissions have been reducing over previous years from 21.1 million tonnes in 1990 to 15.3 million tonnes in 2013 – representing a decrease of 27.5% (New Economy 2016). Much of this reduction in carbon emissions across the UK is attributable to conversion of national energy generation from coal to gas but also reflects increases in renewable energy generation and smaller scale achievements of local programmes. At the same time, Greater Manchester's rate of economic growth showing an increase "from £ 49,461 million in 2011 to £ 50,991 million in 2012, a rise of £ 1,530 million, or 3.1%. This is almost double the national average" (GMCA, GMLEP, AGMA 2014:15). Although this suggests promise of decoupling, when examining the annual targets, a report by Manchester a Certain Future suggests Greater Manchester has actually only met its 48% target trajectory on CO_2 emissions reduction in two reporting years since 2005: in 2009 and 2011:

Figure 3.3: Greater Manchester Carbon Reduction Budget Achievement to date

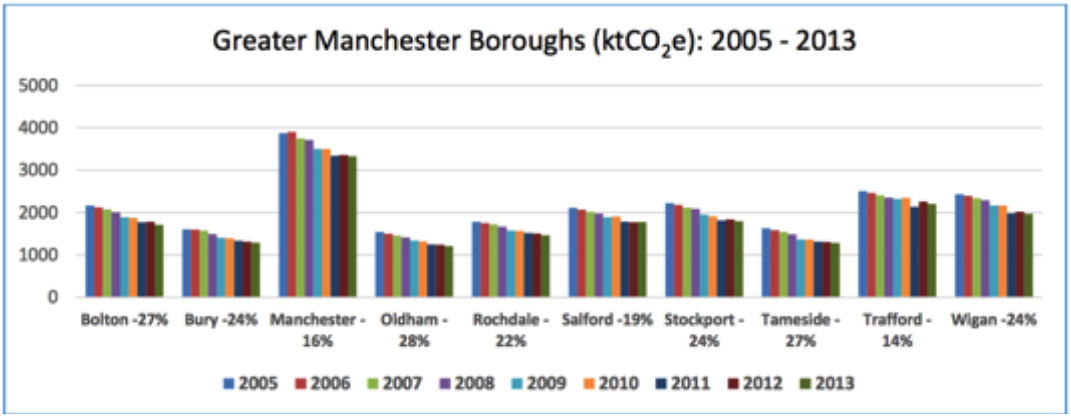


Source: MACF 2016:25

As such Manchester's journey to achieving its target carbon reduction outcomes is still a long way off: "Analysis by the MACF CO_2 Monitoring Group of Manchester's emissions from a carbon budget perspective shows that we need to make steeper cuts from 2015 to 2020 to stay within our carbon budget. Given we have emitted more than we should between 2005 and 2014 (the area above the target line), we would now need to achieve a 62% reduction by 2020 in order to make up the difference" (MACF 2016:25). These gains need to be further understood against a background UK national context in which "UK net imports of carbon emissions rose by 70% between 1990 and 2010" (CCC 2013:30) and "growth in imported emissions has more than offset reductions in production emissions" (CCC 2013:7).

The Greater Manchester Climate Change and Low Emission Strategies Joint Implementation Plan (2016) reports carbon emissions between 2005 and 2013 for each local authority as a bar graph that shows general trend of carbon emission reduction in each local authority area with some stagnation between 2011 and 2013. It is difficult to assess absolute values and to consider the progress of GM as a whole:

Figure 3.4: Greater Manchester Carbon Reduction Monitoring 1



Source: GMCA 2016a:18

The focus on reporting progress instead is on forecasts of achievement if the plan is met and process indicators: for example, setting ambitious targets and developing strategic plans, bringing in funding and developing strong working relationships with UK Government (GMCA 2016:11).

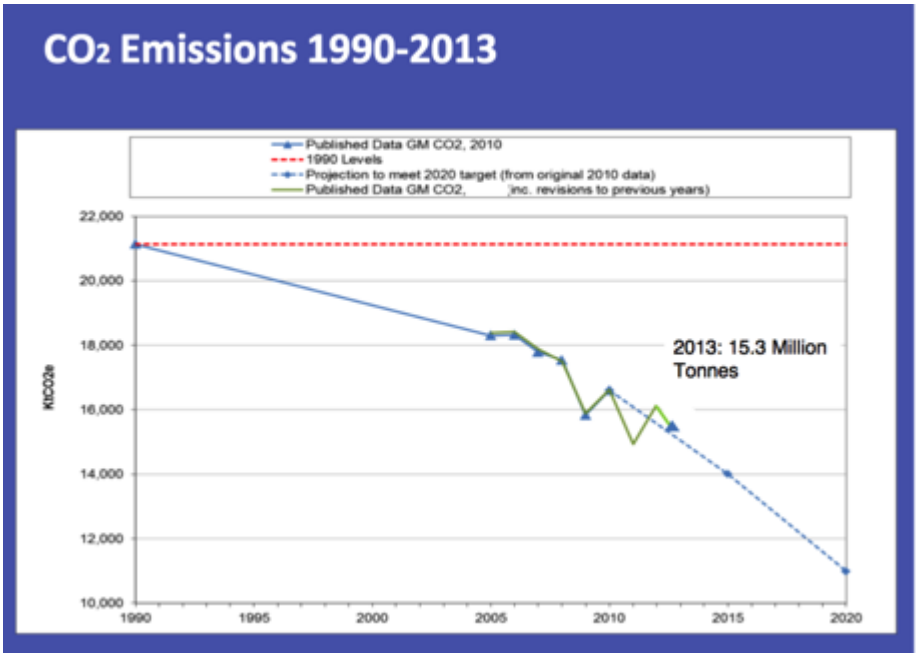
Reporting of absolute GM figures also occurs through the Carbon Disclosure Project (https://www.cdp.net/en) (Interview 1). However, this shows a mixed result of increases in CO_2 in 2013 and 2015, no data for 2014, and a decrease in 2016: although figures are difficult to access and to compare as reporting methodologies have changed.

Estimations of carbon savings from specific activities such as the GM Green Deal Communities Retrofit programme are given as illustrations: estimating a total of 15,000 tonnes CO_2/year (source GMCA 2016:5) although direct measurements were not built into programmes (Interview 3). In the GM state of the Environment Report 2015, data is represented for GM as a whole until 2013 and again shows 2011 as the year reaching the lowest reductions.

The GM Climate Change Report (2015d) further frames success in terms of recent funding successes for low carbon activity: including £ 300,000 for heat network feasibility, £ 99,000 to establish a District Energy Procurement Agency, £ 3 million programme of resource efficiency business support, £ 30 million domestic heat programme, £ 6 million retrofit initiative, £ 20 million "Velocity" cycling infrastructure grant, € 1.2 million for adaptation planning and a share of € 24 million to demonstrate smart green technologies from Horizon 2020 and £ 30 million to deliver low carbon network innovation pilots by Electricity North West (GMCA 2015d). Whilst important, these process indicators stop short of demonstrating that Greater Manchester's

approach is achieving outcomes, and instead reflect the wider interests that low carbon activity is serving.

Figure 3.5: Greater Manchester Carbon Reduction Monitoring 2



Source: GMCA 2015d: 4

This picture is similar to that across the UK as a whole with the CCC reporting that:

> *"Emissions have fallen by 13% in the last three years to 38% below 1990 levels in 2015. However, almost all the fall in emissions has been in the power sector, as a result of reduced use of coal and increased generation of electricity from renewables... current policies are not sufficient to continue the good progress to date or broaden it to other sectors… There has been almost no progress in the rest of the economy, where emissions have fallen less than 1% a year since 2012…there has been slow uptake of low-carbon technologies and behaviours in the buildings sector … and 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" (CCC 2016:12).*

3.6 Specific added value of GMCA cooperation in this city-region

It has previously been suggested that "GMCA's draws a great deal of strength from its history of governance at the city region scale" (Cowie et al 2013:13). With various vestiges of metropolitan cooperation surviving multiple reorganisations, this strength is perceived to arise through the following qualities that come from working at a regional or city-regional scale:

1) Strategic Prioritisation – The GMCA suggest that "A key advantage of the Combined Authority model is its joint governance arrangements… which allow for strategic prioritisation across the functional economic area" (GMCA 2016:6). As one city region policy maker described, this enables activity to be undertaken more flexibly and more strategically than if all 10 Local Authorities operated separately (Interview 1).

2) Integration – The GMCA also identify integration of service delivery across boundaries. This enables GMCA to look at the needs of GM population and their needs that cross the 10 LA geographical boundaries (Interview 1). It also allows working across organisational boundaries, exemplified by Transport for Greater Manchester which "facilitated much greater integration and closer working relationships with the Highways Agency and the ten local authorities on the operation and development of the road network" (GMCA 2016:6). However, it is the opportunity to work across thematic boundaries that comes from the specific partnership mode of working within AGMA and GMCA that was identified as critical to innovation:

> *"where you've got public private, voluntary sector being brought together, to focus on a common area, I think that can stimulate innovation…what it allows us to do is get the right people around the room…if those groups meet frequently, and meet for a period, trust builds up, that's where you get projects developing… you start to get the innovation because rather than energy alone or buildings alone, you start to get the interaction between energy and buildings" (Interview 1).*

GM policy stakeholders describe the benefits of integration resulting from the strong relationships already in place through AGMA rather than through the specific formalising of these through the GMCA: "whether its AGMA or the CA, the real innovation comes from looking at the overlaps between some of those boundaries and looking at the innovation across, and I think I would probably argue we were doing that as AGMA" (Interview 1).

3) Stability – The long history of collaborative working since 1986 has allowed "a great deal of shared knowledge, trust and capacity to be developed" (Cowie et al 2013:13). This provides stability of working relationships at a local level. In addition such stability is also perceived by central government and is highlighted particularly strongly in the decision to build a city deal with Greater Manchester. For this the legal constitution of the GMCA is important. It is Manchester's "stable and accountable governance" provided through the GCMA (GMCA 2016:4) and the fact that GMCA has "powers in its own right, so is not dependent on delegations from its constituent authorities, and decisions to pursue a particular policy are binding (GMCA 2016) that "provides a stable and accountable platform for Government to devolve powers and functions as part of the City Deal process" (GMCA 2016).

4) Leadership brings gravitas and access to resources – The ability to work and speak collaboratively gains Greater Manchester greater gravitas in dealing with UK Central Government and enables it to "reach out beyond the region to establish networks and to gain access to resources" (Cowie et al 2013:13). GMCA emphasise: "Not only does the Greater Manchester Combined Authority provides a stable and strong governance structure enabling it to take on new powers and functions, it also has the gravitas to engage with central government and national agencies successfully. This will enable Greater Manchester to secure future devolution and resource prioritisation." (GMCA 2016:6). This is reinforced by the Greater Manchester Energy Plan who suggest, "Working together across Greater Manchester enables a scale of activity that warrants the attention of significant national and international investment, and a

collective influence that secures the attention of policy and decision makers" (GMEP 2011:88). With the backing of the 10 constituent local authority elected leaders and a scrutiny committee comprised of 30 elected members through AGMA, stakeholders interviewed felt that strong "democratic legitimacy" for such leadership is established (Cowie et al 2013:14-15). This will presumably be enhanced by election of a metropolitan Mayor in 2017.

5) Co-operation facilitates Smooth Project Delivery – The Greater Manchester Energy Plan identifies cooperation leading to greater delivery capability: "The advantage of ten local authorities working together with the private sector allows for increased project development capacity, single points for contact for the private sector, economies of scale, knowledge transfer and less duplication of effort" (GMEP 2011:88). In particular, cooperation between sectors early on in project planning allows sharing of practical knowledge and expertise that facilitates project development and streamlines the identification and circumventing of potential challenges to energy project delivery.

6) Allows strategic reframing to fit different agendas – Finally, it was suggested that "it enables us to … work in partnership…to share perspectives…one of things that's really important with this agenda is to see low carbon, or the green agenda more broadly speaking from different stakeholders perspectives, and the low carbon hub provides a space through which to do that" (Interview 8). By reframing the low carbon economy to the perspectives of different stakeholders it is hoped that it will achieve greater resonance with core activities and encourage action to be taken.

4 National and European cohesion policy background

4.1 The role of cohesion policy for regional low carbon development

GM is currently part of the "more developed region" cohesion policy regime 2014-2020 (previously part of the Competitiveness & Employment cohesion policy regime 2007-2013). Although the receipt of cohesion funding to the UK and GM in particular might appear comparatively small, this has played a vital role in low carbon activity in the GM region since the early 2000s. Interaction between GM city-region and the EU appears to occur primarily through three main channels:

- The implementation of EU directives
- Specific direct relationships with EU Commission on specific projects or consultations.
- Funding programmes

4.1.1 EU Directives

EU directives form a raft of legislation that affects cities and is only sometimes incorporated into UK law (Interview 1). There are currently 501 EU Directives involving Energy, 141 involving Climate change, 333 on carbon and 6 on "Low Carbon" (EUR-LEX 2017). Particularly, relevant examples cited by those interviewed in GM include the Renewable Energy Targets, the Water Framework Directive, and air emissions quality targets. These present themselves as both drivers and challenges to GM but only to the same extent as any city in UK (Interview 1).

4.1.2 EU Commission

In some instances involvement in specific projects with the EU Commission was cited – for example, the Low Carbon Hub's involvement in the EU smart cities consortium. However, these types of involvement were suggested to have been more common in the past, with limits on local authority resources limiting the extent that cities can justify attending meetings in Europe. Increasingly, in the context of Brexit, enthusiasm for these forms of engagement is getting squeezed out and energies are being redirected. Although it was suggested more attention would be directed this way had the UK voted differently in July 2016, it was suggested "its quite difficult to be motivated to do more in Europe right now other than through projects…I'm probably not doing as much trying to influence European Policy as I was 12 or 18 months ago, I'm not sure that policy is going to affect me in the future, and I don't have enough resources to have the largess to say I'll give you my brain for nothing, there's got to be something in it" (Interview 1).

4.1.3 EU Funding Programmes

The majority of EU interaction discussed occurred through GM's receipt of EU funding. European funding was described as an important driver for activities (Interview 8) with GM being party to, or leading, a range of EU projects which bring much stronger connections with the EU through working with DG Regio and DG environment (Interview 1). Greater Manchester currently receives £ 356 million to support investment in innovation, businesses, skills and job creation through European Structural and Investment Funds (GMCA 2017c) and focuses on six priority areas:

- competitive places
- science innovation
- competitive business
- reducing carbon emissions
- skills, employment and inclusion
- reforming public services

Part of the current ERDF allocation to GM is being spent on developing a recyclable loan fund for low carbon investments – especially heat networks and loans for commercial buildings in which payback comes from business savings, profit or equity (Interview 1).

GMCA suggested in 2015 that:"European Funds have played a significant role in the economic development and growth of Greater Manchester over the last twenty years" (GMCA 2015: point 40) particularly through ERDF and ESF programmes. In low carbon particularly: "some of our bigger programmes have been delivered through European Funding" (Interview 1). ERDF funding has been identified as particularly important for market reform, business productivity and energy efficient and renewables infrastructure deployment (Local Enterprise Board 2016). Of the £ 195 million GM received from ERDF programme in 2014-20 – £ 15 million was invested into a Low Carbon Investment Fund (GMCA, GMLEP, AGMA 2014:14). Formally, ERDF was administered through the NWDA and although this responsibility now formally rests with DCLG, it was suggested that the intermediary body status of GMCA allows it "greater influence and decision making in respect of the € 413.8 million 2014-2020 European Regional Development Funds (ERDF) and European Social Funds (ESF)…This will allow Greater Manchester to integrate and align investments with other aspects of the devolution deal and local economic priorities, to improve performance and maximise economic impact" (GMCA 2015: point 40). "In theory it can approve own projects" (Interview 1).

Other forms of European funding have also been identified as essential to delivery of the CCLES 2016-2020 beyond ERDF including Horizon 2020, INTERREG, ELENA (GMCA 2016:4). For example, Horizon 2020 allocated approximately £ 6 million to the Triangulum Sustainable Cities Project (Low Carbon Board 2015d). Other transnational funds which could have applicability to low carbon activities, include: Connecting Europe (Energy, transport and broadband infrastructure), European Funds for Strategic Investment, COSME (Competitiveness and SME programme), Erasmus for All (Education, training, youth and sport), Life+ (Environment and climate action), Creative Europe, Employment and Social Innovation and Third

Health Programme (GMCA 2017c). A further opportunity for becoming involved in European funded programmes occurs through University led projects to which the Low Carbon Hub are invited to participate and the EU Fuel Poverty Network (Interview 3). However recently Universities are indicating to the Low Carbon Hub that they are being actively discouraged from putting forward funding bids because of Brexit, which is hitting the low carbon agenda hard (Interview 6 and 8). This is confirmed by recent UK media reports that suggest universities across the UK are reducing staff and citing Brexit and reduction of European Funding income as an important driver (see for example Pidd 2017).

While it was suggested that GM had "done quite well in European programmes in the past" and they had been "hugely important" (Interview 1) it was recognised that this was unlikely to continue and there is great uncertainty as to the possibility for future participation in ERDF in future rounds. While the UK chancellor has given commitment that any projects funded before 2022 will be underwritten by the UK Government, as long as they in national interest (which remains unspecified) creating confidence to continuing pursuing funding programmes earmarked as central to delivery of the LCEEES 2016-2020, GMCA "are making the assumption that low carbon energy efficiency and smart are in the National interest" (Interview 1). Undoubtedly ERDF has been central to delivery of many of GM's low carbon economy activities and the proposed leaving of the EU will impact the resources available for GM to deliver future programmes. To some extent the impact of this on future delivery is being deferred "this plan only runs to 2020, by 2022 we'll have developed another plan and we'll say how we're going to fund this one" (Interview 1). Although it is envisaged that ERDF will not continue "we're going to chase EU funding until we can't do it anymore" (Interview 1). The combined forecast decline in both UK Government and EU funding available for low carbon activity is prompting attention to developing what is referred to as "innovative financing models" (Interview 1) see section 3.26.

4.1.4 The role of EU policies and Initiatives as drivers or Barriers for Greater Manchester

The response of many city-region actors interviewed to questioning around where the drivers of low carbon activity come from tend to rehearse a narrative of the city-region as driver (Interview 1, Interview 8). It was suggested that:

> *"We have a plan, we have lots of actions in the plan, if we can get EU funding to make those actions happen – great, if we can get National funding to make those actions happen – we'll do it, but these are our local priorities, if it's not in the plan we won't do it" (Interview 1).*

> *"The framework that we operate under isn't dictated to by Covenants and Memorandums of Understandings its more about the willingness of institutions and the interest of people within Greater Manchester, and the real desire to do something around this agenda that drives…we don't need to be convinced by international arrangements that this is important" (Interview 8)*

There was strong emphasis on the need to lead with the city-region plan "otherwise you're just chasing funding – we're not going to do that" (Interview 1). This reflects a claim for self-autonomy in policy action, a pressure on resources in which "If you're chasing the funding monkey you could see tensions, but we haven't got the resources to do that, so we only pitch for resources that will help us to deliver this [indicating the LCEES]" (Interview 1). Despite this official line, the circumstances by which low carbon became an important emphasis in GM's city region priorities (outlined in section 3.2) remain unarticulated.

As well as signposting the way in which climate change has been aligned to the economic argument: "it kind of reflects what I said earlier about us having one of the largest green economies in the country really" (Interview 8), Greater Manchester is eager to be seen as a "doer" almost immaterial what is being done. The role of European funding in enabling Greater Manchester to "do things" was often emphasised (Interview 8) and so access to EU funding around low carbon provides a thematic focus through which this active delivery may be demonstrated. It was stressed that the LCH provides a forum that focuses on delivery: "rather than creating talking shops, we're fundamentally not interested in that, we're interesting in doing things and collaborating to win bids, get the Government interested in this agenda, demonstrate to Government what we're doing in Greater Manchester with a view to trying to influence policy nationally and also obviously illustrate to the rest of the world and to Europe how we do things here in Greater Manchester" (Interview 8).

Whilst the narratives of Greater Manchester as the driver and powerhouse behind low carbon aspirations are common in both written and verbal accounts, it is important to dig behind these narratives to the extent that low carbon has become a vehicle through which Greater Manchester can position itself as a compliant, mature and reliable delivery partner for the UK Government and a European exemplar. Doing so requires being a flexible grass in the wind of dynamic national and European policy ambitions.

4.1.5 Experiences of using financial means of cohesion policy for low carbon development in Greater Manchester

ERDF programmes are considered highly valuable sources of finance for enabling activity at the regional to local scale. Despite the UK's overall low levels of structural funding comparative to other (succession) countries, structural funds have played a vitally important function (both materially and through soft power) in delivering programmes, leveraging UK Government funding to the regions and leveraging private sector investment. Nevertheless ERDF funding is known for being administration heavy, highly restrictive, and requires operation on a particular scale to work well. This poses a number of challenges for working with ERDF that are reflected in the many experiences of working with ERDF funding in GM city-region.

ERDF's requirement for 50% match funding historically provided an important way in which regions could levy in funds from UK central government. Typically match-funding requirements for ERDF are sourced from public sector UK National Government, certain local public

sector funding, or private sector – including levies or loans (Interview 1). In a context of declining UK Government public sector funding, and in the absence of the RDAs who played an important role in facilitating the securing of match funding for ERDF programmes, it is increasingly difficult to rapidly pull match funding together in time to secure ERDF funds. So instead of an "ability to deliver projects that were actually needed when you wanted to do it…Now, you have to look quite carefully to see where the match funding might come from and there's not a lot of it around, so that might limit you in what you can do" (Interview 1). Further, the tightening up of ERDF regulations around "in-kind" contributions (staff time) have made claiming staff time on ERDF projects increasingly difficult. In the context of public sector cuts this places more emphasis on hard cash match funding in a context where little public sector hard cash is available, and therefore in turn places increasing pressure on looking to the private sector for match funding.

At the same time ERDF restricts support to only supporting SMEs. In the past, the RDA used to provide a larger proportion of match funding than was needed for ERDF so that there was a clean pot of money that could be kept separately from ERDF funding to allow businesses who were non eligible for the ERDF programme to be supported alongside those who were (Interview 2), this is now no longer possible. Working with SME's poses its own challenges around managing liability. ENWORKS suggest that ERDF programmes carry a lot of liability (in terms of reclaiming money) and whilst "in theory you can pass that liability down, but the organisations we were working with, if you turn round and take 500,000 off them they were going bust, so we held a lot of liability" (Interview 2). This was managed by keeping very strict audits. Recommendations for working with ERDF from ENWORKS follow good project management principles and include firstly separating out delivery from a claims and contracts management team that remain separate from the delivery team. This avoids any conflicts of interest and temptation to flexibly interpret the rules which it was suggested will always come back to bite you. Secondly, always checking eligibility by going back to primary guidance, not UKGOV guidelines which always include small print stating they won't be held accountable. And finally evidencing as you go along not at the end.

In light of these challenges, and in the context of the ENWORKS programme it was highlighted that "ERDF is extremely expensive to run" (Interview 2). Whilst essential to the ENWORKS programme throughout its duration, successful deployment of ERDF depended upon a substantial management team who developed significant expertise in managing ERDF programmes. This means that ERDF programmes only make sense for projects of a certain size and organisations of a certain scale. It was suggested that one of the most common places people go wrong with ERDF is in not putting enough resource into project management and even a £ 2 million ERDF project would only make sense in an organisation that was already managing ERDF: "if you weren't I wouldn't go near anything like that, because of your fixed costs" (Interview 2). In fact the overhead skills are so significant that the ENWORKS contracts management team are said to now run all contracts for Business Hub because of the skills developed over the period of the ENWORKS programme.

A final important feature of ERDF is the specification of very clear and quantifiable outputs that need to be achieved. This was seen as both a positive and a negative. On one hand it can restrict the types of project that are put forwards: “you’re driven by the outputs, so you might want to do project x over there but if project x doesn’t give you the outputs you require you’ve got to do project y” (Interview 1). On the other hand it was suggested that where previous ERDF programmes had greater scope for flexibility, the current ERDF programme focuses activity more tightly around the programme objective of low carbon, allowing less scope for ERDF funding to be used in loosely related ways “personally I think that’s a benefit, I think other people might argue not, or depends where your priorities lie” (Interview 1). However, one of the restrictions this imposes is that “some of the work that I would argue is necessary on resource efficiency, can’t be counted, which I think is ridiculous given the amount of energy embodies within goods and materials, it makes no sense” (Interview 1). In this sense, the current ERDF Programme controls the objectives to which money is spent more tightly – ensuring a carbon reduction focus, but sometimes at the cost of holistic programme approaches.

4.2 Complementarity of regional, national and EU low carbon policies

4.2.1 Historical development of current UK low carbon policy

Since the United Nations Framework Convention on Climate Change (UNFCCC) at the Earth Summit in Rio de Janeiro 1992, and expansion of the 1989 Non-fossil fuel obligation (NFFO) from nuclear electricity generation to renewables in 1990, the UK had, at least up until 2011, developed a relatively strong national low carbon policy framework. This was first formally expressed through the UK’s commitment towards the Kyoto Protocol (agreed in December 1997) to reduce emissions of six greenhouse gases by 12.5% below 1990 levels over the period 2008-2012: a higher target than both the collective EU target of 8% and the overall Kyoto figure of 5.2% (CCC undated). In 1997 the labour Government was elected with a manifesto pledge of reducing carbon emissions by 20% below 1990 levels and they soon introduced the UK Climate Change Programme (2000) which problematized high carbon fossil fuels and positioned carbon emissions reduction through emphasis on energy efficiency and renewable energy generation as required action to address climate change (DETR 2000). This was followed in 2001 by the Climate Change Levy (CCL) – a tax on the use of energy in industry, commerce and the public sector was introduced with Climate Change Agreements (CCAs) giving special dispensation for certain high energy sectors which agreed to implement targets for improving their energy efficiency and reducing carbon emissions (DECC 2008). In 2002, the UK Government began implementing the first of several market-based mechanisms for governing carbon reduction through introduction of the Renewable Obligation Scheme (RO). The RO placed an obligation on licensed electricity suppliers to source a proportion of their generated electricity from renewable sources, to purchase ROCs from third party generation schemes (giving them a market value independent of the buy out price) or face payments into a redistributive “buy-out fund” (Ofgem 2017). Policy commitments to carbon reduc-

tion increased in the Energy White Paper 2003, which proposed carbon emissions reductions of 60 per cent by 2050 (DTI 2003). However despite updates to the UK policy framework for addressing climate change through the publishing of the Climate Change Programme (DEFRA 2006) following the Montreal UN Climate Change Conference, it wasn't until 2008 that the UK target for emissions reduction in the UK Climate Change Act 2008 was substantially increased to at least 80% from 1990 levels by 2050 requiring 5-year interim carbon budgets (DECC, 2011). This was based on a report by the newly established UK Climate Change Commission "Building a Low-carbon Economy" which outlined the urgency of increasing the targets for action.

In addition, specific guidance was passed down from the UK Government to local and regional authorities including supplements to Planning Policy Statement 1 in 2007 that provided government guidance on planning policy and climate change. This included technical advisory notes 8, 12, 18 and 2, which offer advice on renewable energy provision, good design including environmental sustainability, design, transport planning and sustainable building respectively (DCLG 2007). It also included the Planning Act 2008 which imposed a duty on local development plans to include policies to ensure that they make a contribution to both climate mitigation and adaptation (RTPI 2012). The UK Government launched the Code for Sustainable Homes in 2007 (which set minimum performance standards for the design and construction of homes covering energy, waste, materials and water) and the Warm Homes, Greener Homes Strategy in March 2010 for UK domestic energy management. In 2010 the CRC Efficiency scheme was launched as a mandatory scheme requiring large public and private sector organisations over 6,000 MWh to reduce carbon emissions. This affected most large local authorities across England.

This policy commitment was matched by extending the Carbon Emissions Reduction Target (CERT) that required energy supply companies to meet a carbon reduction target through promoting and funding uptake of low carbon solutions especially among low income domestic sectors, and in 2009-12 developing the Community Energy Saving Programme (CESP) which targeted low income areas with a whole house approach (and was used to deliver the first phase of the Manchester Retrofit Programme (GMEP2011: 78)). Feed-in Tariffs to subsidise small renewable heat and electricity generation (less than 5MW) that were not eligible to participate in the energy market trading of ROCs and Renewable Heat Incentives for larger generations, were also introduced in April 2010 and 2011 respectively. The policy commitment in the Climate Change act 2009 was soon followed with the Low Carbon Transition Plan in July 2009 and the UK Energy Bill 2010-2011 which introduced the ECO Scheme – replacing CERT and CESP – and the Green Investment Bank – as further market mechanisms to address market failures preventing investment in renewable energy. At the same time Ofgem the electricity market regulator established the Low Carbon Networks Fund (LCN) to encourage distributed network operators to develop innovate projects that develop large scale trials of infrastructure upgrading or innovation that enable knowledge and expertise to be shared across the electricity industry (Ofgem 2017b).

Since election of the Conservative Lib-Dem Coalition Government in 2011, the framework for national low carbon policy shifted significantly towards stripping back regulation and favouring business needs and private sector provision. A new Carbon Plan was published in 2011 outlining strategy to meet the 2008 Climate Change Act's legally binding targets which focussed attention on energy efficiency, electrification and carbon capture and storage, striving to "generate competition that will drive innovation and cost reduction"(HM Government 2011:5). This was accompanied by the UK Nation Infrastructure Plan (2011) that emphasised the need to ensure "a secure, diverse and reliable energy supply for the UK while reducing the carbon intensity of electricity generation at least cost to consumers"(HM Treasury 2011:6). This infrastructure plan outlined expectations that "two thirds of the expected investment between 2011 and 2015 will be privately funded" and to address the "upward pressure on taxpayers and consumers" that this could create the Government focussed on "Electricity Market Reform, Energy Company Obligation and the Green Deal to manage the impact on energy bills of the transition to a low carbon energy system… [focussing] on those who need it most and …to reduce the costs of electricity for the most electricity intensive industries" (HM Treasury 2011:7). The Renewable Heat Incentive was extended to domestic systems in 2013 and the Green deal in 2012 which encouraged domestic energy consumers to invest in energy efficiency improvements to their home through loans linked to their property and repaid through energy savings. In 2013 the Energy Act received Parliamentary Ascent, which established the intention for a decarbonisation target for the electricity sector for 2030 but defers the setting of this, and places increased emphasis on nuclear power and emissions performance standards for new coal generation plants (DECC 2013). The Act initiated replacement the Renewables Obligation Scheme with a Contract for difference Scheme in which a private company owned by DBEIS – the Low Carbon Contracts Company establishes a private contract with low carbon electricity generators to pay the difference between the cost of investing in a particular low carbon technology and the average market price for electricity in the GB market (DBEIS 2016d). The Act also introduced a number of Electricity Market Reforms including expanding FITs to allow larger community energy schemes to benefit and limits to the additional costs of generating renewable energy that can be passed onto consumers. In July 2015, the Summer Budget of the Conservative majority Government removed the tax exemption on renewable energy generators established through the 2001 Climate Change Levy (HM Treasury 2015).

Since election in majority in 2015 the UK Government has weakened its national framework for low carbon policy, announcing "at least 11 Treasury-led green policy reversals" often without consultation or assessment (TUC 2015). These include abolishing the Zero Carbon Homes building standards, changing vehicle excise duty so that very few low emissions vehicles will now be exempt, cutting renewable energy subsidies for onshore wind, larger solar power schemes and small scale renewables and abolishing the Green Deal for home energy efficiency investments (TUC 2015). The Green Investment Bank has also been privatised and there are concerns among the UK Committee on Climate Change that "beyond 2020, there are limited market and regulatory signals" (CCC 2015). This comes from an ideological com-

mitment to private sector leadership in which the UK Energy Strategy describes whilst: “During the last decade, energy policy in the UK was often discussed through the framework of a ‘trilemma’ – the need simultaneously to find policies that would contribute to meeting climate change targets, guaranteeing security of energy supply and minimising energy costs. Nearly 10 years on from the Climate Change Act, that framework requires updating.… It is the private sector that will ultimately be the driving force behind our low carbon economy” (DBEIS 2017:89).

At a UK national level, remaining public policy to address climate change is currently split between the Department for Business Energy and Industrial Strategy (DBEIS) who lead on mitigation (including carbon reduction and energy), and the Department for Environment Farming and Rural Affairs (DEFRA) who lead on climate change adaptation. Since abolition of the former Department for Energy and Climate Change in 2016, BEIS have taken over responsibility for climate mitigation activities. BEIS brings together climate mitigation concerns with those of business, industrial strategy, science and innovation and leads policy areas on Climate Change Agreements, international Climate Change action, Energy and Climate Change policy, Energy reduction and Energy Demand Reduction, Greenhouse Gas emissions, Low Carbon Technologies, Energy Security and City Deals. Important current climate change policy frameworks at UK National level include:

- The UK Climate Change Act (2008)
- The UK Carbon Budgets 2-5
- Energy Company Obligation (ECO) 2013
- The National Policy Planning Framework 2016
- Building our Industrial Strategy Green Paper 2017
- Emissions Reduction Plan (forthcoming 2017)

In addition to Government Policy, the UK Committee on Climate Change established through the UK Climate Change Act 2008 as an independent statutory body still advises the UK Government and Devolved Administrations on emissions targets, and reports progress towards both emissions reduction and adaptation to UK Parliament. The Energy Savings Trust and Carbon Trust also both operate across the UK. EST began as an independent not-for-profit, government sponsored organisation in 1992 to provide free advice on energy efficiency and sustainable energy and facilitate access to grants for domestic households. The Carbon Trust is a not for dividend company established 2001 to provide advice on energy efficiency to businesses and public sector organisations, which now trading globally.

Whilst early UK national policy offered complementarity with EU policy frameworks on climate change and low carbon transition, seeking to position the UK as a leader in climate change policy implementation, recent trends have seen this unravel and currently, much less complementarity can be seen with both the EU policy framework and the local and regioanl frameworks that were developed and have gathered momentum over the preceeding years.

4.2.2 Experiences of interrelation Between UK National and GM regional policy

GMs approach to climate change and low carbon economy needs to be understood within its position as the UKs second city and eagerness to establish itself in the eyes of National Government and Industry as more than an immature sibling to London. Part of the generally strong alignment of GM city-region policy framework with current UK National policy comes from this desire to be responsive to national priorities, but is also consistent with longstanding emphasis placed on a particularly ecological modernist vision of addressing climate change at a regional and city-region scale. For example, emphasis on domestic retrofit in the context of fuel poverty and market-led models for releasing private sector investment were a strong component of regional policy in the period 2005-10 prior to the shifts in National Governement Policy since 2011. However, experiences of interacting at a national scale vary widely.

In the context of heat networks, a specific unit in Government opened in 2014 to look at heat networks and experiences of the city-region team in GM which focus on heat network projects was described as very positive offering two-way dialogue (Interview 4). With policy priorities are very much aligned, there are opportunities for GMCA to feed into industry discussions as a member of the Association for Distributed Energy and the UK District Energy Association – which is considered quite unique for a public sector body (Interview 4). However, even in this Government priority area, withdrawel of low carbon policy framework within Spatial Planning legislation has created difficulties in delivering investment and connection to heat networks at a city-region scale:

> *"until National Policy around building regulations changes its really difficult locally …unless developers are happy to consider it anyway, it will always come back to: we don't need to, and we're not going to, because its not the cheapest option, so its really really difficult, and its difficult therefore for us to speak to the planners because they're quite limited on what they can ask, because they're not allowed to go beyond…building regulations…they've moved away from zero carbon homes, and it's really irritating" (Interview 4)*

This resulted in perceived tension between political commitment to high level targets and the ability to deliver this at a city-region level. "You can have a plan that says something but if you can't deliver it then its just fancy isn't it, it has to be deliverable… you sign up to something at the Paris agreement but what's our responsibility…otherwise…you fail because its fine words" (Interview 7).

Similarly, while the City Deal framework, arising from the Heseltine Growth Review (Heseltine, 2012) called for greater city-region autonomy, this is perceived to offer mixed benefits for Greater Manchester. Where health and transport have seen significant devolution of both responsibility and budget, spatial planning and housing have been expected to pick up devolved responsibility for a city region spatial plan but with little resources to deliver this (Interview 1). Where it was described that "There have been some wins in terms of new build, I think that was part of the City Deal, but I'm also aware of cities who haven't had city deals

who have also had funding for new housing" (Interview 1). In the context of low carbon, while the Low Carbon Hub was a key priority in the first City Deal with 3 aspirations – to deliver a low carbon hub, work with green investment bank, and work closely with universities (Interview 1), there is no direct funding to support the running or work of the hub.

> *"When we say City Deal, is it really a Deal? I mean we asked for something in the region of £ 500 million and we only ended up getting £ 130 odd million, so in capital terms we're getting nowhere near enough…we always fighting for the crumbs from the table" (Interview 8).*

The two most important advantages of participating in the City Deal appeared to be that: "the City Deal and Devolution allows us to have a more detailed discussion with Government and Government departments about what we feel we can contribute to the UK economy, and what they could do to help us to contribute more" (Interview 1). This relationship enables Greater Manchester's success in attract funding and to "influence the development of national policy" (Cowie et al 2013:20). It was described as "very useful" and "gives us an opportunity to talk to Government departments about demonstrator activity that we could run, some of that demonstrator activity is certainly funded by Government" (Interview 1). Rather than direct funding, these conversations are enabled through Memorandums of Understanding with particular UK Government Departments. These MOUs become a space through which to sell Greater Manchester as a good place and a trusted partner to trial programmes and do business:

> *"the primary benefit I think of devolution, is being able to have more flexible discussions with Government about what is the art of the possible…we've made the case for is that Greater Manchester is a great place to do innovation, a great place to deliver things. We've got a good track record now of delivering" (Interview 1)*

Until DECC's abolition in 2016, the LCH and DECC were working together on a number of initiatives including piloting a District Energy Procurement Agency to provide a procurement framework for Local Authorities(Low Carbon Board 2016d), piloting delivery mechanisms for community renewable energy initiatives "to demonstrate how funds may be blended with other forms of local finance to increase uptake" (Low Carbon Board 2016d) exploring the role of LEPs in developing municipal energy companies to accelerate the delivery of national priorities (Low Carbon Board 2016d) and to helping design future national energy efficiency programmes (Low Carbon Board 2016d). Greater Manchester continues to play a strong role in testing and shaping national policy. For example, DEFRA is currently developing a 25 Year Environment Plan setting out the Government's long term vision for Britain's environment – testing approaches towards "Pioneer Areas" including a river catchment, an urban area, landscape, and a marine area. As part of this plan GM has been selected as a Pioneer City Region for the urban pioneer area (Low Carbon Hub Board 2016c). Cowie et al suggest that "Whilst not bottom up governance in the pure sense, this form of evidence based territorial

governance is increasingly important in the age of a more managerial style of governance at all levels" (Cowie et al 2013:24).

However, frustrations were expressed around the inconsistencies in UK Government policy and the undercutting of national policy frameworks for low carbon. In reference to nation policy direction one respondent suggested "it would be nice to have some" (Interview 6). Another signalled the changing policy targets as:

> *"one of the criticisms of the whole low carbon bit …I mean the whole green deal went its own way didn't it, then the retrofitting…that comes down to nationally, if we had a clear strategy nationally …the Government … they don't want to intervene in anything, so planners have been told for years it's their fault nothing is being built, and you step back away from planning to let the market do its own thing and then with the last white paper on housing, at least, they were saying its not quite as black and white as that is it" (Interview 7)*

As section 3.2 describes in particular the loss of financial subsidies for renewable energy schemes and domestic energy efficiency programmes is impacting both community and local authority project delivery. This shows a "lack of real support…the same with ECO really, the autumn statement where Eco was really slashed, that was a turning point for a lot of projects" (Interview 6). One example was given of Greater Manchester Community Renewables, a local community group supported by Salford District Council who raised £ 886,000 through a share offer in a project to put PV on a local school but "without the feed-in tarriff, the business model becomes so difficulty" (Interview 6). It was suggested, the council were still working with GMCR and:

> *"we'd love them to carry on but its whether they can make it stack up…its had a similar effect on the hydro schemes we were looking at as well. Although there's still a reasonable feed in tariff in terms of hydro…because of the change…you don't know what you're going to get…that uncertainty has put the developer off we were working with and…it doesn't give any certainty to the community group who would want to put money into it… between the two of them they would have produced enough electricity for 300 houses…would have been good for education …we're still pushing on, but we've been pushing on for years now and it'll just get to the point that we'll have to say well we've tried and we're going to have to wait for a big change in policy, or a change in technology or something" (Interview 6)*

It is suggested that 12,000 jobs in solar energy have been lost across the UK as a result of FIT reform along with £ 127 million in potential investment in local energy initiatives (Quantum 2015).

4.2.3 The role of national policies as drivers/barriers for Greater Manchester activity

As a result of this mixed relationship with UK national Government, narratives around the importance of national policies for delivering low carbon programmes in Greater Manchester were also varied. On one hand those interviewed were critical of the loss of a strong policy framework at UK national level: "we have lacked a national carbon reduction work programme for ten years" (Interview 1) and describing this national "policy vacuum" (Interview 1,6,8) as particularly challenging in the context of uncertainty around the relationship with EU post Brexit. Energy Technology Institute identifies two specific impacts of weakening the national policy framework that pose challenges and barriers to low carbon delivery at a city region and local level. First, reforms to national policy and subsidies for renewable energy technologies such as the Feed-in Tariff and Renewable Heat Incentive which "will impact future take-up" (Energy Technologies Institute 2016:31). Second, weakening the national policy framework makes it difficult for regions and local authorities to require higher performance levels than are set nationally through their local spatial planning and building standards. Both examples were raised by city-region stakeholders interviewed independently of this report, when describing ways in which recent changes in Government policy restricted the ability of the city region to act:

> *"The Government's move away from zero carbon homes certainly does restrict what we might wish to do locally on putting in elevated environmental conditions on new building development, because the national planning policy framework does tie your hands to what can be done in that area" (Interview 1)*

> *"Feed-in tariff reduction, that's obviously reduced our ability to put more PV for example onto social homes…about three years ago…we had a programme of putting … about 8000 PV units onto social homes, the feed-in tariff change was announced and we managed to get a thousand done before the change….there has been a drop off in PV uptake, but we are starting to see the market shift…you can continue to do it, but has it reduced the scale – I think it has across the board" (Interview 1)*

Not only are existing incentives being removed but now solar PV on schools will shortly be taxed as part of UK business rate revisions (Interview 8).

On the other, there was a degree of positioning the city region as doing its own thing anyway, with the strength of drivers somewhat independent from changing national policy. For example the 48% target and emphasis on the low carbon environmental goods and services sector as a focus for economic growth both predated GMCA and the current national policy framework and were seen to be driven through AGMA and the NWDA rather than national scales (Interview 1). When asked the extent to which changes in national policy since 2011 had affected the shape of low carbon policy at a city-regional scale, policy practitioners described an undoubted greater demand for low carbon activity to be framed in economic terms – through the language of cost reduction, economic benefits or economic growth (Interview 1) which

was described as “trend towards trying to put a pound sign on everything” (Intervew 1) but there was a suggestion that this shift in language was almost superficial: “Do I think its substantially changed from where it was ten years or so – actually no – I think the drivers are the same, its still carbon reduction, its still about jobs, perhaps a little bit less about low carbon skills” (Interview 1). In many ways the language post 2011 might be seen to present a more transparent account of the economic drivers that were always present in shaping policy drivers to the low carbon economy and responding to climate change. To this end while “the strategies to which the low carbon economy are seen to support may have changed” (Interview 1) the focus nationally and at a city region scale is about mainstreaming sustainability and carbon reduction activity and it was described that “there have been a number of different strategies that have been developed that have taken up that batton…what we’re starting to see now with DECC being transitioned into BEIS is that low carbon growth is more seen as part of a wider industrial strategy…and actually that’s not a bad thing, because from a broad sustainability point of view what we really want to do is encourage sustainability in all our business sectors” (Interview 1). Given that GM was already positioning its approach to addressing climate change in strongly growth-orientated ways prior to 2011, the national shifts in Government policy emphasis are perhaps less stark in Greater Manchester than elsewhere across the UK.

A number of GM low carbon delivery projects rely on national funding programmes: such as the funding from the UK Government Office for Low Emission Vehicles for electric vehicle infrastructure, funding for cycling infrastructure from UK National Cycle City Ambition Grant for Velocity 2025 (Cox 2013) and the nationally regulated CERT, CESP and ECO programmes for domestic energy efficiency (Data.gov 2013). These have been instrumental in both delivery and levering in other funding through providing much needed match funding for large programmes of low carbon development work in Greater Manchester. Public sector buildings such as offices and schools are also strongly dependant on the national programme of SALIX funding such as the £ 3 million MoU with SALIX Finance for retrofitting GM schools (GMCA 2015b). In Manchester the goal is to fund improvements on 2,364 public buildings through this model of public borrowing to finance energy improvement and renewable energy investment, which is then paid back through revenue savings (Retro Expo 2017). National funding has been identified as important to the future delivery of the CCLES with the following sources particularly identified by the Local Enterprise Board (2016):

- Access to low carbon levies and taxes (including ECO funding for retrofit)
- UK research council and innovation funding (currently funding over £ 100 million of energy and low carbon research across GM’s universities)
- Local Authority revenue and investment funding
- DECC/OFGEM Heat Network, smart networks and energy system transformation funds
- National, international and local transport funding
- Devolved Health funding

This uncertainty over the future of such schemes, together with wider UK national retraction of funding for local tiers of government (as described in section 3.31) is driving the need to explore private sector financing models (as outlined in section 3.27).

The city region is however also partially dependant on the national scale for delivering their 48% target at the city regional level. At a meeting of the LEP in Nov 2015 it was suggested: “The achievement of local carbon targets is significantly dependent on the delivery of national actions, which account for 53% of the target” (GMLEP 2015). This is particularly the case with decarbonisation of the national grid which is largely outwith GM control.

However, difficulty connecting low carbon and growth agendas in a lateral sense (described in section 3.51) also impacts complementarity in a vertical sense, for ERDF funding in particular and increasingly UK National funding requires delivery against measures of GVA and jobs, which in many cases generate a rise in net rise in energy demand and carbon emissions, even where these developments are relatively high performing in carbon terms. This tensions in striving to meet competing objectives from National and EU policy and funding requirements are played out at the regional and local level.

5 Good practices and successful approaches

The examples chosen represent a diversity of types of good practice in low carbon development that are all highlighted by GMCA or other regional stakeholders, as examples of successful low carbon initiatives. The first, GM Green Deal Communities (Housing Retrofit) programme, is a good example of the interrelation of national and regional policy and the combining of public and private funding. The second example – Enworks – is an example of low carbon best practice led on a regional level. The final example discusses two examples of a community led initiatives – Carbon Co- Op and Stockport Hydro which both offer examples of bottom up community-led low carbon activity that connect with regional national and European scales in different ways. In each case, specific experiences of implementing regional strategies, realizing projects and making use of EU cohesion funds are highlighted.

5.1 Greater Manchester Green Deal Communities Housing Retrofit Programme

In 2011 the UK Government DECC launched the national Green Deal Programme – "a new finance framework that will provide householders and businesses with the upfront capital to carry out energy efficiency improvements to their properties and repay through their energy bill" (DECC 2011). Properties benefiting from the Green Deal have a charge attached to the electricity meter at the property to schedule repayment, with the guarantee that any charge attached must be less than the expected retrofit savings (DECC 2011). In 2016 The GM Green Deal Communities Programme "Little Bill" won the "Large Scale Project of the Year Award" at the National Energy Efficiency and Retrofit Awards ceremony. Little Bill was the first regional programme in the UK to exceed its target (installations in 1200 homes) within the UK Government deadline of the end of March 2016 (GMCA 2016e). The scheme achieved measures in 1302 households totalling 12,000 tonnes of CO_2e savings with the majority of measures in low income and fuel poor households (especially those with solid walls) achieving an average saving on resident fuel bills of £ 350 pa (GMCA 2016e). The programme is a good example of cross-sectoral and cross-scalar working that is based on a longer history of housing retrofit ambitions. The Programme totalling £ 8.8 million was financed through a mix of UK Government Funding (£ 6.1 million), Local authority contributions (£ 948,000), Energy Company Obligations (£ 589,100) and Customer Contributions (£ 1.2 million) (GMCA 2016e).

History of domestic retrofit in GM city region

In 2009 AGMA secured Greater Manchester as the UK's 4th Low Carbon Economic Area for the Built Environment. AGMAs active role in securing the LCEA and later the Local Enterprise Partnership (LEP) have played important roles in creating a regional umbrella through which Greater Manchester has sought to position itself as a leader in retrofit (Eames et al 2014:2). In 2009 AGMA commissioned Ernst and Young to develop a prospectus for linking carbon reduction and systemic retrofitting of demand-side management measures such as energy efficiency and alternative sources of heat and power with economic opportunities, jobs and

skills development (Hodson and Marvin 2012:432). In 2011 AGMA also commissioned Urbed to write Draft Low Carbon Housing Retrofit Strategy, which although never formally adopted, further successfully aligned ambitions for carbon reduction with economic advantages of attaining "First Mover" status in the emerging North West and UK retrofit market, attracting private sector investment to improving homes and neighbourhoods, addressing fuel poverty and encouraging uptake of national Government programmes such as Feed in Tariff (FiT), Renewable Heat Incentives (RHI), and the – then anticipated – Green Deal and Energy Company Obligation (ECO) schemes (Urbed 2011:5). Responding to the newly established city-wide carbon reduction target of 48%, with 6,233 kilo-tonnes of CO_2 coming from domestic activity (GMHECA 2015), the Draft Low Carbon Housing Retrofit Strategy set out a city region target for Greater Manchester of "55% carbon reduction in housing by 2022" (Urbed 2011:4).

Unlike a funded project, there was no single source of funding for the LCEA but ambitions relied on partnership working to "constantly position the LCEA to try and attract funding" (Hodson and Marvin 2012:433). Following this preparatory strategy work a number of funded housing retrofit programmes were secured, including:

- An ERDF project to implement Greater Manchester Energy Smart Homes (GMESH) in social housing – financed by (£ 5 million ERDF matched from CESP) delivering approx. 3,159 tonnes CO_2 saving per year (GMHECA 2015).
- A £ 3.065 million DECC funded project to deliver the Green Deal Go Early schemes that tested the Green Deal and ECO processes, measures and supply chain across seven local authorities, eight social landlords, a number of community organisations, and local supply chain partners (GMHECA 2015).
- Several Department of Health funded Warm Homes Healthy People projects to reduce fuel poverty totaling £ 1,800,716 in 2011/12 and £ 1,153,181 in 2012/12. (GMHECA 2015).
- The "Get Me Toasty Campaign" which between 2011 and 2013 accessed Energy Company Obligation (ECO) funding to deliver 25,000 free energy efficiency measures including free insulation and some heating improvements to people living in low income areas of Greater Manchester (AGMA 2013). Get Me Toasty also delivered a number of research reports (O Doherty 2014).
- And finally, in 2014 GM received £ 6.1 million of funding from DECC to deliver Green Deal Communities "Little Bill" campaign. This targeted a new group of "able to pay" customers as well as vulnerable households (Manchester Climate Monthly 2014: online) and working with three new delivery partners – who in turn worked with installers and assessors in the local supply chain – focused on street-by-street housing retrofit in specific neighbourhoods (Green Growth 2014). Little Bill worked with to retrofit 60,000 households over five years (Green Growth 2014) with a focus on solid wall insulation (GMHECA 2015).

Locally, Regionally or Nationally Driven?

On one hand the focus on retrofit is positioned as bottom up, building upon a whole range of retrofit interests at local authority level (Interview 3), at community level and among individual buildings that serve as exemplars of retrofit success. Examples include:

- the CIS Tower – a retrofit flagship based on its inclusion of PV cladding in its £ 5.5 million refurbishment in 2005 that was part-funded by the North West Development Agency (£ 885,000) and the Energy Saving Trust (£ 175,000) (BBC News, 2004)
- University Hospiral South Manchester's structured Carbon Trust carbon management programme implemented in 2007 that included £ 3.3 million energy efficiency and renewable heating equipment that gained the hospital an Innovation Award for Sustainability and the "Winner of Winners" Award in the 2010 Guardian Public Services Awards (Burrai 2014:55) and
- Davyhulme Energy Saving Project established by a community church based group in 2006 who worked with the Energy Saving Trust, with the support from Trafford Council, to introduce energy saving measures in 180 homes and the parish hall through £ 4,000 from their own resources and £ 20,950 from The Veolia Environmental Trust, made through the Landfill Communities Fund (Burrai 2014: 28).

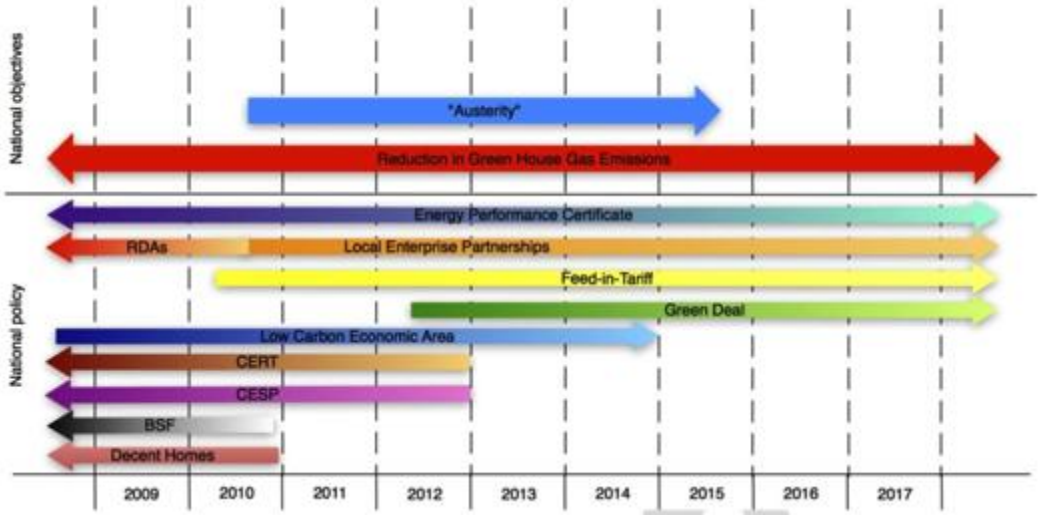
In this sense, the specific Green Deal Communities programme sits within a wider range of retrofit activities in GM which Hodson et al (2012) distinguish into five categories – zones, portfolios of property, community initiatives, initiatives of streets and individual buildings. In addition domestic retrofit was positioned as an important concern for many Local Authorities with numerous examples of Local Authority led projects funded through the ERDF with match funding from the Community Energy Saving Programme, CESP. The strength of priority given to domestic retrofit varies between local authorities with about 5 of the 10 prioritising emphasis, staff and resources to address the challenges and some councils taking an ealy lead in developing green loan schemes for private tenants and owner occupiers regardless of income (Interview 3).

At a city region level, AGMA have had a strong initiation role and in 2011 stepped in to ensure that the Greater Manchester Energy Advice service (GMEAS), which was threatened with closure as the Energy Savings Trust were having their UK Central Government funding withdrawn post 2011, was continued with financial support from all GM local authorities. AGMA also coordinated a bi-monthly Strategic Asset Group meeting attended by all GM RSLs/ALMOs (GMHECA 2015). GMCA have since provided a strong focus for supporting retrofit across the ten LAs, first through Low Carbon Hub Domestic Retrofit Meetings and secondly through the GM Retrofit Innovation Network launched in 2014 to bring together experts in community engagement, retrofit design and supply chain development (O Doherty 2014). The LCH plays an important role in supporting and encouraging action among those who do not have dedicated teams and resources, as well as supporting those who have to progress the agenda in their areas (Interview 3). GM led the "Get Me Toasty" and Little Bill programmes. Whilst national carbon reduction targets (through the CCC proposed third and fourth carbon budgets to 2022 and 2027) are drivers in this agenda, working with the regional policy target in the Greater Manchester Climate Change Strategy of 48% carbon reduction by

2020 “implies that the CCC’s modelled take-up of retrofit measures for 2027 will need to achieved across Greater Manchester by 2020” (Urbed 2011:11).

However, Hodson et al emphasise the way that the initiative also “deliver[s]—and provide a model for delivering—specific national priorities in relation to smart metering and mandatory carbon reduction targets” (Hodson and Marvin 2012:433). In this sense Manchester is positioning itself as responsive to national low carbon policy – including the Decent Homes Programme, Building Schools for the Future, the Community Energy Saving Programme (CESP), the Carbon Emissions Reduction Target (CERT), the Low Carbon Economic Area (LCEA), the Green Deal, the Feed-in-Tariffs (FITs), and the Energy Performance Certificate (EPC). Hodson et al develop the following schematic to show the influence of these different programmes over the past ten years which “represent a very broad narrative within which local level actors make reference” (Hodson et al 2012:5).

Figure 5.1: Time line of national objectives & policy pressures around retrofit in Greater Manchester



Source: Hodson et al 2012:5

In addition to these specific low carbon policy objectives Hodson et al emphasise the importance of national discourses around sustainable development and economic growth “that are even more implicit than those already listed” in shaping regional narratives of intervention (Hodson et al 2012:5). Demonstrating delivery on retrofit importantly became about being seen to be a progressive and active partner in the eyes of Government in light of the forthcoming devolution City Deal of 2015. Burrai noted the way in which retrofit became central to GM’s attempts to offer a different image of the city-region nationally and internationally (2014:3). In this process Hodson et all argue that GM retrofit is not only about emissions reduction, but also about positioning Greater Manchester as a leader and “first mover” in an emerging UK retrofit market to attract private investment to the city-region and with it green growth, job creation, skills development and product innovation (Hodson et al 2012). Here retrofit attention is about market making: “The dominant message of retrofit in GM is that it is about the making of new markets. That is it is about governing GM to make it amenable to the

market opportunities afforded by retrofit" (2012: 26). Here, the low carbon agenda becomes another form of "entrepreneurialism" that will help avoid the economic costs of inaction on climate change and allow the city-region to accrue economic opportunities and benefits (Hodson et al 2012:40). As Burrai suggests, the logics around retrofit that reshape and transform cities are wound into "the economic and political changes which exposed cities to liberal markets" (2014:3).

Becoming a national test bed is not only a means of aligning with national retrofit programmes but also accessing associated national resources and subsidies such as through the Feed in Tariff (FiT), Renewable Heat Incentive (RHI) and the Energy Company Obligation (ECO). Combining public and private financial sources enables delivery beyond public sector regional budgets. In 2015, the value of the GM Toasty, Green Deal and ECO programmes across GM since 2011 was estimated to be £ 3.9 million per year (GMHECA 2015) with the Greater Manchester Advice Centre co-ordinated bids for external funding to attract over £ 12 million as match funding and leveraging twice this amount in additional investment (O Doherty 2014). Hodson et al (2012) suggest that the reason why retrofit became prioritised in Greater Manchester needs to be understood within the wider changing governance context since the 1970s (as outlined in section 3). They argue that the metropolitan governance of Greater Manchester is caught between the strong influence of national priorities and a limited capacity to act created by the reducing flows of state funding (in an era of austerity) and focus instead on using governance interventions and limited public funding to lever private sector investment and business-led forms of governing, (Hodson et al 2012:11). It was identified early in the process that meeting Greater Manchester's proposed domestic retrofit target was likely to require somewhere between £ 12 billion and £ 27 billion of investment over the next decade – given the increasing restrictions on public finances, the role of private sector finance was identified to be critical (Urbed 2011:5).

Low carbon retrofit also delivers against local concerns around fuel poverty and improved wellbeing amongst disadvantages sectors of GM population, and with regeneration interests as home improvement measures reconfigure the built environment through a suite of technological interventions (Hodson et al 2012). A final touch points between national policy and regional and local delivery is how to ensure that Greater Manchester as a territory and a workforce benefits from particular programmes:

> *"How can our Green Deal provider partners, who by definition are large organisations who tend to work on a national basis…engage with the supply chain of Greater Manchester, ensuring that we capture GM jobs, and that GM businesses including SMEs, benefit from the programme. How can we ensure we are capturing that local pound, so not only that savings made by households are spent in the local economy, but also wages paid to local people are spent back into the Greater Manchester economy?" (Manchester Climate Monthly 2014: online)*

The success of domestic retrofit in GM is therefore in its ability to integrate these considerations beyond carbon reduction and to deliver on different agendas for different actors. With slightly different drivers in different programmes retrofit activity across GM was able to: support economic growth in the low carbon economy (LCEA) support affordable warmth and health (Toasty 2011), develop new employment and skills (Corridor Manchester, 2009 – Hodson et al 2012:17), to achieve commercial advantage through the ability for new commercial tenants to see how much energy a commercial property will use via the Energy Performance Certificate (Bruntwood – Hodson et al 2012:17), to regenerate and create a more attractive urban environment for residents of Barton Village 1960s tower blocks (City West Housing Trust, 2011) and to reduce carbon footprints of individuals while improving the local community and getting local residents involved (The Carbon Co-op, 2010).

However, recent limits to the usefulness of constantly responding to national policy changes are emerging. Since 2014, implementing retrofit programmes has suffered from national policy changes that scale back incentives and mechanisms to engage developers and energy providers in programmes, and for domestic customers to participate. For example reductions to FIT and Cert Programmes and stretching the target for CERO element of ECO from 2015 to 2017 in the 2014 "Autumn Statement" that created a challenge for localities such as Greater Manchester who have a large number of hard-to-treat pre-1919 homes as "there's less onus on the energy companies to funding these works, particularly solid-wall and hard-to-treat cavities" (Manchester Climate Monthly 2014: online). Further, as a result of increasing austerity cuts on local authority budgets, Manchester City Council decided in a review of all of its non-statutory functions to close the GMEA in 2015. This was a service MCC had supported since EST had been forced to centralise its energy advice service in 2012. This has impacted the provision of localy energy advice services, encouragement of uptake in energy efficiency measures and co-ordination of funding bids at a local level. Despite the Little Bill award, the implications for the programme are that in "the last twelve months we haven't delivered as much as we'd like to under the interim ECO scheme….we've got to work that much harder now to use ECO funding, Green Deal cash-back funding, funds from government…but also Green Deal and other finance routes to try and drive that" (Manchester Climate Monthly 2014: online). It was described during interviews that it was a struggle to keep domestic retrofit on the agenda. While there is a political will among many elected leaders there is a resource issue for financing it meaning: "its a constant battle, and if I wasn't here, domestic may be addressed but as part of projects that would have happened anyway rather than someone pushing" (Interview 3). At least formally, there appears to be little blame on the ideological approach of the national UK government, and instead a wholehearted embracing of the narrative of market led programmes:

> *"We've got to get homes retrofitted, we have to kick-start the market, that's the reason for doing this. Yes, government policy changes and sometimes that can make it difficult, but ultimately Greater Manchester has to demonstrate how it is helping to drive the market." (Manchester Climate Monthly 2014: online).*

Challenges of working through rapid changes in government policy are being addressed by locating work programmes within strong city-region priorities. This process began before Little Bill when it was suggested: "We've not procured a framework just to deliver Green Deal and ECO, we've procured a framework to deliver housing retrofit – that's important… we wouldn't necessarily have to start again if there were a change in government policy" (Manchester Climate Monthly 2014: online). However this emphasis on a city-region driven agenda regardless of national policy was again strongly evident during current interviews with the LCH team:

> *"we've been running alongside national policy which, I think now we kind of think – why are we doing this … So over the last ten years it has been a case of where national policy is, what the offer is and we'll just go with that…there was a point early on when it was quite attractive, and it was worthwhile, but now its not that attractive, utilities are a nightmare to work with, and …we're now looking at: let's put that aside, what do we want? And how do we get there" (Interview 3).*

This involves scoping out alternative finance mechanisms to support retrofit work in which the focus is on loans or charges placed on properties. This builds on existing loan schemes that are seen to work well in GM (although not well marketed) such as Hoot Credit Union and Manchester Care and Repair interest free loan (Interview 3). Despite the rhetoric of city region leadership, this is mirroring the same distinctly economic focus of national policy and so the extent to which GM is really providing leadership beyond national policy trajectories is questionable.

The importance of the public sector and GMCA in retrofit success

The Low Carbon Housing Retrofit Strategy emphasise that the role of the public sector is in "making the city-regional context amenable to inward investment…[and] promoting the development of market opportunities for finance capital" (Hodson et al 2012:34). Public sector funding (often through prudential borrowing and bank debt) is considered important to both "attract and underwrite private finance for domestic retrofit" (Urbed 2011:27) by de-risking investment opportunities (Hodson et al 2012:34). It is also important for supporting measures in deprived urban neighbourhoods where investment is difficult because of limited public funding, short termism by private landlords, limited equity in owner occupied properties, and poor individual credit ratings (Urbed 2011:27). Hodson et al emphasise, there is a class politics to private financing which, unlike public investment, is not governed by social priorities. This raises questions about how socially deprived communities and neighbourhoods become attractive to such forms of investments (Hodson et al 2012:35).

However, the role of public sector leadership goes beyond these pragmatic market roles. The priority towards retrofit given by local authorities is driven not only by the statuory duties of local authorities to report through HECA on what is being done to reduce energy consumption, or by local, regional and national "promise" to reduce carbon emissions through the targets set, but also because "personally…I feel we have a duty to vulnerable residents…I think we should do things to assist the fuel poor residents of Greater Manchester" (Interview 3).

This duty of care to residents can be seen in specific examples – such as the way that officers from Stockport Homes are exploring developing their own biomass supply chain to protect district-heating customers from exposure to the rising energy market costs. There is also a wider duty of care around public funding that crosses sectors which informs the work of local authorities which can be seen most explicitly in the case of crosscutting impacts of fuel poverty and health where investment in homes is seen to protect the public purse through the bill incurred to the NHS through cold related respiratory and cardiovascular illnesses (Interview 3). This caretaking around public funding goes beyond the economic costing concerns of the private sector. Unlike the economic bottom line, for these very poor households for whom its often heat or eat, as a public authority "we can justify helping those residents" by the savings to the NHS, education improvements etc (Interview 3).

Challenges

Nevertheless, despite their success key challenges remain. The first is the ability to scale up beyond demonstration and high cost-per-unit programmes (Interview 1) confirming suggests that the making of "retrofit markets" remains highly aspirational and "to date, has been embedded in only a sporadic and limited way" (Hodson et al 2012:10). Secondly, maintaining continuity in availability of private sector suppliers was highlighted (as discussed in 3.35). The building of longstanding good relationships amongst different partners often undertaken by local public sector actors and emphasised as central to the success of projects is (Interview 1) is difficult in transitionary workforces responding to fluctuating market demand. Thirdly, it was highlighted that "National Policy does not have an egalitarian approach to energy" (Interview 3). ECO for example funds old traditional heating systems not smart systems, "which is unfair…its aimed at fuel poor…and there's nothing about smart technology" (Interview 3). Finally, a substantial challenge in programmes trying to deliver against both carbon reduction and fuel poverty is the entext to which these ambitions although partly complementary often in practice do not mesh. In particular it is often seen that energy consumption doesn't fall when lifting the full poverty: "if you improve the energy efficiency of someone in fuel poverty, they don't save carbon, they just don't die of cold" (Interview 2). People are warmer and healthier but then "we then do loose the carbon reduction" (Interview 6).

5.2 ENWORKS Business Support Programme

ENWORKS exemplifies one of Greater Manchester low carbon programmes that have been driven at the regional (North West former RDA) level and is subsequently is being driven forwards post 2011 at the city region level. Formed in 2001 Enworks is an evolving collection of programmes that have deployed public funding (ERDF and UK Government match) to provide high-quality environmental support to companies to "Make environmental practice profitable" and "Decouple environmental degradation from economic growth" (ENWORKS: undated a). The case illustrates skilful change management that moved delivery of environmental business advice first from a mode of competition to a mode of co-operation through co-ordinated

delivery and secondly from mundane compliance with environmental health and safety concerns to more complex integration of resource efficiency, carbon reduction and low carbon sector support.

Origins of the programme 2000-2007

ENWORKS was first initiated around 2000 in response to work undertaken by the Environment Agency (led by a former ICI executive) that sought to simplify the plethora of environmental advice available to businesses. It was felt that the multitude of sources of environmental advice were confusing to businesses, often had variable quality (using graduates to deliver programmes which risked trivialising concerns) and were competing with each other for funding (Interview 2). As funding for business advice increasingly moved from a local authority level to regional level via the development agencies – Groundwork moved form being a relatively minor funder of such programmes to a primary and then almost the sole funder (Interview 2). This enabled them to pull together a partnership board made up of the chief executives of the individual delivery organisations (under the chairmanship by the EA) to respond to agree key principles and a shared direction of travel through soft power. Groundwork then put together (and became the accountable body for) a bid to the Single Regeneration funding programme to deliver this agreed programme that provided a co-ordinated programme of delivery working closely with the existing providers and various Business Links (Interview 2). The single programme bid was strong but benefitted from contacts inside the RDA with whom the approach resonated. Through successfully securing Single Programme funding and match from the RDA, ENWORKS sought to provide "a co-ordinated and coherent service that would be quality assured and available to all North West businesses, regardless of size, sector or location" (ENWORKS: undated). The programme was based on the Aire and Calder model (Interview 2), which focuses on businesses in a geographical region sharing best practice with each other and the Environmental Technology Best Practice Programme (from late 80s) which combined on-site audit support with help to deliver through workshops and one-to-one support. Taking this soft partnership approach removed the potential for parochial infighting and tensions over funding. The foundations of the transition lay in building trust among the chief executives of these delivery organisations who then stepped back and allowed the board to increasingly be made up of business facing staff and connect through their networks to other private sector actors (Interview 2).

Although regional drivers were strong, it can be seen that establishment of ENWORKS responded also to European and UK National policy changes. At a European level, addition of the Gothenburg Agenda (environmental pillar) to the Lisbon Agenda in 2001 emphasised: "that economic growth must be decoupled from the use of natural resources to ensure a more sustainable pattern of development. The stated aim is to decouple environmental degradation and resource consumption from economic and social development by 2010" (SQW consulting 2008:6). Early focus on waste minimisation likely also reflected the UK Government's first Waste Strategy for England in 2000, and the early stages of the ENWORKS programme

benefitted from receipt of NWDA's component of the Business Resource Efficiency and Waste (BREW) programme that used landfill tax to fund business incentives to reduce waste. Nevertheless, the initiative was given substantive impetus at a regional level by the NWDA, and Groundwork (who also operated regionally). The NW Regional Economic Strategy prioritised addressing waste management and resource efficiency in the region (SQW consulting 2008:7) and the Regional Waste Strategy (2004) strongly reflected the EU emphasis on breaking the link between waste growth and economic development through a more efficient use of resources. Strong complementarity between policy concerns as well as policy scales can be seen in the resonance of resource efficiency concerns with addressing the £ 17.8 billion GVA gap in the North West compared to the UK – £ 14.3 billion of which was considered to be a result of lower productivity (SQW Consulting 2008:8) and in Department for Business, Innovation and Skills (BIS) support for integrating the programme within the UK Government's Business Support Simplification Programme (SQW Consulting 2014:80).

Throughout, this history, the ENWORKS programme has been driven and funded by the public sector. SWQ suggest that in the early stages, there was no demand expressed by businesses, but a clear justification for public sector intervention based on market failure (SQW consulting 2008:11). Key staff at ENWORKS indicated that "without NWDA Single Programme funding there would have been no Project" and other funding during the first phase was "essentially levered by NWDA's involvement" (SQW Consulting 2008:26). In fact, between 2001 and 2008, the public sector accounted for well over 90% of the total funding – made up of £ 1.38 million of Single Programme, £ 1 million ERDF and UK match funding provided by BREW with a small contribution from the private sector (SQW Consulting 2008:26).

Table 5.1: Funding of ENWORKS between 2001 and 2008

Table 5-2: Total funding picture of the Project

	2003-05 (£k)	2006-08 (£K)	Total (£k)	Proportion of total funding
NWDA Single Programme	681	698	1,379.5	41%
ERDF	602	409	1,011	30%
Other public	217	321	538	16%
Private/income generation	99	143	242	7%
BREW	-	220	220	6%
Total	**1,600**	**1,791**	**3,391**	**100%**

Source: ENWORKS monitoring data

Source: SQW Consulting 2008:26

During 2007-2010, this pattern of direct funding continued, and where ENWORKS sub-regional delivery partners (Groundwork Trusts) were encouraged to seek contributions from the private sector when working with ERDF-ineligible companies (mainly non-SMEs) "where they judged the companies had the ability to pay and where seeking a contribution was not likely to result in the company disengaging from the project" (GHK 2011:19), the overall contribution from the private sector increased little as Table 5.2 shows:

Table 5.2: Funding of ENWORKS between 2007 and 2010

Funding Source	Total Target Spend	Total Actual Spend
NWDA Single Programme	£6.129,192	£6,102,263
ERDF Funding	£2,483,872	£2,441,506
Private, In Kind and Other Funding	£287,714	£262,299
Total	£8,900,777	£8,806,067

Source: GHK 2011:19

Development of the Enworks Programme Phase 2: 2011-present

In 2011 ENWORKS ownership transferred from regeneration charity Groundwork UK to Economic Solutions Ltd (legal name for organisation that trades as "Manchester Growth Company"). The context for this was another savvy shift to navigating changing significance of regional structures. The new coalition Government's rapid shift away from regional structures meant that: "we recognised if we weren't careful we would get stranded in a no-man's land of being a regional organisation with no-one thinking regionally anymore" (Interview 2). Instead it was emphasised that although the programme operated at a regional scale all the reporting occurred at LEP and county levels and was only aggregated for reporting up to Government. The lead officer therefore opened up a dialogue with the specific branch of Economic Solutions Ltd named "Manchester Growth Solutions" to see if the Programme could be transferred (Interview 2). Specific challenges around TUPE[1]'ing liabilities across from Groundwork required specific negotiation over financial provision (Interview 2) but this process was negotiated with little conflict with Groundwork because they too "recognised this fundamental change, they too had a regional structure that they needed to move away from it very quickly" (Interview 2).

Towards the end of the lifetime of this first TUPE'd project, ENWORKS sought further funding to extend their programme. In an absence of match funding, services that still focused around resource efficiency and environmental risk advice became integrated into the Business Growth Hub. Business Growth Hubs were a central Government Initiative replacing the former Business Link model (that has become regional and had subsequently been closed). At this time there was again a strong focus on simplifying and bringing together business support providers with AGMA seeking to bring together the Commission for New Economy, MIDAS, Marketing Manchester and Economic Solutions. At the same time Envirolink – a sector development programme for environmental goods and services was brought into this group, although not without some tensions. Unlike the ENWORKS light delivery framework that worked through co-ordination of third party providers, Envirolink was a staff heavy programme delivered in house which presented cash flow and liability issues for ERDF that relied on slimming down staff structures. Since 2012, ENWORKS has been part of the Greater Man-

[1] Transfer of Undertakings (Protection of Employment) Regulations 2006

chester Business Growth Hub (ENWORKS 2012) and since 2015 has been completely integrated as another Business Growth Hub service (Interview 2).

GHK identified challenges in continuing the service given the abolition of the RDA and suggested moving towards an income generation and/or loan rather than grant based approach – recognising this had disadvantages in terms of ERDF. While charging for the service was considered, this was considered to threaten the perceived independence of support, and was not possible under ERDF regulations (GHK 2011:50-51). Instead, match funding for ERDF was negotiated with GMCA through the City Deal: "we did a lot of work though the CA …we had a raft of evidence for why this was a good thing, why it was good for Greater Manchester, we also played it back a little bit, saying this has been going on for 12 years, its won European awards, it was something you agreed with the Development Agency was really important, do you want it to die on your watch? But you know other good things have died so that was no guarantee" (Interview 2).

This involved a number of implications. First, the discursive emphasis of the programme shifted from waste minimisation to increasing emphasis on economic growth with ENWORKS and Greater Manchester Business Growth Hub sharing an ambition to realise growth whilst achieving low carbon objectives: "We help businesses to grow by using resources more efficiently and by taking advantage of the transition to a low carbon economy. We convert environmental pressures into competitive advantages" (ENWORKS: undated b). Second supported activity shifted from resource efficiency and environmental risk to low carbon goods and service sector development (fitting within a wider priority sector development programme of Business Growth Hub), eco-innovation (fitting within a wider innovation programme of Business Growth Hub) and carbon reduction (Interview 2). Today ENWORKS support is divided between resource efficiency support and specific support to the low carbon economic growth sector and consists of on-site reviews, access to monitoring software, skills & knowledge support, links to other projects & organisations, and help identifying new markets (Nicholson 2014). The specific focus on carbon reduction and the need to keep this programme separate from the wider Business Growth Hub programmes was the result of the specific European funding programme (ERDF) being utilised. It was ERDF funders that both prompted the focus on carbon reduction and required that the funding be kept discrete so that the resultant carbon emissions can clearly be captured (Interview 2). Third, despite the City Deal Match funding secured, this wasn't sufficient for the full ERDF funding available so part of the specific Priority 4 ERDF programme now includes a 50% business grants stream of support. While one advantage of this is to "create some false urgency in the market" (Interview 2) and overcome businesses identifying but not acting on carbon reductions identified, it was in many senses imposed through simply not having any other source of match funding for ERDF that was available (Interview 2). Consequences of relying on levering in this private sector match are that "in terms of economic and environmental impact you get less from it…if you invest a million into grants you get less economic growth, less jobs and less carbon savings than if you put a million into revenue support for businesses…for £ 20,000 you could

probably very easily advise four of five companies…you give a company £ 20,000 as a grant and they'll buy a new compressor…you get nothing like the same kind of return from it…which is why we have never got involved with grants in the past" (Interview 2).

Record of Achievement

ENWORKS presents an impressive evidence based narrative of success in both economic and environmental terms regardless of which source is consulted (Enworks undated c, ENWORKS 2012, Nicholson 2014). In carbon terms ENWORKS have achieved 190% of their carbon targets – exceeding their 250,221 tonnes CO_2 target to reach an actual figure of 475,570 tonnes (GHK 2011:21). In other measures they claim to have:

- Advised 13,594 businesses in total (Enworks undated c) 4012 in GM (ENWORKS 2012)
- Invested £ 20 million in Greater Manchester businesses between 2001 and 2012 (ENWORKS 2012)
- Leveraged in £ 59 million private sector funding up until 2012 in GM (ENWORKS 2012) or £ 12.3 million investment from the private sector between 2007 and 2013 creating overall a 1:20 Net Additional GVA Return on ERDF & UK Investment (Nicholson 2014).
- Saved 1.3 million tonnes of CO_2e overall (ENWORKS undated c) or 217,200 in GM (ENWORKS 2012)
- Saved 2.3 million cubic metres of water in GM (ENWORKS 2012), or 1.8 million cubic metres overall (Nicholson 2014)
- Saved 2.2 million tonnes of material savings per year and diverting 189,000 tonnes from landfill in GM (ENWORKS 2012), or 30.6 million tonnes material saved and 1.1 million tonnes of waste averted from landfill overall (ENWORKS undated c).

Between 2001 and 2012 creating 833 jobs, safeguarding 3,474 more and creating or safeguarding £ 112 million sales contracts in GM (ENWORKS 2012) 8314 jobs, £ 371 million worth of contracts and saving £ 316 million for businesses overall (ENWORKS undated c). Greater Manchester and Lancashire were the most successful in achieving target numbers of businesses assisted (GHK 2011:24)

ENWORKS have also been awarded the following awards:

- Learning Northwest Awards – Outstanding Workforce Development Campaign, 2002
- European Social Fund – Merit Award for Sustainable Development, 2005
- European Commission – Best Practice Principals of Sustainable Development, 2005
- SustainIT Awards – Climate Change and Environmental Efficiency, 2006
- Regeneration and Renewal Awards – Economic Development Project of the Year, 2007
- The Ashden Awards for Sustainable Energy – Energy Efficiency, 2007
- European Commission – Best Practice Environmental Support Network, 2009
- Business Green Leaders Awards – NGO of the Year, 2011.
- European Commission's RegioStars Award for Sustainable Growth, 2013.

In addition, the initiative was a finalist in the Sustainable Energy Europe Awards 2011 (out of 309 project applications from across the EU) and in the UK Edie Awards for Environmental Excellence specifically for its carbon reduction achievement (ENWORKS 2012).

ENWORKS has played a strong role in influencing both regional and national UK policy. At a city-region level, ENWORKS Environmental Sustainability Technical Assistance (ESTA)

ERDF and Environment Agency funded project (2012-2014) supported four of the North West Local Enterprise Partnerships (LEPs) to embed environmental sustainability into their economic development priorities and work streams (ENWORKS 2014). It was suggested: "we helped the LEPs to understand what environment was, a lot of them weren't thinking about it…we helped them undertand that and we had a bag of consultancy cash…helping them develop projects, so we did work in terms of mapping the low carbon sector …work around how do you use public sector procurement to drive efficiency through the supply chains. That was quite successful because it was adopted by the Low Carbon Hub and actually when it went to the Combined Authority for approval they said that's really good but we want it adopted across everything now…so that piece of work has been adopted cross the combined authority, AGMA and all ten districts now and NHS is looking at how they can do that" (Interview 2). This has extended to other important policy shaping reports such as the wedges work for Manchester on the 48% (Interview 2).ENWORKS has also influenced national environmental policy, by contributing data, learning and experience to reports and research projects, for bodies such as BIS, DECC and DEFRA (ENWORKS 2012). The data collected through the programme is seen as unique and sufficient to test statistically. This has therefore been used to contributed towards the DEFRA Oakdene Hollins and Grant Thornton report on the "Quantification of the business benefits of resource efficiency" (2007) influencing the Environment Agency (GHK 2011:48) and by the Department for Business Innovation and Skills to identify the scale of resource saving opportunities in commercial and industrial waste streams. The Enworks Toolkit was also adopted by other RDAs – the South East England Development Agency, the Welsh Assembly and the London Development Agency (GHK 2011:49). ENWORKS also sat on Business Link Transition board and wrote the Energy Efficiency Guide for SMEs for DECC (Ellerby 2017, Interview 2) and have fed into the UK National Energy Efficiency Action Plan 2014 (DECC 2014). However, some areas in which national influence have been less successful have been national resource efficiency programmes such as Carbon Trust and WRAP including Envirowise (GHK 2011:48).

Summary of Success Factors

It is clear that the success of the ENWORKS programme is as much about strategic navigation of changing governance structures, savvy business and change management, and effective grant management, as much as it is about success in carbon reduction programmes. The GHK evaluation report suggested that "ENWORKS provides an important strategic leadership role in the region which goes further and deeper than its function in the EBS Programme" (GHK 2011:60). As well as longevity of the programme secured through careful positioning vis-à-vis governance structures, there have been serendipitous professional connections between the programme and those responsible for funding at both the regional and city-regional level which helped the programme to find a good fit. The programme has remained strategically flexible to the changing dynamics in environmental focus aligning itself both with the objectives of the public sector funding interests and the pragmatics of working with businesses. For example, the early programme focussed on compliance with environmental

health and health and safety risk management as a way to engage with businesses "we had used this as a bit of a Trojan horse for engaging with companies" (Interview 2). Likewise, the current focus on competitive advantage and new markets acts as a way of opening doors to wider programmes of environmental performance monitoring. In addition particular programme management features have been important to success.

Firstly, at the heart of the narrative of success lies the ENWORKS toolkit which alongside the tight financial and project management of ERDF programmes testifies to the strength of management capabilities within the programme. Typically business support reports sit on shelves and businesses see reporting data on performance as a burden and both these are seen to underlie difficulties in delivering and reporting change (Interview 2). With ENWORKS, these two problems were addressed in parallel through use of a software toolkit that enabled consultancy reports to become much thinner, clear quantification of business opportunities, and collection and presentation of information on payback and carbon savings. The toolkit also enabled transparency around programmes at several levels. First, within a supported company, thus overcoming problems of staff dependency. Second within ENWORKS, for monitoring what was being delivered, where and managing up the performance both of companies and advisors comparative to each other through sharing best practice and skills: "we were constantly improving the quality of the service…we were using the information not just as a reporting tool but as a way of delivering the service" (Interview 2). Third, for the funders and board members, by integrating the data requirements for reporting into the service delivery and enabling funders and board members to have log on details to access aggregated data at any time: "by delivering the service you delivered the important data" (Interview 2). It was suggested that:

> *"that transparency was very valuable…people funding projects think its absolutely brilliant, people delivering projects don't … like that transparency, because they are concerned that they can't deliver against it…my experience that's not the case, you can do that and we've demonstrated that for the best part of 20 years" (Interview 2).*

Secondly, the impressive record of success also reflects a very conscious marketing strategy that alongside their savvy governance navigation has been central to their success:

> *"we always had an eye for PR – success breeds success – so if you want someone to keep on funding you, show them how good you are… go for awards, tell them you've won awards, write the press release that their press team can roll out. Make sure…you have a case study you can just give them…then you become – ah they're easy, we'll just go and ask them…. I can give you three case studies, I can give you up to date figures on exactly where we are, how much carbon we've saved, how many hot air balloons that is, how many times you can drive to the moon in a hummer… we actually brought in a dedicated marketing person to make sure our messages were getting out there…we really made sure that everyone knew the impact that we were having and without their contribution we wouldn't have that so we were seen as their success story" (Interview 2).*

Thirdly, separation of delivery and contracts management means that the uncertainties of BREXIT are not affecting delivery of existing programmes, avoiding momentum loss (Interview 2). This was considered vital allowing a programmes team to focus on bid development to secure the next stage of funding (which if European will be underwritten by UK Government up until the point of exit) without staff becoming nervous and loss of intellectual capital that precipitates a loss of relations with businesses that makes it harder to deliver agreed outcomes and causes project delays (Interview 2).

What is interesting about the ENWORKS case is the strengths drawn from both the private and public sector modes of working. On one hand, the initiative was initiated by a former ICI executive and frustrations were expressed with the slow pace and bureaucracy of the public sector were expressed, in which messages got watered down, decisions are filtered before ever reaching elected members and risk averse approaches in which the balance between risk and reward isn't that well understood often fail to grasp that by "not taking any risks, it opens itself up to other risks by inaction" (Interview 2). The programme speaks the language of business and emphasises the way in which the public sector really value the programme because "they're talking to people who absolutely understand the subject matter" (Interview 2). On the other, the early strategic working between Groundwork and the Environment Agency, the drive to move from a model of competition between business advice services and co-ordinated and simplified points of delivery draw specifically from public sector logics of service management. The roles of public sector bodies such as the EA, NWDA and the importance of public sector European and UK match funding throughout the whole programme was described as "fundamental" (Interview 2). Since the initial Single Regeneration Programme, ENWORKS activity has been 50% funded by ERDF and without ERDF "it just wouldn't have happened" (Interview 2). In many ways ENWORKS has been able to operate as a business-facing programme with all the benefits of public sector funding but "without thinking well what's in it for us" (Interview 2). They have been able to operate with the agility of corporate decision-making, without the constraints of democratic decision-making.

5.3 Community Led Low Carbon Development

Burrai reviews examples of "alternative retrofit projects in GM" (where retrofit extends beyond domestic housing energy efficiency improvements). She distinguishes between projects in which communities were mobilised by institutions to partake in community scale programmes as "a governmental strategy elaborated to decentralise the power, to keep a high degree of control over residents and to achieve competitive visibility on regional and national scales" (2014:18) and those that are community driven – often through resistance to political, economic, social and environmental issues at both a local and global scale. In the latter category Burrai identifies 14 projects that were initiated by community groups (2014:10). This section looks at two projects Stockport Hydro which maintains a tight community focus and Carbon Co-Op which is developing a more outward facing and networked approach.

Locally Focussed Low Carbon Development – Hydro-generation in Stockport

Stockport Hydro is located at Otterspool Weir on the river Goyt and champions itself as Greater Manchester's first community-owned renewable energy project (Stockport Hydro 2017). The project began in 2011 by an individual from h2ope who identified the site and co-ordinated a Stockport community group to take the project forwards (Stockport Hydro 2017). This group soon constituted itself as "Stockport Hydro Ltd" – "an industrial and provident society for the benefit of the community for the specific purpose of owning a Hydro Electric Scheme" (Stockport Hydro 2013). The group wanted to produce green electricity in order to reduce carbon emissions and provide a tangible benefit for locally run projects (Burrai 2014:51). Stockport Council is the landowner of the site where the hydro scheme was developed so the group began early consultation with the council and gained advice from H2ope, a social enterprise specialised in developing hydro schemes (Burrai 2014:51). Initial financing for the two Archimedes screws (nicknamed Thunder and Lightning) was secured primarily through a community share offer together with supporting grants and loans. Members of the Society, were offered an ownership stake in the scheme and in return are entitled to receive dividends from the sale of electricity and Feed-in-Tariff returns – estimated at pre-tax profit rate of £ 30,000 pa (Stockport Hydro 2013). The initial share offer (of between £ 250 and £ 20,000) raised £ 280,000 and this was extended in 2013 to try to gain an extra £ 100,000 of community investment. Shares were tied in for three years and non tradable (Stockport Hydro 2013) and in the end only a third of the 323 Members live in the local Stockport area with others all over the country (Stockport hydro 2017).

A further £ 360,000 towards capital costs for the project came from supporting loans including a bank loan from the Charity Bank (North West Development Agency, Charity Bank and Key Fund) and £ 45,000 worth of financial assistance from Stockport Council in the form of a 10 year loan at 7% interest from the Council's Green Regeneration Fund – assigned in part to supporting the deployment of sustainable energy projects in the Borough. The rate of interest was considered a good investment rate for the Council and could be reinvested into other schemes through the Green Regeneration Fund in the future (Burrai 2014:51). Burrai suggests that "although the interest rate was low, the funders were said to have an economic return in the investment and also, it could be "prestigious" for them to be involved in the first community-owned renewable energy scheme" (Burrai 2014:51). The hydro generation scheme, which will generate enough green electricity per year to power approximately 60 average houses, is expected to save over 4,000 tonnes of CO_2 over an expected lifetime of 40 years (Stockport Hydro 2013), began feeding into the National Grid in 2012. As of 24/01/2017 has generated 829,000 kWh of electricity (Stockport Hydro 2017). The project is protected from recent changes to the Feed-in Tariffs by the clause that once a hydro system is registered for FITs it is locked into that tariff (which is index-linked) for 20 years, so its value in real terms will not be eroded by inflation (Renewables First 2016). However, a surge of uptake in shares in anticipation of the UK Government announcing closure of the EIS tax rebate scheme the directors have had to suspend offering shares until the situation is re-

viewed (Stockport Hydro 2017). The community group behind the project have kept their focus on the Stockport area and are delighted that the scheme now provides annual funding of around £ 2000 for up to 10 local projects that will benefit the community within the SMBC boundary (Stockport Hydro 2017).

Networked Communitarianism – the Carbon Co-Op in Manchester

The Carbon Co-Op is identified as one of five innovator projects by the GM Energy Plan (GMEP 2011:64). The focus for the group is private owner-occupied domestic low carbon retrofit. First conceived in 2008 and incorporated as a not-for-profit community benefit society "Society for the Reduction of Carbon Limited" in 2011, the group known as Carbon Co-op is made up of private householders interested in improving their homes to 2050 standards (Carbon Coop: undated). They receive support from Urbed an urban design and sustainability consultancy company based in Manchester and London who provide discounted rate (between £ 300-600) home energy assessments to Co-Op members. Works can either be taken forward through recommended architectural consultancy services or through DIY approaches. Carbon co-op has so far conducted over sixty whole house retrofit assessments and demand has exceeded support capabilities (Carbon Coop: undated).

Funding from InnovateUK has enabled the home energy assessment tool to be made available online open source and Carbon- Co-Op are piloting social franchise replication with other community energy groups (Carbon Coop: undated). The online tool available at: https://openenergymonitor.org is "reducing the time it takes to deliver assessment reports, enabling more assessors to deliver the service and providing householders with more control over the data generated….we can reduce the price we charge and see more assessments delivered both in Manchester and around the country" (Carbon Coop: undated). As well as assessing what needs to be done, Carbon Co-op offer training in procurement of services and bulk discounts are sometimes negotiated (Carbon Coop: undated). A series of demonstration homes are being developed through funding from DECC, ECO subsidies on certain measures and access to zero interest loans, the energy use is then being monitored by University of Salford (Carbon Coop: undated). In 2017 Carbon Co-Op are also partnering their work on the online energy assessment tool with Dalarna University (Sweden) to look at energy forecasting through machine learning algorithms for the development of smart grids (Carbon Co-Op: 2016b).

Carbon Co-Op works through community champions, trailblazers and piloteers who are prepared to trial new approaches and snowball interest among others. The group organises information sharing events and connects with other communities to learn from best practice demonstrating Hodson et al's observations that communities become networked across scales based on information, experience and emotional support (2012). This community networking can be recently exemplified by Carbon Co-Ops involvement by invitation in a visit to the EU in Brussels led by Regen and Plymouth Community Energy. This visit offered networking with several UK community energy groups from the South West of England as well as

some other guest community energy groups from London and Wales and hearing from a range of guest speakers from across Europe including Flanders-based co-operative retailer Ecopower and President of REScoop, the community energy federation, Solar Power Europe, who discussed an innovative new community energy model for communal solar panels from Germany, the European Federation of Local Energy Companies, Greenpeace Energy, and the President of TEN Section of European Economic and Social Committee. The groups received tours and introductions to the EU Commission, Council and Parliament and spoke with MEPs from the south West and North West of the UK (Carbon Co-Op: 2016a). The Carbon Co-Op offered a source of technical advice, supporting installation of energy monitoring in Lancaster Cohousing and have developed a web tool – My Home Energy Salford – whereby any resident can identifying an accurate energy assessment of their house – 80% as accurate as full servey – much more accurate than the green deal (Interview 6).

Carbon Co-Op interact with regional governance through collectively responding to consultation on the approach to low carbon within the draft Spatial Framework and Greater Manchester Climate Change Strategy and National Government through co-ordinating responses to consultations such as the call for evidence on smart systems and energy storage. Carbon Co-Op was trying to develop a “Carbon Saving Society” as a model of financing community investment in renewable technology. In 2012 Hudson et al reported it was trying to raise £ 2.5 million over three years through community equity or local bonds to finance community renewable installations that trigger guaranteed income through contractual arrangements via the Feed-in-Tariff and Renewable Heat Incentive schemes that is reinvested in household retrofit alongside other mechanisms such as Green Deal. The Strategy outlined the potential for a domestic retrofit Building Society but this option would face challenges around the significant start up capital (c £ 1 m) required (2012:34). No further information can be found on this and it is anticipated that these plans have been hindered by the wide scale reduction of UK Government subsidies on renewable energy generation in 2015. In both cases, projects were taken forward without European structural funding. Probably due to their scale and scope – projects relied instead on local community fundraising, public and private sector loans and relied strongly on the financial returns made available through the UK Governments FITS and RHI schemes.

6 Concluding remarks

Activity on low carbon economy within GM has been driven by two simultaneous objectives: the early adoption of a 48% carbon reduction by 2020 from 1990 baseline as a key indicator for the city region and the desire to develop GMs environmental goods and service sector which was seen to offer the largest potential for growth outside London and the south east (MA interview). The parallel ambitions of carbon reduction and economic growth are positioned as complementary. Whilst its easy to see where carbon reduction activity can be made complementary with the economic growth agenda it is less easy to see the symbiotic relationship working the other way round.

At a national level, there has been a shift in policy over the last 10 years to increase the ideological commitment to private sector leadership. The effect of this at Greater Mancheset level is that "there remains a low carbon strategy, targets and an implementation plan but the effect of accelerating growth is a relative squeezing of low carbon concerns" (Hodson et al forthcoming:12). The extent to which Greater Manchester has been successful in integrating economic growth and environmental concerns historically shows longstanding tension. Hunt describes the way in which, like in many other cities, environmental concerns have always played second fiddle to economic drivers and despite early activities "high profile conflicts between local government and environmental groups over air quality and airport expansion in the 1990s…[generated] side-lining of environmental issues to pursue economic, social and physical renewal" (Hunt 2012:18). Sustainability also became a means to an end rather than in its own right: "the main stimulus for a turn towards a more environmentally conscious mode of governance" Hunt argues, lies in the city council's successful bid to host the Global Forum in 1993/4 and, while Manchester City Council developed a local authority Environmental Action Programme in 2001, this can be understood through "a new attitude to environmental policy" initiated with the new millennium in which national policy encouraged local authorities to take a proactive approach (Hunt 2012:18). Here the goal was in profiling Manchester, the mechanism became the national policy flavour of the time. Envoy et al also question the extent to which environmental concerns were driving environmental policy considerations at this time – emphasising instead win-win economic arguments (2000:233). This leads Hunt to conclude that:

> *"Environmental concerns have been integrated into urban management to a degree, but are held to be second to socio-economic regeneration efforts… Manchester's sustainability agenda has long played second fiddle to those of social and economic regeneration and physical renewal, a choice arguable necessitated by the extreme deprivation and decline felt in the city after the loss of the industry …Recent years have seen a growth in the importance of environmental discourse, though it continues to be dominated by an economic rationale." (Hunt 2012:18).*

These remarks hold today with successful integration of the two ambitions occurring where economic savings become available to businesses through energy efficiency improvements

and/or opportunities for green-tech business development. Whilst there are several minor challenges by stakeholders and environmental groups over Manchester's strong pursuit economic growth, for example, by Steady State Manchester who presented a report on Steady State Economics to the Overview and Scrutiny Committee at Manchester City Council in 2012 to prompt debate over Manchester's strong focus on economic growth (Steady State Manchester 2016), however the priority on continued pursuit of growth was resolute and maintained:

> *"Economic growth remains the only practical means of delivering employment for all, a rising standard of living for citizens, fostering greater opportunity, supporting and valuing diversity, social mobility, delivering a commitment to fairness; and securing a sustainable economic future. Unilateral imposition of steady state economics in Manchester alone will have negligible impact upon major global drivers such as climate change, whilst having a major negative impact upon Manchester's prosperity and the wellbeing of its residents. (Manchester City Council 2012:17)*

As well as local socio-economic fears, difficulties of adopting a position counter to that of the UK National Government and international community are expressed: "even it were desirable there are no realistic prospects of developing an SSE [Steady State Economy] in Manchester – as international and national policy is not geared to this goal" (Manchester City Council 2012:11).

On the possibility of decoupling carbon emissions form growth, the UK Government official line is that "In 2014, UK greenhouse gas emissions were at their lowest levels since 1990, while Gross Domestic Product (GDP) reached its highest rate since 1990… Between 1990 and 2014, there are 15 years with a decrease in greenhouse gas emissions and an increase in GDP compared to the previous year, suggesting that UK territorial emissions are decoupling from economic growth" (UK Government 2016:8). However, the CCC is not so optimistic, suggesting that "Whilst emissions have fallen by an average of 4.5% a year since 2012, this 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. There has been almost no progress in the rest of the economy" (CCC2016:10). Further, with UK Government removal of support for renewable energy generation, it is uncertain whether this trajectory will continue. Off the record, interviewees talked more openly about the tension between economic growth and addressing carbon reduction with one significant figure describing that there was no way of reconciling the current ambitions for growth with the targeted aspirations for carbon reduction. Decoupling was seen as an ideal, and although unlikely, was a necessary discourse in order to get any action agreed at all.

Despite ideological withdrawal from regional governance, Greater Manchester's ability to re-establish a form of city-region governance may be interpreted in the context of each city finding its competitive niche within the global economy such that "City-regionalism represents a contingently produced geopolitical project in late capitalism"(Jonas 2012:823). Within this

framing, Hodson et al signal the way that low carbon initiatives emerge “as part of an emerging world of ecological competition between city-regions to have secure access to the ‘cleaner’ energy resources necessary to literally fuel economic activity” (Hodson et al 2012:26). The Manchester Mini Stern in particular embodied this logic of “extending the economic competition between places into the sphere of climate change and for Greater Manchester to seek to exploit a first mover advantage and distinctiveness in eco-economic competition” (Hodson et al forthcoming:9). Such “intensification of geographical competition” is not contrary to UK National Government’s retreat from regionalism at this time, but rather is further encouraged by austerity and sub-national restructuring (Hodson et al 2012:26). Indeed the new city-regionalism of Greater Manchester is much more about inclusion and facilitation of the private sector (through the LEP, the City Deal and focus on private sector led growth) than devolved public sector governance to a regional scale. Manchester’s city-regionalism has been described as “hybrid regionalism” focussed around moving away from parochial political representation (implicitly framed a bad thing) towards focus on delivering national growth through a lens of sustainable development (Bafarasat 2016:119). It is in this context that George Osbourne described Manchester as “a grown-up city, one that has pulled away from other regional centres” (cited in Folkman et al 2016:5). It is further suggested that Manchester’s governance character as “unapologetically technocratic” and shying away from ideological debate (Deas 2015) has undoubtedly lent itself towards this goal. However, Hodson et al (forthcoming) point to the limitations over the extent to which Greater Manchester’s decision-makers can exercise power or discretion to meet carbon reduction targets, illustrating the “relative structural weakness and the dependency on national government of Greater Manchester’s governing institutions” (forthcoming:13), that “the vast majority of public funding for Greater Manchester remains in the control of the UK state and …the governance of infrastructure systems do not correspond with the territorial boundaries of Greater Manchester” (forthcoming:9). They draw attention to the way in which regional governance attempts within Greater Manchester are strongly shaped by UK national priorities to the extent that in understanding the dynamics of low carbon discourses “urban low carbon transitions are constituted as metropolitan level responses to national priorities” (forthcoming:13) in which Greater Manchester’s low carbon visions are built on the basis of amenability to the interests of ‘others’” (forthcoming:2).

References

ADE (2017) The Association for Decentralised Energy Greater Manchester Energy Master plan webpage. Online at http://www.theade.co.uk/greater-manchester-energy-masterplan_3304.html (last accessed 05/01/2017.

AGMA (undated) “Moving towards Green Deal: ‘Go Early’ success in Greater Manchester” Available online at: http://archive.agma.gov.uk/cms_media/files/76049_go_early_evaluation_summary_hr.pdf?static=1 (last accessed 17/01/2017).

AGMA (2012) The Association Of Greater Manchester Authorities Constitution. June 2012. Available online at: http://archive.agma.gov.uk/cms_media/files/agma_constitution_june12.pdf (last accessed 13/01/2017).

AGMA (2012b) “Adapting the City: Investment and Finance” Seminar Slides. Available Online at: http://slideplayer.com/slide/6262800/ (last accessed 18/01/2017).

AGMA (2013) “Get Me Toasty Campaign” Available online at: http://archive.agma.gov.uk/latest-news/get-me-toasty-campaign/index.html (Last accessed 31/01/017).

AGMA (2017) AGMA Policy and Research Unit “Business Leadership Council” Online at: http://archive.agma.gov.uk/what_we_do/business-leadership-council/index.html (last accessed 04/01/2017).

AGMA (2017b) AGMA Policy and Research Unit “Local Enterprise Partnership”. Available online at http://archive.agma.gov.uk/local-enterprise-partnership/index.html (last accessed 13/01/2017).

AGMA GMCA GMLEP (2011) “Transformation, Adaptation & A Competitive Advantage. The Greater Manchester Climate Strategy 2011-2020”. Version 21. Available Online At: http://media.ontheplatform.org.uk/sites/default/files/gm%20climate%20change%20strategy.pdf (Last Accessed 25/01/2017).

AGMA/R4GG (undated) “Regions for Green Growth Action and Implementation Plan Greater Manchester” Online at: http://www.regions4greengrowth.eu/userfiles/documents/Public/120%20Action%20Plans/published/Greater%20Manchester%20Action%20and%20Implementation%20Plan.pdf last accessed 30/11/2016.

Bafarasat, A.Z, (2016) “Exploring new systems of regionalism: An English case study” in *Cities* 50: 119–128.

BRE – Building Research Establishment (2008) “Energy Analysis Focus Report: A study of hard to treat homes using English Housing Condition Survey Part 1: Dwelling and Household Characteristics of Hard to Treat Homes (prepared by BRE with support from DEFRA through a contract managed by the Energy Saving Trust). Available online at https://www.bre.co.uk/filelibrary/pdf/rpts/Hard_to_Treat_Homes_Part_I.pdf (last accessed 01/01/2017).

Burton, M.H. (2016) Steady State Manchester “Commentary on ‘*Ahead of the Curve’* Manchester’s climate change consultation for 2016-2050”. Available online at: https://steadystatemanchester.net/2016/10/10/manchesters-climate-change-consultation-for-2016-2050/ (last accessed 16/01/2017).

Business Growth Hub (2017) “Business Support” Online at: http://www.businessgrowthhub.com/partners/enworksgreen-growth (last accessed 02/02/2017).

CAG Consultants (2011) Evaluation of the Local Carbon Framework Pilots: A report by CAG Consultants in association with Impetus Consulting and Dr Joanne Wade. Commissioned by the Local Government Association and the Department for Energy and Climate Change. Online at http://www.local.gov.uk/c/document_library/get_file?uuid=271d92fa-dedc-4a76-b931-b8851ff6e8fc&groupId=10180. Last accessed 07/12/2016.

Carbon Co-Op (undated) ‘ ‘ Online at: http://carbon.coop/about-us (last accessed 31/01/2017).

Carbon Co-Op (2016a) “Community Energy Delegation visit to Brussels” blog online at: http://carbon.coop/blog/jonathan/community-energy-delegation-visit-brussels (last accessed 31/01/2017).

Carbon Co-Op (2016b) “Call for participation: Electricity demand forecasting using Machine Learning Project” Blog online at http://carbon.coop/blog/ben-aylott/call-participation-electricity-demand-forecasting-using-machine-learning-project(last accessed 31/01/2017).

Carbon Plan (2017) “Stockport: ECO Biomass Heat Network” Online at: http://www.carbonplan.co.uk/case-study/stockport-eco-biomass-heat-network/ (last accessed 20/01/2017).

CCC (undated) UK Committee on Climate Change “Global Action on Climate Change” online at: https://www.theccc.org.uk/tackling-climate-change/the-legal-landscape/climate-change-act-and-uk-regulations/ (last accessed 23/01/2017).

CCC (2013) “Reducing the UK’s carbon footprint report by the Committee on Climate Change.” April 2013 Available online at: https://www.theccc.org.uk/wp-content/uploads/2013/04/Reducing-carbon-footprint-report.pdf (last accessed 12/04/2017).

CCC (2015) UK Committee on Climate Change Blog written by Alex Kazaglis: “Balancing visibility and flexibility through a power sector decarbonisation target” Online at: https://www.theccc.org.uk/2015/03/27/balancing-visibility-and-flexibility-through-a-power-sector-decarbonisation-target/ (last accessed 23/01/2017).

CCC (2016) Meeting Carbon Budgets – 2016 Progress Report to Government. Available online at: https://www.theccc.org.uk/wp-content/uploads/2016/06/2016-CCC-Progress-Report.pdf (last accessed 15 May 2017)

CCLES (2016) “Climate Change and Low Emission Strategies” Whole Place Implementation Plan for Greater Manchester (2016-2020) GM Low Carbon Hub. Available online at: https://www.greatermanchester-ca.gov.uk/info/20005/low_carbon (last accessed 20/12/2016)

City West Housing Trust (2011). About Barton Village. Retrieved from http://www.bartonvillage.co.uk/about/

COOP/URBED (2015) ‘A community approach to retrofit and potential implications for the fuel poverty agenda: A report for the Cheshire Lehmann Fund by Carbon Co-op and URBED’. March 2015 (final report) Available online at: http://urbed.coop/sites/default/files/20150923_Chesshire%20Lehmann%20final%20report_0.pdf (last accessed 20/01/2017).

Cowie, P. Davoudi, S. Madanipour, A. and Vigar, G. (2013) ‘Territorial Approaches for New Governance’ Applied Research 2013/1/21. Annex 7, Case Study 7: Reinventing regional territorial governance – Greater Manchester Combined Authority. ESPON TANGO Report. EU.

Cox, C. (2013) Manchester Evening News ‘£20m windfall to put Greater Manchester into the cycling fast lane’ http://www.manchestereveningnews.co.uk/news/greater-manchester-news/20m-windfall-put-greater-manchester-5700862 (last accessed 12/01/2017).

Data.gov (2013) ‘Electric Vehicle Charging Points’. Online: https://data.gov.uk/dataset/electric-vehicle-charging-points (last accessed 20/01/2017).

DBEIS (2016) Department for Business, Energy and Industrial Strategy ‘Sub-National Consumption Statistics Methodology And Guidance Booklet’ Available Online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/579258/Sub-national_Methology_and_Guidance_Booklet_2016.pdf (last accessed 02/01/2017).

DBEIS (2016b) Department for Business, Energy and Industrial Strategy ‘Energy Trends’ December 2016 available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/579542/ET_Dec_16.pdf (last accessed 10/01/2016).

DBEIS (2016c) Department for Business, Energy and Industrial Strategy ‘Sub-regional Feed-in Tariffs statistics’ available online at: https://www.gov.uk/government/statistical-data-sets/sub-regional-feed-in-tariffs-confirmed-on-the-cfr-statistics (last accessed 12/01/2017).

DBEIS (2016d) ‘Policy Paper – Contract for Difference’ Available online at: https://www.gov.uk/government/publications/contracts-for-difference/contract-for-difference (last accessed 23/01/2017).

DBEIS (2016e) ‘Digest of United Kingdom Energy Statistics (DUKES) 2016: main chapters and annexes’ Available online at: https://www.gov.uk/government/statistics/digest-of-united-kingdom-energy-statistics-dukes-2016-main-chapters-and-annexes (last accessed 5t Jan 2017).

DBEIS (2017) Building Our Industrial Strategy Green Paper. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/611705/building-our-industrial-strategy-green-paper.pdf (last accessed 29/04/2017).

DCLG (2007) ‘Planning Policy Statement: Planning and Climate Change Supplement to Planning Policy Statement 1 Available online at http://webarchive.nationalarchives.gov.uk/20120919132719/http:/www.communities.gov.uk/documents/planningandbuilding/pdf/ppsclimatechange.pdf (last accessed 23/01/2017).

DCLG 2011 Environmental Report on the revocation of the North West of England Plan. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/8441/2012175.pdf (last accessed 13/12/16).

DCLG (2013) Strategic Environmental Assessment of the Revocation of the North West Regional Strategy. Post Adoption Statement https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/192043/Strategic_Environmental_Assessment_of_the_Revocation_of_the_North_West_Regional_Strategy_-_Post_Adoption_Statement.pdf (last accessed 13/12/2016).

Deas, I. (2015) 'Who will lead the Manchester Powerhouse?' Blog February 23, 2015. Available online at: http://blog.policy.manchester.ac.uk/featured/2015/02/who-will-lead-the-manchester-powerhouse-3/ (last accessed 25/01/2017).

DECC (2008) CCA-B02 'Climate Change Agreements: Energy Intensive eligibility criteria – guidance for sector associations and participants' Available online at http://webarchive.nationalarchives.gov.uk/20121217150421/http://decc.gov.uk/assets/decc/what%20we%20do/global%20climate%20change%20and%20energy/tackling%20climate%20change/ccas/ccas_guidance/cca-b02.pdf (last accessed 23/01/2017).

DECC (2011) 'Local Authorities and the Green Deal: Information note. November 2011. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/43022/3499-local-authorities-green-deal-info.pdf (last accessed 17/01/2017).

DECC (2014) 'UK National Energy Efficiency Action Plan 'Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/307993/uk_national_energy_efficiency_action_plan.pdf (last accessed 02/02/2017).

DECC (2017) 'National Statistics Solar photovoltaics deployment' Online at: https://www.gov.uk/government/statistics/solar-photovoltaics-deployment (last accessed 05/01/2017).

DECC-LGG (2011) Memorandum of Understanding: Between the LG Group and the Department for Energy and Climate Change' 9th March 2011. URN 11D/0034. Available online at: https://www.gov.uk/government/publications/memorandum-of-understanding-between-the-lg-group-and-the-department-of-energy-and-climate-change (last accessed 13th Jan 2017).

DECC (2008)' Climate Change Act 2008' Available online at: http://www.legislation.gov.uk/ukpga/2008/27/pdfs/ukpga_20080027_en.pdf (last accessed 23/01/2017).

DECC (2012) – 'The Future of Heating: A strategic framework for low carbon heat in the UK' Department for Energy and Climate Change Consultation Document Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48574/4805-future-heating-strategic-framework.pdf (last accessed 05/01/2017).

DECC (2013) 'UK Energy Act 2013' Available online at: http://www.legislation.gov.uk/ukpga/2013/32/pdfs/ukpga_20130032_en.pdf (last accessed 23/01/2017).

DECC (2016) Department for Energy and Climate Change – now Department for Business, Energy and Industrial Strategy – Interactive Maps. Online at: http://tools.decc.gov.uk/en/content/cms/statistics/local_auth/interactive/domestic_solar/index.html (last accessed 02/01/2017).

DEFRA (2006) 'Climate Change: The UK Programme': Tomorrows Climate Todays Challenge. CM 6764 SE/2006/43. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/272269/6764.pdf (last accessed 23/01/2017).

Deloitte (2008a) Greater Manchester Strategic Housing Market Assessment. Final Report. In association with GVA Grimley, prepared for AGMA.

Deloitte (2008b) Mini-Stern for Manchester. Assessing the economic impact of EU and UK climate change legislation on Manchester City Region and the North West. Final Report September 2008. Available online at: http://media.ontheplatform.org.uk/sites/default/files/UK_GPS_MiniStern.pdf (last accessed 05/01/2017).

DETR (2000) Department for Environment Transport and the Regions 'Climate Change: The UK Programme' Available online at: http://www.cne-siar.gov.uk/emergencyplanning/documents/Climate%20Change%20-%20UK%20Programme.pdf (last accessed 23/01/2017).

D'souza, F.(2016) Local Gross Value Added (GVA) 2015 Manchester and comparators. Manchester City Council Public Intelligence December 2016. Data Source: Office for National Statistics (ONS) on 15/12/2016. Available online from: http://www.manchester.gov.uk/downloads/download/422/corporate_research_and_intelligence_population_publications_economy (last accessed March 2017).

DTI (2003) Department for Trade and Industry 'ENERGY WHITE PAPER: Our energy future – creating a low carbon economy' Available online at: http://webarchive.nationalarchives.gov.uk/20090609003228/http://www.berr.gov.uk/files/file10719.pdf (last accessed 23/01/2017).

Eames, M. Dixon, T., Lannon, S., Hunt, M., De Laurentis, C., Marvin, S., Hodson, M.,Guthrie, P., Georgiadou, M.C. (2014) Retrofit 2050:Critical Challenges for Urban Transitions. Cardiff University ISBN: 978-1-899895-12-0

Ellerby, J, (2017) 'Government Publishes Guide To Energy Efficiency For SMEs' online at: http://www.manchestergrowth.co.uk/news/?filterby=ENWORKS (last accessed 02/02/2017).

ENWORKS (undated a) 'Origins' Online at http://enworks.com/about/origins (last accessed 02/02/2017).

ENWORKS (undated b) 'Home' Online at http://enworks.com/home (last accessed 02/02/2017).

ENWORKS (undated c) 'Achievements' online at: http://www.enworks.com/achievements (last accessed 02/02/2017).

ENWORKS (2012) 'Making an impact in Greater Manchester' Online at: http://www.enworks.com/resources/Making_an_Impact_Greater_Manchester.pdf (last accessed 02/02/2017).

ENWORKS (2012) 'ENWORKS joins forces with Business Growth Hub to support green growth' Online at: http://www.enworks.com/enworks-business-growth-hub (last accessed 02/02/2017)

ENWORKS (2014) 'Action Planning for the ESTA project' Available Online at: http://www.enworks.com/resources/Action%20Planning%20for%20the%20ESTA%20Project%20Final.pdf (last accessed 02/02/2017).

Energy Technologies Institute (2016) Greater Manchester Spatial Energy Plan Evidence Base Study. Full Report. Available online at: https://es.catapult.org.uk/wp-content/uploads/2016/05/Compressed_GMCA_Spatial_Energy_Plan_2016_11_07-LATEST-ilovepdf-compressed.pdf (last accessed 05/01/2017).

Environmental Economy of North West England (2012) Website available at: http://enviroeconomy northwest.com/leadership-2/the-northern-way/ (last accessed 13/12/2016)

EUR-LEX (2017) Access to European Law Search Results for Energy Climate and Low Carbon. Available online at: http://eur-lex.europa.eu/homepage.html (25/01/2017).

Eurostat (2013) NUTS 2 regions in the UK. Available online at: http://ec.europa.eu/eurostat/documents/345175/7451602/nuts-map-UK.pdf (last accessed 17/01/2017).

Folkman, P., Froud, J., Johal, S., Tomaney, J. and Williams, K. (2016) 'Manchester Transformed: Why We Need A Reset Of City Region Policy' CRESC Public Interest Report November 2016. Available online at: http://www.cresc.ac.uk/medialibrary/research/ManchesterTransformed.pdf (last accessed 25/01/2017).

Fudge, S., Peters, M., Wade, J. (2012) Locating the Agency and Influence of Local Authorities in UK Energy Governance. Centre for Environmental Strategy, Working Paper 01/12. University of Surrey, UK. March 2012. ISSSN: 1464-8083. Available online at: https://www.surrey.ac.uk/ces/files/pdf/01-12_Paper_Fudge_Peters_Wade.pdf (last accessed 13/01/2017).

GHK (2011) 'ENWORKS Environmental Business Support Programme – Independent Evaluation – Northwest Regional Development Agency & ENWORKS' Available online at: http://www.enworksinabox.com/sites/default/files/ENWORKS%20EBS%20Programme%20Independent%20Eval%202011_0.pdf (last accessed 02/02/2017).

Gibbs, D., Jonas, A., & While, A. (2002). Changing governance structures and the environment: economy–environment relations at the local and regional scales. *Journal of Environmental Policy & Planning*, *4*(2), 123-138.

GMCA (2015) 'Greater Manchester Environment Report 2015' Available online at: http://media.onthe platform.org.uk/sites/default/files/annual%20report%20final%20Oct%2015%20e%20version.pdf (last accessed 17/01/2017).

GMCA (2015a) 'Scrutiny Pool' Friday 13th February 2013. Available online at: https://www.greater manchester-ca.gov.uk/meetings/meeting/93/gmcaagma_scrutiny_pool (last accessed 18/01/2017).

GMCA (2015b) 'Minutes: Greater Manchester Low Carbon Hub Board Friday 17th July 2015' Available online at: http://archive.agma.gov.uk/cms_media/files/merged_complete_lch_board_agenda_170715.pdf?static=1 (last accessed 20/01/2017).

GMCA (2015c) 'GMCA Scrutiny Pool Friday 16 January 2015' Available online at: https://www.greater manchester-ca.gov.uk/meetings/meeting/92/gmcaagma_scrutiny_pool (Last accessed 20/01/2017).

GMCA (2015d) 'Greater Manchester Environment Report 2015' Available online at: http://media.onthe platform.org.uk/sites/default/files/annual%20report%20final%20Oct%2015%20e%20version.pdf (last accessed 20/12/2016).

GMCA (2015e) 'Further devolution to the Greater Manchester Combined Authority and directly-elected Mayor' Available online from: https://www.greatermanchester-ca.gov.uk/downloads/download/30/further_devolution_to_the_greater_manchester_combined_authority_and_directly-elected_mayor (last accessed 18 Dec 2016).

GMCA (2016) 'Greater Manchester City Deal'. Online at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/221014/Greater-Manchester-City-Deal-final_0.pdf last accessed 30 Nov 2016.

GMCA (2016a) Climate Change and Low Emissions Implementation Plan: Whole Place Implementation Plan for Greater Manchester Available online at: https://www.greatermanchester-ca.gov.uk/downloads/file/221/change_and_low_emissions_implementation_plan_2016-2020

GMCA (2016b) Draft Greater Manchester Spatial Framework. Available online at: http://gmsf-consult.objective.co.uk/portal/2016consultation/gmsfoct16?pointId=4204587#document-4204587 (last accessed 05/01/2017).

GMCA (2016c) Web pages 'Testing New Heating Systems' https://www.greatermanchester-ca.gov.uk/info/20056/testing_new_heating_systems – last accessed 13/12/2016.

GMCA (2016d) 'News: 07/03/2016 Greater Manchester Smart Energy project hits halfway mark' Available online at: https://www.greatermanchester-ca.gov.uk/news/article/52/greater_manchester_smart_energy_project_hits_halfway_mark (last accessed 20/01/2017).

GMCA (2016e) 'Greater Manchester's 'Little Bill' Scheme Scoops National Energy Efficiency Award. Available online at https://www.greatermanchester-ca-gov,uk/news/article/93/gretaer_manchester_scoops_national_energy_efficiency_award (last accessed 31/01/2017).

GMCA (2016f) 'Greater Manchester's 'Little Bill' Scheme Scoops National Energy Efficiency Award' Available online at: https://www.greatermanchester-ca.gov.uk/news/article/93/greater_manchester_s_little_bill_scheme_scoops_national_energy_efficiency_award (last accessed 17/01/2017).

GMCA (2016g) 'Greater Manchester Green Deal Programme Exceeds Targets' Available online at: https://www.greatermanchester-ca.gov.uk/news/article/80/greater_manchester_green_deal_programme_exceeds_targets (last accessed 17/01/2017).

GMCA (2016h) 'GM Housing Fund and Low Carbon PDU – Recruitment Update and Request to establish new posts'. Item 20: Available online at: https://www.greatermanchester-ca.gov.uk/meetings/meeting/247/greater_manchester_combined_authority (last accessed 20/01/2017).

GMCA (2017) 'Core Investment Fund'. Available online at: https://www.greatermanchester-ca.gov.uk/info/20033/core_investment_fund (last accessed 20/01/2017).

GMCA (2017a) 'Stronger Together: Greater Manchester Strategy' Summary Strategy Available online at: https://www.greatermanchester-ca.gov.uk/info/20067/greater_manchester_strategy (last accessed 25/01/2017).

GMCA (2017b) Greater Manchester Combined Authority Website 'Heat Networks' Online at https://www.greatermanchester-ca.gov.uk/info/20112/heat_networks (last accessed 10/01/2016)

GMCA (2017c) 'European Funds 2014-2020' Available online at: https://www.greatermanchester-ca.gov.uk/info/20036/european_funds_2014_-2020 (last accessed 15/05/2017).

GMCA, GMLEP, AGMA, (2014) A Plan for Growth and Reform in Greater Manchester. Available Online at: https://www.greatermanchester-ca.gov.uk/info/20074/growth_and_reform_plan (last accessed 6/12/16)

Greater Manchester Energy Group (undated) 'Connected: the Greater Manchester Energy Plan – Powering Greater Manchester's Low Carbon Future. Executive Summary'. Available Online at: http://media.ontheplatform.org.uk/sites/default/files/connected_executive_summary.pdf last accessed 07/12/2016

Greater Manchester Energy Commission (2011) 'Decarbonising the City. Greater Manchester District Heat Networks. Case study 2/5. Funded by DECC's Local Carbon Framework and NWIEP. Available Online at: http://media.ontheplatform.org.uk/sites/default/files/district_heat_spreads.pdf (last accessed 20/01/2017).

Greater Manchester Energy Commission (2011) 'Decarbonising the City. Greater Manchester Domestic Retrofit Programme Red Brick To Green Brick'. Case study 3/5. Funded by DECC's Local Carbon Framework and NWIEP. Available online at: http://media.ontheplatform.org.uk/sites/default/files/retrofit_spreads.pdf (last accessed 20/01/2017).

GMSHMA (2010) Greater Manchester Strategic Housing Market Assessment: Update Report. May 2010. AGMA/New Economy.

Greater Manchester Passenger Transport Authority (2007) "The Greater Manchester Area and its Regional Context". gmltp.co.uk. Archived from the original on 27 September 2007. Retrieved 14 March 2016.

GMHECA (2015) GM Home Energy Conservation Act: Greater Manchester (2015/16-17/18) Available online at: https://www.wigan.gov.uk/Docs/PDF/Council/Strategies-Plans-and-Policies/Housing/GM-Home-Energy-Conservation-Act-Report-2015.pdf (last accessed 31/01/2017).

GMLEP (2015) Partnership Board 12th Nov 2015 'GM Climate Change And Low Emissions Implementation Plan 2016-2020' Available Online At: Https://Www.Greatermanchester-Ca.Gov.Uk/Download/Meetings/Id/381/Item_8

GMWDA (2014) 'The Authority's work at a glance' Presentation given by GMWDA available online at: http://www.gmwda.gov.uk/clientfiles/File/Authority%20at%20a%20glance%20pub%20090714.pdf (last accessed 20/01/2017).

Green Alliance (2016) Commissioned report 'Renewable energy capacity and generation' by RegenSW. Reported online at http://www.green-alliance.org.uk/NW_renewables_.php (last accessed 03/01/2017).

Green Growth (2014) 'Greater Manchester launches 'Little Bill' Campaign' Available Online at: https://www.green-growth.org.uk/article/greater-manchester-launches-little-bill-campaign (last accessed 31/01/2017).

Halsey, R. (2016) 'Local Area Energy Planning – Greater Manchester' paper 05 Annex 1 – Catapult Energy Systems/Energy Technologies Institute LLP Presentation available online at: https://www.greatermanchester-ca.gov.uk/download/meetings/id/1385/5a_annex_1_-heat_and_energy (last accessed 03/01/2017)

HM Government (2011) 'The Carbon Plan: Delivering our low carbon future' Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/47613/3702-the-carbon-plan-delivering-our-low-carbon-future.pdf (last accessed 23/01/2017).

HM Treasury, Infrastructure UK (2011) 'National Infrastructure Plan 2011' Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/188337/nip_2011.pdf (last accessed 23/01/2017).

HM Treasury (2015) 'Summer Budget 2015' Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/443232/50325_Summer_Budget_15_Web_Accessible.pdf (last accessed 23/01/2017).

Hodson, M., Marvin, S., & Bulkeley, H. (2013). The intermediary organization of low carbon cities: a comparative analysis of transitions in Greater London and Greater Manchester. *Urban Studies*, *50*(7), 1403-1422.

Hodson, M., Marvin, S. and Thompson, M. (2012) '*Retrofit and Greater Manchester: Landscape, Governing and Practice'* Retrofit 2050 Draft Working Paper WP1 Case study Report- Greater Manchester city-region Available online at: http://www.retrofit2050.org.uk/sites/default/files/resources/WP1_case_study_report_%20manchester_Region.pdf (last accessed 31/01/2017).

Hodson, M. Marvin, S. and McMeekin. A. (forthcoming) 'The Amenable City-Region: The Symbolic Rise and the Relative Decline of Greater Manchester's Low Carbon Commitments, 2006-2017' in A Luque-Ayala, H Bulkeley and S Marvin 'Rethinking Urban Low Carbon Transitions' Routledge forthcoming.

Hunt, M. (2012) Retrofit 2050 Working Paper: Greater Manchester: Sustainability Context. Welsh School of Architecture, Cardiff University. WP2011/3 – July 2012

Innovation Seeds (undated) 'Greater Manchester Low Carbon Investment Pipeline' Available online at http://www.innovationseeds.eu/Policy-Library/Core-Articles/Greater-Manchester-Low-Carbon-Investment-Pipeline.kl (last accessed 17/01/2017).

Insider (2011) 'ENWORKS REACHES £100M SAVINGS MILESTONE' online at: https://www.insidermedia.com/insider/northwest/59023-enworks-reaches-100m-savings-milestone (last accessed 02/02/2017).

Inteli-inteligênciaeminovação (2014) Pocacito European Post Carbon Cities of Tomorrow. Marketplace of Ideas: Smart City – Good Practice Climate and air quality: Manchester: A Certain Future. Available online at http://pocacito.eu/marketplace/manchester-certain-future (last accessed 13/01/2017.

Jonas, A.E.G. (2012) 'City-regionalism: Questions of distribution and politics' Progress Report in *Progress in Human Geography* 36(6): 822–829

Kitchen, T. (1997) People, Politics, Policies and Plans: The City Planning Process in Contemporary Britain. Sage. London.

Leader's Blog (2014) Manchester City Council 'New Powers to Greater Manchester' Available online at: http://www.manchester.gov.uk/blog/leadersblog/post/707/new-powers-to-greater-manchester (last accessed 17/1/17).

Local Enterprise Partnership Board (2016) ' Climate Change and Low Emissions Strategies' Implementation Plan (2016-20) 16th May 2016 Item number 5. Available online from: https://www.greatermanchester-ca.gov.uk/meetings/meeting/180/greater_manchester_local_enterprise_partnership (last accessed 23/01/2017).

Low Carbon Economic Area Initiative (2011) The Missing Quarter: Integrating Behaviour Change in Low Carbon Housing Retrofit. Available online at: http://www.salford.ac.uk/__data/assets/pdf_file/0005/593258/Missing-Quarter-Behaviour-Change-report.pdf (last accessed 16/01/2017).

Low Carbon Board (2015a) Item 5: 'GM HEAT AND ENERGY EVIDENCE BASE' Report of GM Environment Director: Mark Atherton 7th October 2016. Available online at: https://www.greatermanchester-ca.gov.uk/meetings/meeting/282/low_carbon_hub (last accessed 12/01/2017)

Low Carbon Hub Board (2015b) Greater Manchester Low Carbon Hub/Bulletin November 15. Available online at: http://media.ontheplatform.org.uk/sites/default/files/LowCarbonHubBulletinNov2015.pdf (last accessed 12/01/2017).

Low Carbon Hub Board (2015c) Minutes Of A Meeting Of The GM Low Carbon Hub Board Held On Friday 17 July 2015 Item 2. Available Online At: https://www.greatermanchester-ca.gov.uk/meetings/meeting/235/low_carbon_hub (Last Accessed 17/01/2017).

Low Carbon Hub Board (2015d) 'Minutes Of A Meeting Of The GM Low Carbon Hub Board Held On Friday 2 October 2015'. Available online at: https://www.greatermanchester-ca.gov.uk/meetings/meeting/236/low_carbon_hub (last accessed 17/07/2017).

Low Carbon Hub Board (2015e) 'Potential GM Low Carbon Opportunities From Enhanced Devolution' 6th March 2015 Available online at: https://www.greatermanchester-ca.gov.uk/meetings/meeting/49/low_carbon_hub (last accessed: 17/01/2017).

Low Carbon Hub Board (2016a) 'Decisions Of A Meeting Of The GM Low Carbon Hub Board Held On Friday 1 April 2016' Available online at: https://www.greatermanchester-ca.gov.uk/download/meetings/id/793/decision_agreed_010416 (last accessed 05/01/2017)

Low Carbon Hub Board (2016b) Draft minutes 'Decisions Of A Meeting Of The Greater Manchester (GM) Low Carbon Hub Board Held On Friday 7 October 2016 At 10.00 Am Manchester Town Hall' Available online at: https://www.greatermanchester-ca.gov.uk/meetings/meeting/351/low_carbon_hub (last accessed 17/01/2017).

Low Carbon Hub Board (2016c) 'Proposal for GM to be designated a DEFRA Pioneer City Region' Available online at: https://www.greatermanchester-ca.gov.uk/download/meetings/id/1384/04_defra_pioneercity_region (last accessed 24/01/2017).

Low Carbon Hub Board (2016d) Report of GM Environment Director: Mark Atherton and Patrick Allcorn, DECC 01/04/2016. 'GM Devolution – Energy Update' available online at https://www.greatermanchester-ca.gov.uk/download/meetings/id/775/8_devolution_-_energy_update (last accessed 17/01/2017).

Low Carbon Hub Board (2016e) Report 11 – 'Community Energy' Report of Andrew Hunt, Strategy Partnerships & Policy Manager (Oldham MBC) – Available online at: https://www.greatermanchester-ca.gov.uk/download/meetings/id/1089/download_the_reports (last accessed 24/01/2017).

Low Carbon Hub (2016) Low Carbon Fund' Available Online at: https://www.greatermanchester-ca.gov.uk/info/20035/low_carbon_fund (last accessed 17/01/2017).

Manchester A Certain Future Stakeholder Steering Group (2013) Manchester A Certain Future: Our Collective Action on Climate Change Update 2013. Manchester City Council. March 2013. Available online at: http://www.manchesterclimate.com/sites/default/files/MACF%20Update%202013_1.pdf (last accessed 13/01/2017).

Manchester A Certain Future (2016) 'Manchester A Certain Future: Annual Report'. Available Online from: http://www.manchesterclimate.com/sites/default/files/MACF%20Annual%20Report%202016_0.pdf (last accessed 03/05/2017)

Manchester City Council (2009) 'Manchester Climate Change Call to Action Full Report: January 2009' Available online at: http://www.manchesterclimate.com/sites/default/files/Mcr%20Climate%20Change%20Call%20to%20Action.pdf (last accessed 16/01/2017).

Manchester City Council (2012) 'Manchester's Economy in the context of Environmental Sustainability' Item 5: Economy Scrutiny Committee – 20 June 2012. Available online from: http://www.manchester.gov.uk/meetings/meeting/1830/economy_scrutiny_committee (last accessed 25/01/2017).

Manchester City Council (2013) 'Investing in Green Growth for Greater Manchester' Report of Mark Atherton GM Director of Environment to MCC Economy Scrutiny Committee 22/05/2013. Item 6. Available online at: http://www.manchester.gov.uk/download/meetings/id/15119/6_investing_in_green_growth_for_greater_manchester (last accessed 16/01/2017).

Manchester City Council (2016) Our Manchester: The Manchester Strategy. Available online at: http://www.manchester.gov.uk/mcrstrategy (last accessed 13/01/2017).

Manchester Climate Monthly (2014) *'Interview with Greater #Manchester housing retrofit etc. lead officer! #climate #GreenDeal etc.'* 26/03/2014 Available online at: https://manchesterclimatemonthly.net/2014/03/26/interview-with-greater-manchester-housing-retrofit-etc-lead-officer-climate-greendeal-etc/ (last accessed 31/01/2017).

Midas (2106) Energy and Environment – http://www.investinmanchester.com/why-manchester/industry-strengths/energy-environment (last accessed 18/01/2017)

New Economy (2013) Integrated GM Assessment Environment Evidence Base Available Online from: http://www.neweconomymanchester.com/publications/2013-integrated-greater-manchester-assessment (last accessed 3/05/17).

New Economy (2014) Integrated Greater Manchester Assessment Transport Evidence Base. Available Online at: http://neweconomymanchester.com/media/1584/igma-transport-evidence-base-final-may-2014.pdf Last Accessed 07/12/2016.

New Economy (2016) Greater Manchester Key Facts. Available from: www.neweconomymanchester.com

Nicholson, S. (2014) 'ENWORKS' Available online at: https://ec.europa.eu/growth/tools-databases/regional-innovation-monitor/sites/default/files/report/North%20West%20of%20England,%20ENWORKS.pdf (last accessed 02/02/2017).

NOMIS (2015) Labour Market Profile – Greater Manchester' Available online at: https://www.nomisweb.co.uk/reports/lmp/comb/1853882369/report.aspx?town=Manchester#tabidbr (last accessed 12/12/2016).

O'Doherty, M. (2014) 'Greater Manchester goes all retro (fit)' in Energy Housing and Society, Greater Manchester Carbon Hub. Available online at: http://gmlch.ontheplatform.org.uk/article/greater-manchester-goes-all-retrofit (last accessed 31/01/2014)

OFGEM (2017) 'About the RO' Available Online at: https://www.ofgem.gov.uk/environmental-programmes/ro/about-ro (last accessed 23/01/2017).

OFGEM (2017b) 'Low Carbon Networks Fund' Online at: https://www.ofgem.gov.uk/electricity/distribution-networks/network-innovation/low-carbon-networks-fund (last accessed 23/01/2017).

ONS (2014) 'Time Series: GVA UKD3 Greater Manchester Raw per head £. Online at: https://www.ons.gov.uk/economy/grossvalueaddedgva/timeseries/aeq2/ragv (last accessed 05/01/2017).

ONS (2015) City Regions Article. Online at https://www.ons.gov.uk/economy/economicoutputand productivity/output/articles/cityregionsarticle/2015-07-24 (last accessed 15/12/2016).

ONS (2016) Statistical bulletin: Regional gross value added (income approach), UK: 1997 to 2015. Online at https://www.ons.gov.uk/economy/grossvalueaddedgva/bulletins/regionalgrossvalueadded incomeapproach/december2016 (last accessed 05/01/2017).

ONS (2017) 'Gross Domestic Product, preliminary estimate: July to Sept 2016. Online at: 'https://www.ons.gov.uk/economy/grossdomesticproductgdp/bulletins/grossdomesticproductpreliminaryestimate/julytosept2016 (last accessed 05/01/2017).

Ofsted (2014) Meeting Local Skills: The Responsiveness of further education and skills providers in Greater Manchester. Ref 140034 26th Nov 2014. Online at: www.oftsed.gov.uk/resources/140034. (Last accessed 15/12/2016).

Panasonic (2016) 'Soapworks Case Study' Available online at: http://www.aircon.panasonic.eu/IE_en/cases/case/1990/ (last accessed 18/01/2017).

Perchant, E. (2016) 'Manchester Councils Looking To Three-Weekly To Avoid Rocketing Disposal Costs'. Resource 22 June 2016. Available Online at: http://resource.co/article/manchester-councils-looking-three-weekly-avoid-rocketing-disposal-costs-11190 (last accessed 17/01/2017).

Pidd, H. (2017) 'University of Manchester to axe 171 staff amid Brexit concerns' in The Guardian newspaper Wednesday 10th May 2017. Available Online at: https://www.theguardian.com/uk-news/2017/may/10/university-of-manchester-to-axe-171-staff-amid-brexit-concerns?CMP=share_btn_tw (last accessed 15/05/2017).

Quantum 2015 'Community Energy:Generating More than Renewable Energy' a Report for Community Energy England. Available online at: http://www.greenpeace.org.uk/sites/files/gpuk/CEE-Survey-FITs-Impact-pdf.pdf (last accessed 28/04/2017).

Raco, M. (2016) 'State-led Privatisation and the Demise of the Democratic State: Welfare Reform and Localism in an Era of Regulatory Capitalism'. Routledge. London.

Re-heat (2016) Stockport Homes: Biomass district heating. Available online at: http://reheat.uk.com/case-studies/stockport-homes/ (last accessed 9/01/1982)

Renewables First (2016) 'Feed in Tariff for hydro, and other sources of income' – online at https://www.renewablesfirst.co.uk/hydropower/hydropower-learning-centre/feed-in-tariffs-for-hydropower-and-other-sources-of-income/ (last accessed 02/02/2017).

Retro Expo (2017) 'Manchester Eyes Huge Public Building Retrofit Programme' Online at: http://www.retrofit-roadshow.co.uk/news/industry-news/manchester-eyes-huge-public-building-retrofit-programme/ (last accessed 20/01/2017).

RTPI (2012) Royal Town Planning Institute 'Planning for climate change – Guidance for local authorities 'Available online at: http://www.rtpi.org.uk/media/505555/planning_for_climate_change-guidance_for_local_authorities___rtpi_endorsed_l_2012.pdf (last accessed 23/01/2017).

Saddleworth Moor Community Hydro (2016) 'The story so far' Available online at: https://sites.google.com/site/saddleworthcommunityhydro/the-story-so-far (last accessed 20/01/2017).

SMBC (2012) 'Stockport Hydro – Otterspool Weir Hydro Scheme' Available online at: http://democracy.stockport.gov.uk/ieIssueDetails.aspx?IId=11784&PlanId=0&Opt=3 (last accessed 17/01/2017).

SMBC (2015) 'Corporate Leadership Team Meeting: Tuesday, 8 September 2015 – Outcomes Of Energy Efficiency Projects'. Available online at: http://democracy.stockport.gov.uk/mgConvert2PDF.aspx?ID=80718 (last accessed 17/01/2017).

SQW Consulting (2008) 'Evaluation of the ENWORKS NW Minimisation Project A Final Report to NWDA' June 2008 Available online at: http://www.enworksinabox.com/sites/default/files/NW%20Waste%20Minimisation%20-%20Evaluation%20Report%20June%202008_0.pdf (last accessed 02/02/2017).

SQW Consulting (2014) 'Evaluation of Invest NI Sustainable Productivity Programme Final report December 2014' Available online at: http://www.sqw.co.uk/files/2914/2411/8660/sustainable-productivity-evaluation-report-dec-14.pdf (last accessed 02/02/2017).

Steady State Manchester (2016) 'Greater Manchester Spatial Framework – our response. Posted on 23 December, 2016 by The Steady State Manchester team Available online at: https://steadystatemanchester.net (last accessed 25/01/2017).

Stockport Hydro (2013) 'Stockport Hydro Ltd The Otterspool Hydro project: Invitation to Invest' Available online from: https://www.stockport-hydro.co.uk/uploads/Prospectus-180213.pdf (last accessed 02/02/2017).

Stockport Hydro (2017) 'Funding Now available for local projects – Stockport Hydro Environmental Challenge 2017' Online at: http://www.stockport-hydro.co.uk (last accessed 02/02/2017).

Sustainability West Midlands (2010) Good Practice in City Regions Developing the Low Carbon Economy.

Times (2016) '£3bn PFI waste deal heads for scrapheap' The Sunday Times Newspaper. November 13 2016. Available online: http://www.thetimes.co.uk/article/3bn-pfi-waste-deal-heads-for-scrapheap-szxfgqt58 (last accessed 17/01/2016).

The Carbon Co-op. (2010). The Carbon Co-op Manual. Manchester.

TFGM (2011) Greater Manchester's third Local Transport Plan 2011/12 – 2015/16. Available online at: http://www.tfgm.com/journey_planning/LTP3/Documents/Greater_Manchester_Local_Transport_Plan_Core_Strategy.pdf (last accessed 20/01/2017).

TfGM (2011a) Local Transport Plan 3: Figure 1 in Figures – Available online at http://www.tfgm.com/ltp3/Documents/Integrated-Assessments-Figure-1-Transportation-Features.pdf (last accessed 05/01/2017).

TfGM (2014) T2K Investment Sheets: Micro hydroelectric power scheme TfGM (Manchester). Available online at: http://www.tickettokyoto.eu/sites/default/files/downloads/T2K_WP2_Inv20_TfGM_hydroelectric_power.pdf (last accessed 20/01/2017).

TUC (2015) 'TUC Response to Environmental Audit Committee Inquiry. Promoting sustainable development, August 2015' Available Online at: https://www.tuc.org.uk/sites/default/files/TUC%20Response%20to%20EAC%20-%2011%20green%20policies%20cut.doc (last accessed 23/01/2017).

Urbed (2011) 'GM Housing Retrofit Strategy' Available online at: http://urbed.coop/projects/gm-housing-retrofit-strategy (last accessed 31/01/2017).

UK Government (2016) ' HM Government: Government response to the Committee on Climate Change Progress on meeting carbon budgets' October 2016. Available online at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/559954/57204_Unnumbered_Gov_Response_Web_Accessible.pdf (last accessed 29/04/2017).

van den Bent-Kelly, A. (2016) 'Manchester to be carbon neutral by 2050' The Mancunion Monday 11th January 2016. Last Accessed 11/01/2016

Vital Energy (2016) Oldham District Heating Project Overview. Available Online at: http://www.vitalenerginetworks.co.uk/casestudies/oldham-district-heating-scheme/ (last accessed 9/01/16.

List of interviewed persons

Interview 1: GMCA Low Carbon Hub 03/03/2017

Interview 2: Business Growth Hub 09/03/2017

Interview 3: GMCA Low Carbon Hub 09/03/2017

Interview 4: GMCA PDU 10/03/2017

Interview 5: GMCA PDU 10/03/2017

Interview 6: Carbon Co-Op/LA Climate Change 10/03/2017

Interview 7: GMCA Spatial Planning 10/03/2017

Interview 8: GMCA Leader Elected Member for Low Carbon Economy 24/03/2017

ESPON 2020 – More information

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