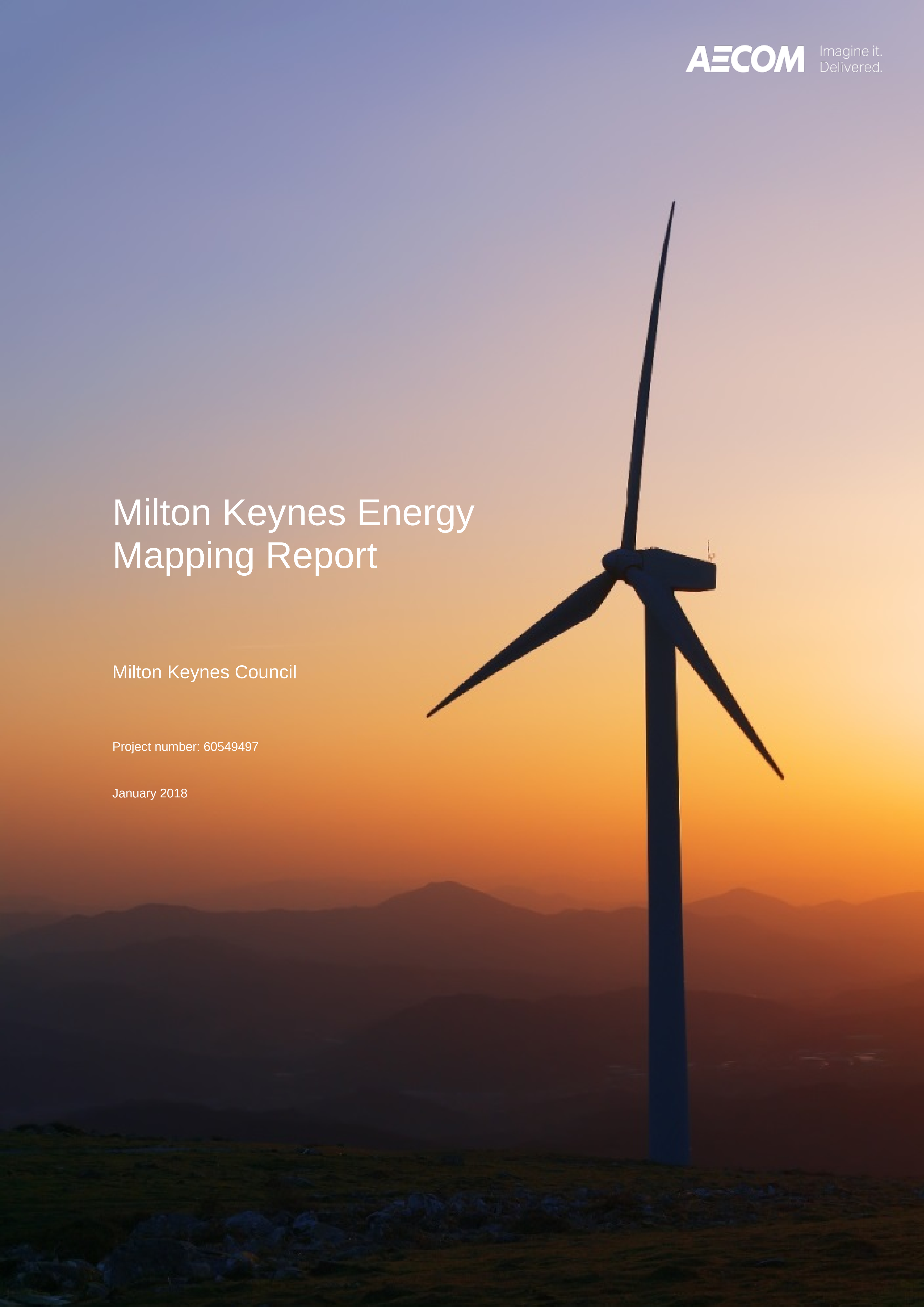

Milton Keynes Energy Mapping Report

Milton Keynes Council

Project number: 60549497

January 2018

Quality information

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Revision History

Revision	Revision date	Details	Authorized	Name	Position
1	02/11/2017	Draft	MT	Matthew Turner	Regional Director
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1. Introduction

Milton Keynes Council (MKC) has commissioned AECOM to provide technical evidence in support of energy and sustainability policy within the forthcoming strategic development plan, Plan:MK.

This report aims to describe the current state of affairs with regards to energy use in Milton Keynes, discusses some of the anticipated changes that may arise in the coming years as a result of the development proposed in Plan:MK, national policy and wider changes, and provides a high-level assessment of potential opportunities for renewable energy deployment in the borough.

The analysis undertaken is intended to deliver a quantitative and spatial understanding of the energy consumption within Milton Keynes and contribute to an evidence base that will support future deployment of renewable, low and zero carbon technologies.

The report is structured as follows:

- **Section 2** – Provides an overview of the relevant policy and regulatory context with regards to carbon emissions and energy efficiency in the built environment;
- **Section 3** – Describes existing fuel consumption in Milton Keynes, broken down by fuel type and sector, in order to establish a baseline demand, and presents a carbon emissions baseline with reference to historic trends and future outlook;
- **Section 4** – Provides an estimation of the projected gas and electricity demand for future developments, referencing key trends that are expected to impact fuel consumption and carbon emissions, including some low-level analysis on potential electric vehicle uptake;
- **Section 5** – Sets out the current level of installed low and zero carbon (LZC) energy generation in Milton Keynes, including renewable technologies and Combined Heat and Power (CHP);
- **Section 6** – Examines opportunities for additional LZC energy generation in Milton Keynes, through a high-level assessment of physical or technical capacities, planning and regulatory constraints, and practical considerations;
- **Section 7** – Draws out key conclusions and briefly summarises the findings of the work;
- **Appendices** – Supply additional information including modelling assumptions and detailed results.

Note: In this report, the primary focus is on energy demands in the built environment. When referencing 'new development', this is taken to include buildings that are supplied by fuel. Unless otherwise stated, the analysis is not intended to address other sectors (e.g. transport, agriculture, etc.) or any associated infrastructure and land use change that may arise from new development.

2. Policy and Regulatory Context

The following section sets out the key policies and regulations relating to energy use and carbon emissions which support low and zero carbon energy generation and energy efficiency in buildings initiatives in Milton Keynes and inform this study.

2.1 International policy

The Kyoto Protocol (1997) is an international treaty with the goal of achieving the "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system".

The Paris Agreement (2016) is an international agreement relating to national level commitments to reducing greenhouse gas emissions. Each country that has signed up to the agreement set nationally determined contributions which specify how much they will reduce their emissions by.

EU Energy Performance of Buildings Directive (EPBD, 2002) is European legislation which requires all EU countries to improve their Building Regulations and introduce energy certification schemes. The 2010 recast EPBD requires countries to move towards new and retrofitted 'nearly zero energy buildings' standards by 2020 (2018 for public buildings). The directive was updated in 2016 to cover additional efficiency and technology in buildings.

EU 2030 Energy Strategy (2014): The 2030 Strategy sets out a framework for the development of climate and energy policies across EU member states. The UK is committed to meeting targets agreed between the European Commission and the Member States to reduce CO_2 emissions by 40% on 1990 levels by 2020.

2.2 National policy

2.2.1 Climate Change Act (2008)

The Climate Change Act sets a legally binding target to reduce UK carbon emissions by 80% by 2050, against a 1990 baseline. The Committee on Climate Change advises the Government on the setting of binding 5-year carbon budgets on a pathway to achieving the 2050 target. The first four carbon budgets covering the period up to 2027 have been set in law. The current budget requires a 29% emissions reduction by 2017, while future budgets require reductions of 35% by 2020 and 50% by 2025.

2.2.2 Energy Act (2011)

The Energy Act provides support for energy efficiency measures to homes and businesses through introduction of the Energy Company Obligations and the Green Deal (now withdrawn). The Act also lays out a requirement for energy efficiency improvements to be made in the private rented sector.

2.2.3 National Planning Policy Framework (2012)

The National Planning Policy Framework was published in March 2012, replacing all previous Planning Policy Statements and guidance. Some of the key paragraphs relating to energy are set out below:

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

94. Local planning authorities should adopt proactive strategies to mitigate and adapt to climate change, taking full account of flood risk, coastal change and water supply and demand considerations.

95. To support the move to a low carbon future, local planning authorities should:

- *plan for new development in locations and ways which reduce greenhouse gas emissions;*
- *when setting any local requirement for a building's sustainability, do so in a way consistent with the Government's zero carbon buildings policy and adopt nationally described standards.*

96. *In determining planning applications, local planning authorities should expect new development to:*
    - *comply with adopted Local Plan policies on local requirements for decentralised energy supply unless it can be demonstrated by the applicant, having regard to the type of development involved and its design, that this is not feasible or viable; and*
    - *take account of landform, layout, building orientation, massing and landscaping to minimise energy consumption.*
97. *To help increase the use and supply of renewable and low carbon energy, local planning authorities should recognise the responsibility on all communities to contribute to energy generation from renewable or low carbon sources. They should:*
    - *identify opportunities where development can draw its energy supply from decentralised, renewable or low carbon energy supply systems and for co-locating potential heat customers and suppliers.*

In paragraph 95, reference to 'the Government's zero carbon buildings policy' now needs to be read in the context of the effective cancellation of 2016 Zero Carbon Homes policy (see below). The nature of 'nationally described standards' was addressed in the Housing Standards Review, (see below).The NPPF retains an emphasis on decentralised energy sources, and links this with viability.

2.2.1 UK Heat Strategy: *'The Future of Heating: Meeting the Challenge'* (2013)

The UK Heat Strategy laid out a strategic framework for the transition to a low carbon heat supply. The strategy highlighted the importance of improving energy efficiency of buildings, and incentivised local authorities to enable the development and expansion of heat networks; for instance, by setting up the Heat Network Development Unit (HNDU).

2.2.1 Home Energy Conservation Act (HECA, new guidance issued 2012)

In 2012, the government provided new statutory guidance relating to the HECA (1995). HECA aims to encourage Local Authorities to plan for CO_2 emission reductions on a borough-wide basis. It required all English authorities with housing responsibilities to prepare an initial report by March 2013 setting out 'the local energy conservation measures that the authority – or group of authorities – consider practical, cost-effective, and likely to significantly improve the energy efficiency of residential accommodation in its area.'

The guidance required Councils to consider how they will use government initiatives such as the Renewable Heat Incentive (RHI) and Feed-in Tariff (FiT) (see below), and how they can facilitate improvements on a street-by-street or area basis.

2.2.2 Housing Standards Review and the Code for Sustainable Homes (2015)

In August 2013 the Department for Communities and Local Government published a Housing Standards Review Consultation. The aim of the review was to rationalise technical building standards by bringing local policies more closely in line with the UK Building Regulations, thereby avoiding duplication or conflicting standards; for instance, in regards to minimum space standards, water use, and CO_2 emissions reductions.

Following the Housing Standards Review (2015), a Written Ministerial Statement[1] was issued which indicated that local authorities are 'not expected' to require energy performance above the levels

[1] https://www.gov.uk/government/speeches/planning-update-march-2015

needed to meet Code for Sustainable Homes (CSH) Level 4 (equivalent to a 19% improvement over 2013 Building Regulations).

On the specific issue of energy performance, the Policy Statement includes the following:

> *Local planning authorities will continue to be able to set and apply policies in their Local Plans which require compliance with energy performance standards that exceed the energy requirements of Building Regulations until commencement of amendments to the Planning and Energy Act 2008 in the Deregulation Bill 2015.*
>
> *This is expected to happen alongside the introduction of zero carbon homes policy in late 2016. The government has stated that, from then, the energy performance requirements in Building Regulations will be set at a level equivalent to the (outgoing) Code for Sustainable Homes Level 4. Until the amendment is commenced, we would expect local planning authorities to take this statement of the government's intention into account in applying existing policies and not set conditions with requirements above a Code level 4 equivalent.*

The Government has now withdrawn the CSH, aside from the management of legacy cases. Therefore, whilst it is currently permissible for policies to include energy performance standards in excess of Building Regulations, this ability may be removed in future through amendment to the Planning and Energy Act 2008. This is of particular relevance to BHCC because CPP1 includes a 19% carbon reduction target for domestic developments (beyond Building Regulations 2013 Part L1A), which is equivalent to CSH Level 4 energy target. This was approved by the Planning Inspector on 5 February 2016 in line with legal powers given to Local Planning Authorities (LPAs) under the Planning and Energy Act 2008.

2.2.3 UK Building Regulations (Part L adopted 2013)

The Building Regulations set the minimum standards for building performance and must be met for a building to be approved for construction. Part L of the Building Regulations focuses on the conservation of heat and power and sets specific requirements for the fabric performance, building services efficiency, overheating and the CO_2 emissions. Regulations are amended as necessary; the current approved version of Part L was issued in 2013.

2.2.4 UK Zero Carbon Homes policy (announced 2006; withdrawn 2015)

In July 2015 it was announced that:

> *"the Government does not intend to proceed with the zero carbon Allowable Solutions carbon offsetting scheme, or the proposed 2016 increase in on-site energy efficiency standards, but will keep energy efficiency standards under review, recognising that existing measures to increase energy efficiency of new buildings should be allowed time to become established".*

This announcement effectively interrupted the previous schedule to update energy efficiency standards for homes every 3 years (with standards having been updated in 2013 and the next update due in 2016) and cancelled the policy for new homes to be zero carbon from 2016.

2.2.5 House of Commons: Written Statement HCWS42 (DCLG, 18th June 2015)

The Secretary of State for Communities and Local Government issued a Written Statement (HCWS42) on 18th June 2015 which included the following direction:

> *When determining planning applications for wind energy development involving one or more wind turbines, local planning authorities should only grant planning permission if:*
>
> - *the development site is in an area identified as suitable for wind energy development in a Local or Neighbourhood Plan; and*
> - *following consultation, it can be demonstrated that the planning impacts identified by affected local communities have been fully addressed and therefore the proposal has their backing.*

2.2.6 Clean Growth Strategy (October 2017)

The UK Clean Growth Strategy sets out the Government's vision for decoupling economic growth from carbon emissions. The strategy includes objectives for the improvement in building energy efficiency (including a target to deliver EPC ratings of C in as many homes as possible by 2035), increased generation of energy from renewable sources, increasing the delivery of clean, smart and flexible power and accelerating the shift to low carbon transport., smart grids and energy storage.

The Clean Growth Strategy in particular recognises the need to deliver low carbon heating, as it is acknowledged that there are technical and cost obstacles to achieving this important outcome:

> *'There are a number of low carbon heating technologies with the potential to support the scale of change needed, including heat pumps, using low carbon gases (such as hydrogen) in our existing gas grid and district heat networks.'*

2.2.7 UK Industrial Strategy (2017)

The Industrial Strategy, published in November 2017, emphasises the need for clean growth in order to boost economic prosperity within the UK. Some of the stated aims of the Industrial Strategy relevant to energy use in the built environment include:

- Increasing the delivery of new homes;
- Decarbonising the heat supply; and
- Lowering emissions from the transport sector.

There is a particularly strong emphasis on supporting electric vehicle uptake, through £400m investment in charging infrastructure and by extending the plug-in car grant. The Strategy also states that, 'After the Grenfell Review, we will update Building Regulations to mandate that all new residential developments must contain the enabling cabling for charge-points in the homes' (p. 145).

2.3 Financial Incentive Schemes

Below is a brief overview of some of the key financial incentive schemes for low and zero carbon energy in the UK. The levels of Government incentives for these technologies have been adjusted repeatedly in recent years and it is reasonable to assume that further changes will occur, e.g.:

- There is likely to be a loss of incentive schemes in the short term due to economic factors and increasing competitiveness of certain technologies, e.g. photovoltaics
- On the other hand, there is a possibility that policy requirements will become more stringent, prompting the introduction of new incentive schemes may be in order to meet difficult carbon reduction targets.

2.3.1 Feed-in Tariff (FiT)

Launched in April 2010, FITs provide a financial incentive for uptake of the following renewable electricity generating technologies:

- Photovoltaics
- Wind
- Micro combined heat and power (CHP)
- Hydroelectric power
- Anaerobic digestion

Tariff rates are adjusted annually and deployment caps were put in place in February 2016. New applications are expected to end in March 2019.

2.3.2 Renewable Heat Incentive (RHI)

The RHI provides a financial incentive for the uptake of the following heat generating technologies:

- Biomass boilers
- Air source heat pumps
- Ground source heat pumps
- Solar thermal collectors

Renewable Heat Incentive is available to support renewable heat delivered to homes and for renewable heat installed to serve non-domestic buildings.

Note that the Clean Growth Strategy (2008) identifies a need to strengthen and reform the RHI in recognition of the difficulty and urgency of decarbonising the UK heat supply.

2.3.3 Energy Company Obligations (ECO)

The 2011 Energy Bill, which made provision for the Green Deal, also provided for an Energy Company Obligation (ECO). The scheme has been updated several times with the latest update in 2017, known as ECO2t. Under the scheme energy companies are obligated to promote and support carbon emissions reductions to customers.

2.4 Local policy

2.4.1 Plan:MK

Plan:MK is Milton Keynes Council's emerging development policy which sets out the Council's approach to planning up to the year 2031. The Proposed Submission was approved in October 2017 and it is expected to be adopted in winter 2018, when it would replace both the current Core Strategy (2013) and the previous Local Plan (2005).

Plan:MK emphasizes MKC's commitment to sustainability, for instance via the strategic objectives:

To mitigate the Borough's impact on climate change and reduce carbon dioxide emissions through:

- *Locating development away from areas of flood risk and significant biodiversity value*
- *Promoting community energy networks and strategic renewable energy developments*
- *Reducing waste generation and increasing the amount of material recycled*
- *Sustainable transport initiatives*

Some of the key *'Proposed Submission Plan:MK'* (October 2017) policies relating to sustainability and energy are summarised below. For clarity, they have been split into policies which derive directly from the 2013 Core Strategy policies and those that build upon it.

Policies originating in Milton Keynes Core Strategy (2013)

Policy MK1: Development proposals will be appraised with presumption in favour of sustainable development, in line with the National Planning Policy Framework. The Council will take a pro-active approach to ensure proposals which benefit the borough economically, socially and environmentally are approved without delay.

Policy DS1: Development will be prioritised by the 'Settlement Hierarchy' which aims to concentrate development in the most sustainable locations, so as to take advantage of existing facilities and public transport links.

Policy SD8: Four 'Strategic Reserve Areas' have been allocated for development as sustainable urban extension to Milton Keynes:

- SR1 – Land East of Fen Farm
- SR2 – Glebe Farm
- SR3 – Eagle Farm
- SR4 – Church Farm

These sites, together with other strategic areas, are anticipated to provide around 2,900 homes whilst maximising opportunity for sustainable travel patterns.

Note that Plan:MK identifies additional strategic allocations including Milton Keynes East and South East, South Caldecotte, and Easton Leys; these are shown in Figure 1.

Policy SC3: Low carbon and renewable energy schemes will be attributed significant weight in their favour, and will be supported where it can be demonstrated that there will not be any significant negative social, economic, or environmental impacts associated with them. Large developments (over 100 homes or non-resident developments of over 1000 sqm) and those in proximity to existing CHP or local energy networks will be expected to connect to these unless it can be shown that connection is not viable or greater carbon savings can be achieved through alternative means.

New/additional policies

Policy HN1: Net densities for proposals should fall within 150-500 dwellings per hectare in Central Milton Keynes and 150-250 dwellings per hectare in the area covered by the Central Bletchley Urban design framework.

Policy SD1: […] development should adopt passive design measures to reduce the energy demand for heating, lighting and cooling, create comfortable and healthy environments, and be responsive to predicted changes in climate. […]Consider the use of community energy networks in line with Policy CS14 ‘Community Energy Networks and large Scale Renewable Energy Schemes’ (see below).

Policy SD4: Smart, shared and sustainable mobility programmes will be supported, along with the prioritisation of pedestrian and cycle accessibility and the integration of public transport.

Policy CT1: The Council will promote low or zero carbon means of transport and the development of a sustainable pattern of development which minimises the need to travel and reduces dependence on private vehicles.

Policy CT5: […] We need to tackle climate change through a variety of approaches, such as: high standards of energy efficient design and construction, renewable energy schemes, efficient use of scarce resources, effective public transport and other low carbon travel options such as electric vehicles, car sharing, cycling and walking.

Policy SC1: […] development proposals should implement the Energy Hierarchy in the design of new buildings by prioritising fabric first, passive design and landscaping measures to minimise energy demand. Opportunities to provide energy storage and demand management must be reviewed.

Development proposals for 11 or more dwellings and non-residential development with a floor space equal or greater to 1,000 sqm must […] Provide on-site renewable energy generation or connection to an existing renewable or low carbon community energy scheme

Policy SC4: Planning permission for low carbon and renewable energy sources will be granted unless there is significant pollution to the local area or an unacceptable visual impact. Proposals for large scale renewable energy in the open countryside should be informed by a satisfactory landscape and visual impact assessment. Wind energy proposals must meet specific requirements and permission will only be granted in a Neighbourhood Development Plan or other Development Plan document, following consultation with local residents.

2.4.2 Supplementary planning documents

Wind Turbines SPD (2013) outlines some key health, safety and amenity considerations that MKC will use when assessing wind energy proposals. These are discussed in Section 6.1.1.

Sustainable Construction SPD (2006) was issued in support of the 2006 Local Plan. It provides guidance on the sustainable construction measures that are required by the Local Plan (2006) Policy D4 which covers topics such as energy efficiency and renewable energy.

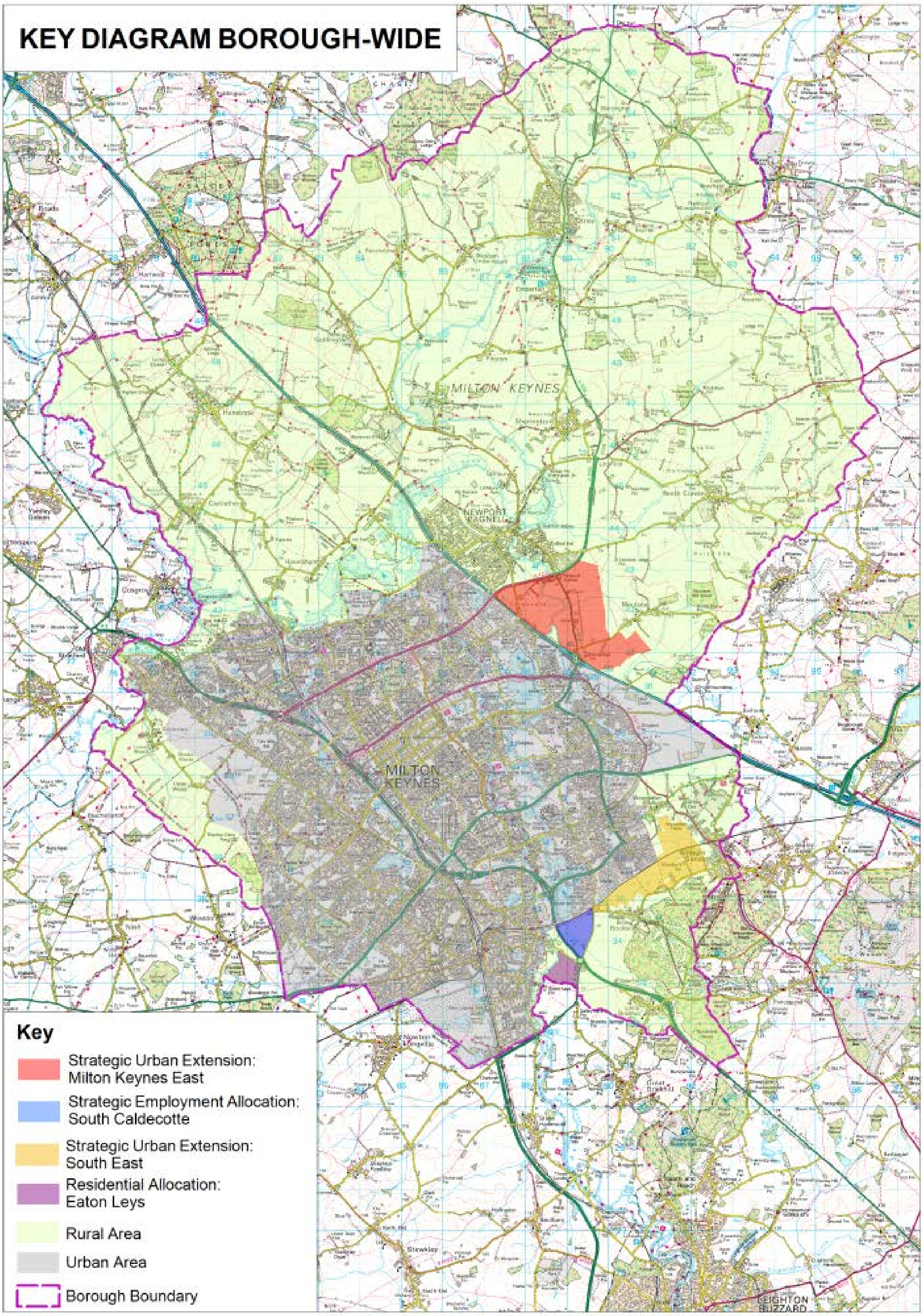

Figure 1. Draft strategic allocations as per the *'Proposed Submission Plan:MK'* (October 2017)

3. Baseline energy demand and CO_2 emissions

This section describes the baseline energy consumption and CO_2 emissions from the building stock and transportation sector in Milton Keynes. A breakdown is provided by fuel type, sector, and building type, for Milton Keynes as a whole, and by LSOA or MSOA (where information is available).

3.1 Energy demand

Fuel consumption figures were taken from the Department of Business, Energy and Industrial Strategy (BEIS) publication: '*Sub-national total final energy consumption statistics: 2005-2015'* (published in 2017).[2] 2015 is the most recent year for which data is available. The dataset includes a breakdown of emissions by sector as follows: industrial & commercial, domestic and transport. Fuel types included are: gas, electricity, coal, petroleum, manufactured fuels and bioenergy & waste.

For further information, see the *'Sub-national methodology and guidance booklet 2016* (BEIS, December 2016).[3]

Table 1 shows that total fuel consumption in Milton Keynes was approximately 5,650 GWh in 2015. As illustrated in Figure 2, the largest portion of fuel consumed was petroleum (40%), with gas and electricity accounting for 33% and 25%, respectively. Other fuels, including bioenergy & waste, coal, and manufactured fuels make up the remaining, less than 3%.

Table 1: Energy consumption by sector and fuel type in GWh per year

Fuel Consumption (GWh)	Industrial & Commercial	Domestic	Road transport	Rail	Bioenergy & waste	Total
Gas	615	1,233	-	-	-	1,847
Electricity	995	412	-	-	-	1,407
Coal	5	12	-	17	-	17
Petroleum	96	33	2,097	4	-	2,230
Manufactured fuels	1	11	-	-	-	11
Bioenergy & waste	-	-	-	-	137	137
Total by sector	1,712	1,700	2,097	21	137	5,650

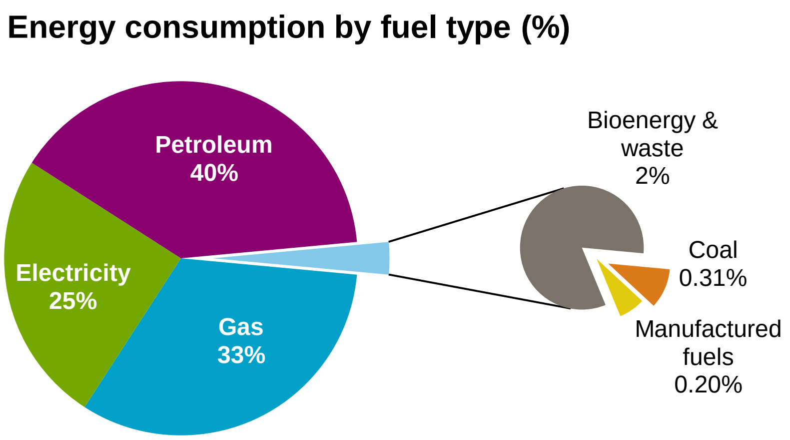

Figure 2: Fuel consumption by fuel type

[2] https://www.gov.uk/government/statistical-data-sets/total-final-energy-consumption-at-regional-and-local-authority-level
[3] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/609332/Sub-national_Methology_and_Guidance_Booklet_2016.pdf

Figure 3 depicts the breakdown of fuel consumption by sector, based on the information provided in *Table 1*. Note that bioenergy & waste is not reported by sector and further details of fuel type for this category could not be sourced.

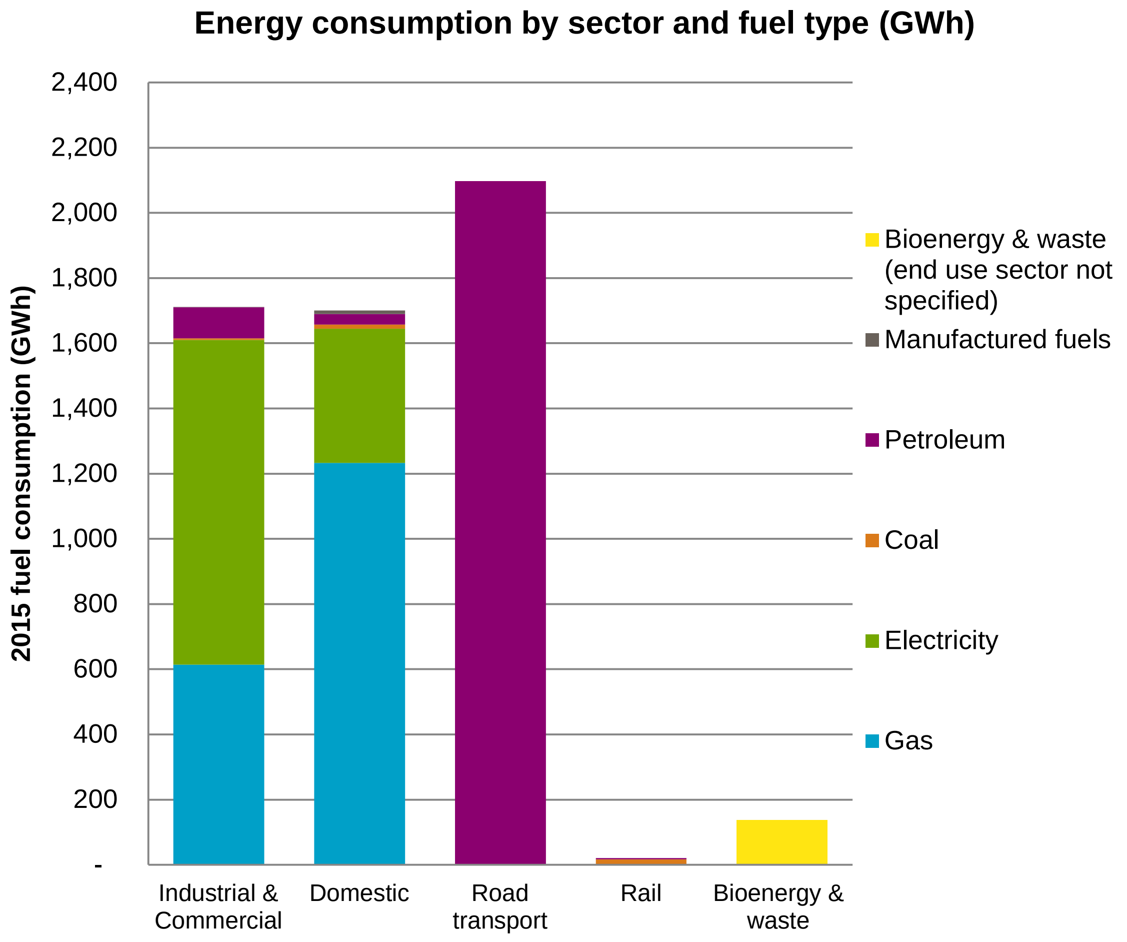

Figure 3: Energy consumption by sector and fuel type

Figure 3 indicates that petroleum consumption is primarily associated with road transport, which is the sector with the single largest energy consumption. Electricity use in road transport, e.g. for electric vehicles, is not represented in the dataset, possibly because it is relatively small, and possibly because it is not always metered separately.

After transport, gas and electricity account for the majority of the remaining energy demand in Milton Keynes. Domestic consumption provides the larger demand for gas, at approximately 67% of the total, with the inverse true of electricity, where non-domestic consumption accounts for approximately 71% of sales.

Note that gas and electricity consumption figures are based on sales data. The BEIS methodology[3] assumes that domestic gas customers are those consuming up to 73,200 kWh annually, the remainder classed as non-domestic. For electricity, data is divided between domestic and non-domestic categories according to the meter's profile type; consumption above 100,000 kWh is automatically assumed to be non-domestic; and consumption levels between 50,000 kWh and 100,000 kWh are processed by address to check for non-domestic labelling (i.e. 'plc'; 'ltd').

3.2 Mapping fuel consumption in Milton Keynes

National government Lower and Middle Level Super Output Area (LLSOA and MLSOA) data on gas and electricity consumption has been used to map energy usage across Milton Keynes.

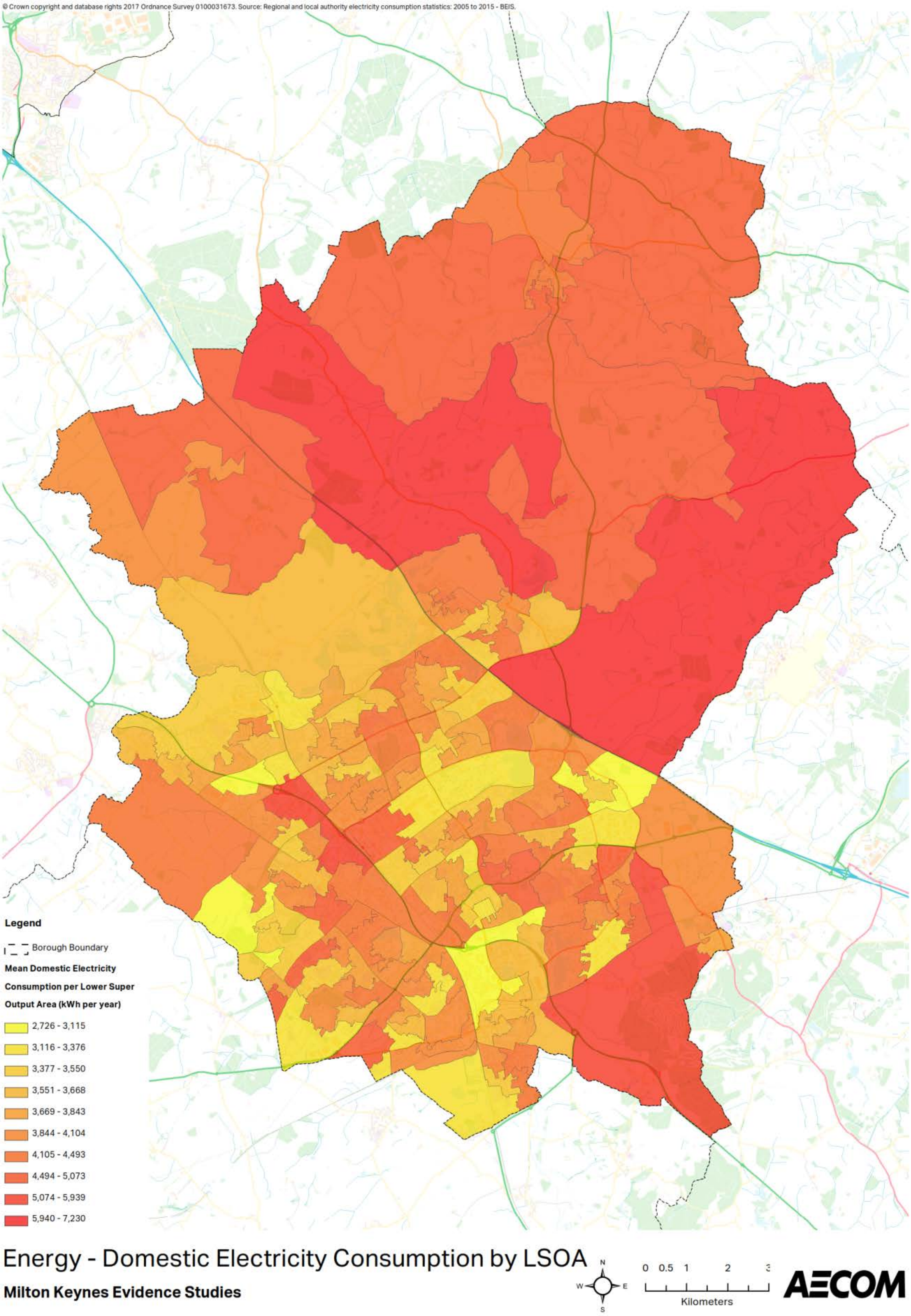

Figure 4 shows the domestic electricity demand by LSOA.

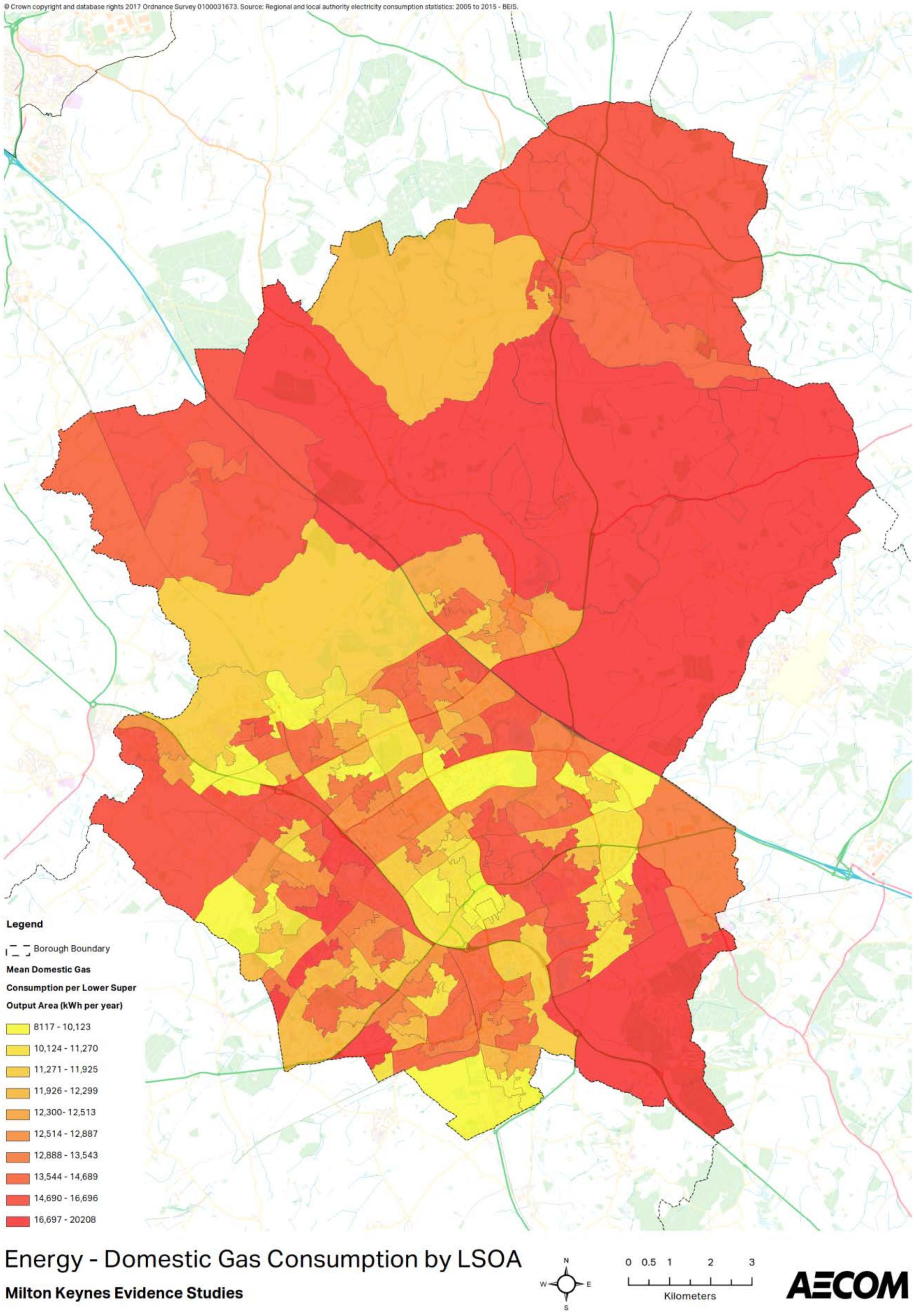

Figure 5 shows the domestic gas demand by LSOA.

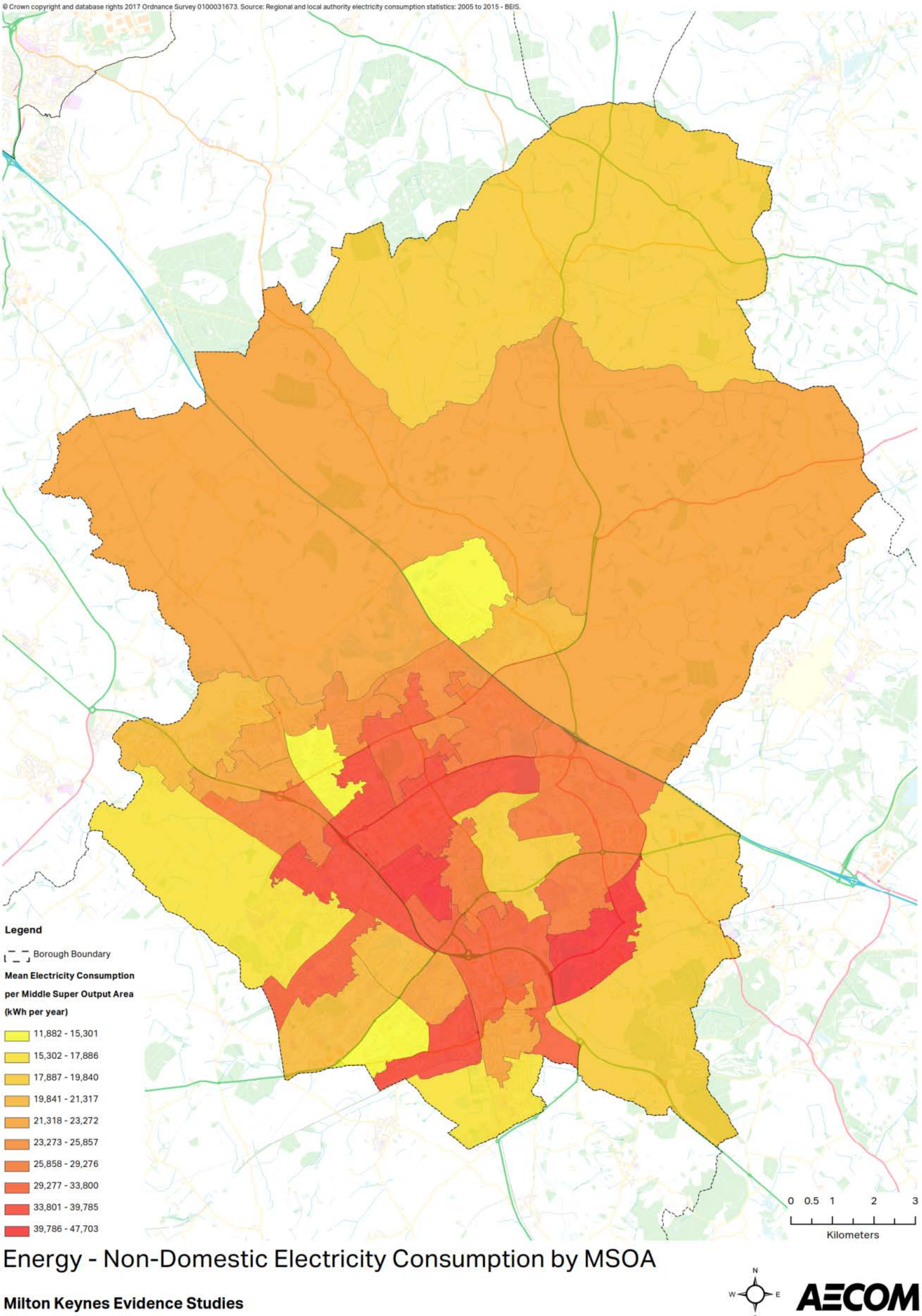

Figure 6 shows the non-domestic electricity demand by MSOA.

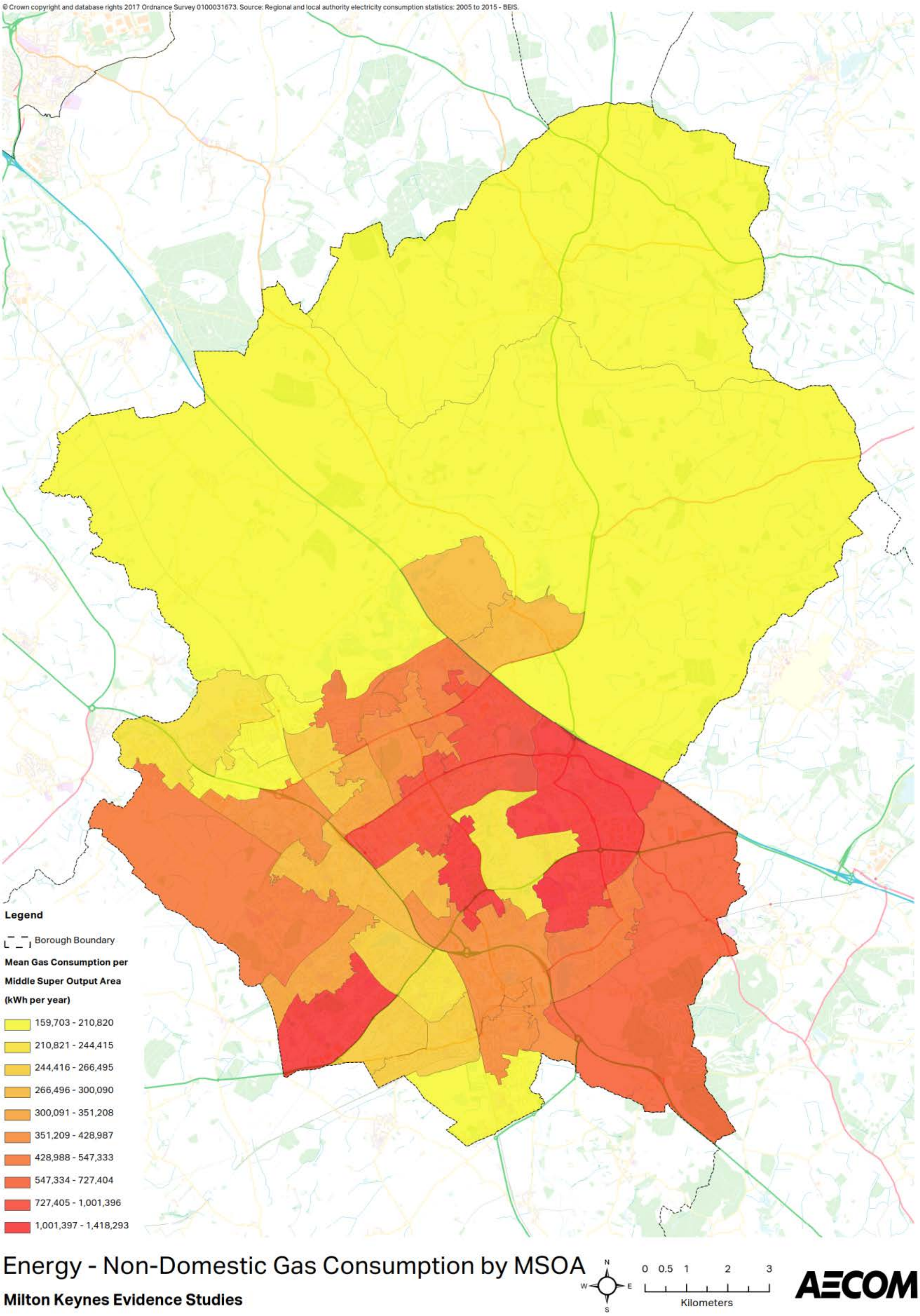

Figure 7 shows the non-domestic gas demand by MSOA.

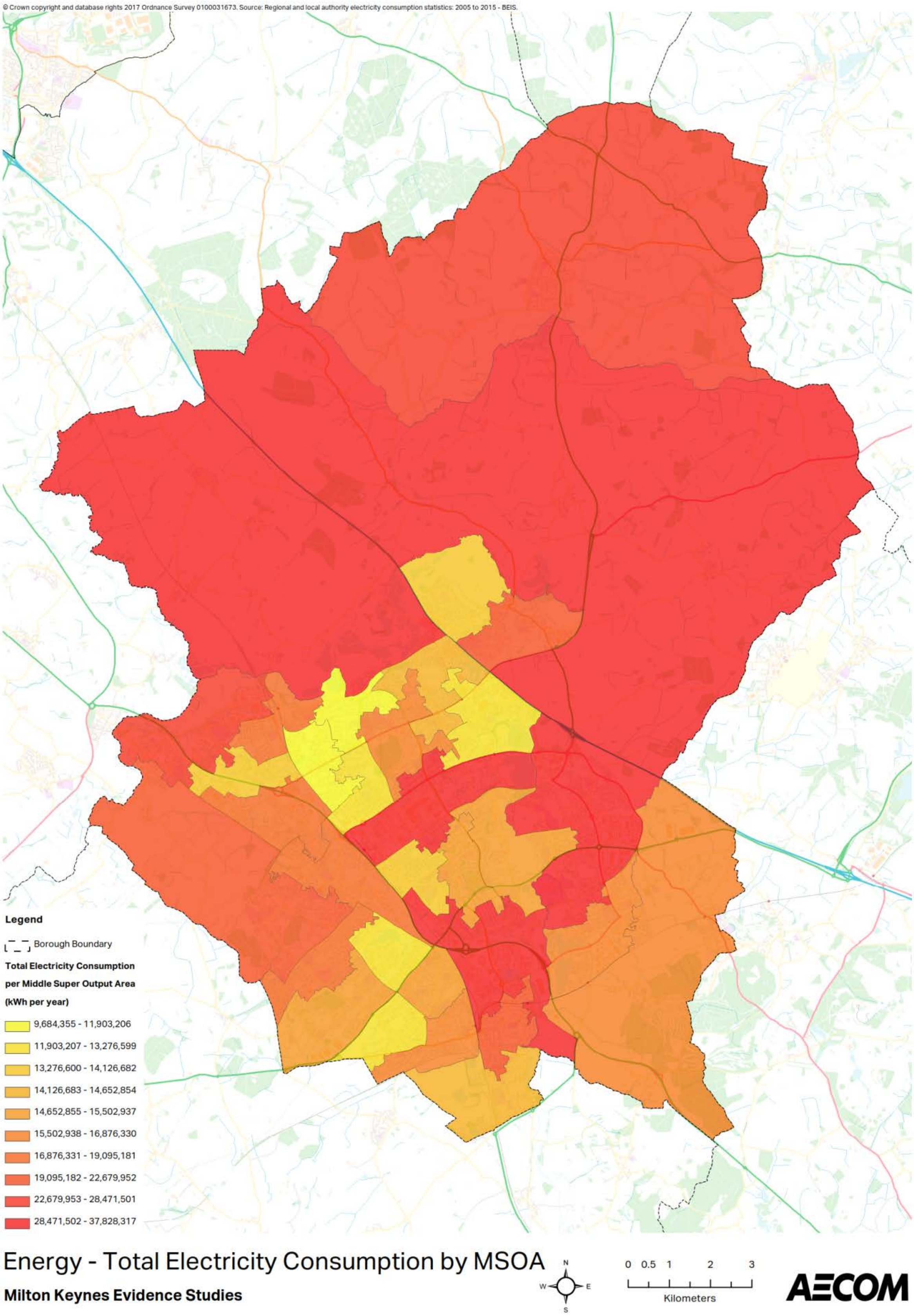

Figure 8 shows the total electricity demand by MSOA.

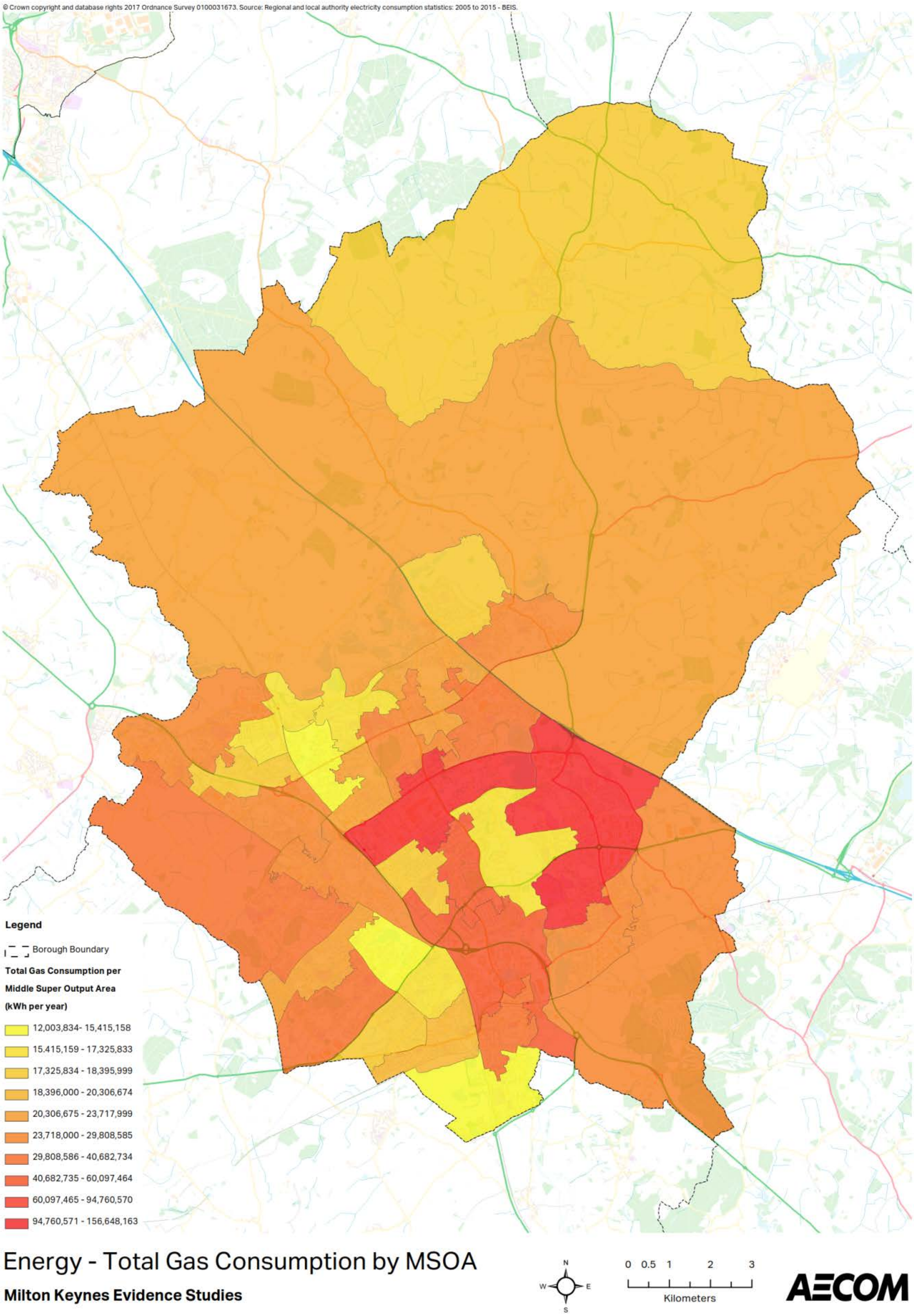

Figure 9 shows the total gas demand by MSOA.

3.3 CO_2 emissions

3.3.1 Current levels

CO_2 emission estimates for the area were taken from *'UK local authority and regional carbon dioxide emissions national statistics: 2005-2015'* (published in 2017).[4] 2015 is the most recent year for which data is available. The dataset includes a breakdown of emissions by sector as follows: industrial & commercial, domestic and transport. As well as electricity and gas emissions, the data provides emission levels from agriculture, although details of the sources is not specified, and from a category of 'other fuels'. For clarity, and in order to align these results as much as possible with the energy consumption figures, 'agriculture' has been included in the category of 'non-domestic' emissions.

For further information, see the *'Technical Report: Local and Regional Carbon Dioxide Emissions Estimates for 2005-2015 for the UK'* (BEIS, June 2017).[5]

The 2015 data breakdown for Milton Keynes is shown in Table 2, and is used as an emissions baseline in this study. The data has also been used to track a historical trend for emissions in Milton Keynes for the decade 2005 – 2015 (Figure 12 and Figure 13).

Table 2: Milton Keynes carbon emissions in 2015

Fuel/sector	Industry & Commercial ($ktCO_2$)	Domestic ($ktCO_2$)	Transport ($ktCO_2$)	Total (unadjusted) ($ktCO_2$)	Total (adjusted) ($ktCO_2$)
Electricity	343.2	142.0	-		
Gas	115.6	232.0	-		*LULUCF adjustment: -3.6 $ktCO_2$*
Large installations	-	-	-		
Other fuels	32.2	12.2	-		
Agriculture	5.6	-	-		
TOTAL	**496.7**	**386.3**	**585.9**	**1,468.9**	**1,465.3**
Percent of total	*33.8%*	*26.3%*	*39.9%*		

The BEIS estimate for total CO_2 emissions in the Local Authority area of Milton Keynes in 2015 is 1,465 $ktCO_2$. This total consists of the industrial & commercial, domestic and transport values shown in Table 2, minus net land use, land use change and forestry (LULUCF) emissions. From this, the per capita emission level is taken to be 5.6 tCO_2, slightly lower than the average for England during this period (5.9 tCO_2).

As shown in Figure 10 and Figure 11, the majority of emissions in Milton Keynes are attributed to transportation (39.9%), followed by industrial and commercial sectors (33.8%). Domestic emissions account for the smallest proportion (26.3%).

[4] https://www.gov.uk/government/statistics/uk-local-authority-and-regional-carbon-dioxide-emissions-national-statistics-2005-2015

[5] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/623020/2005_to_2015_UK_local_and_regional_CO2_emissions_technical_report.pdf

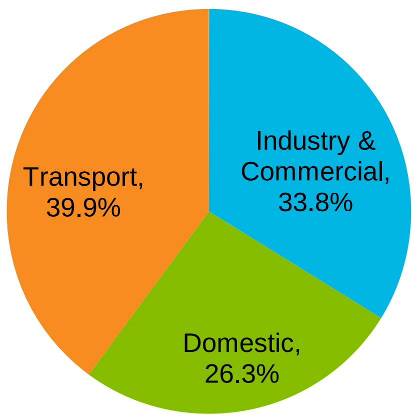

Figure 10: Carbon emissions by sector (%) 2015 data

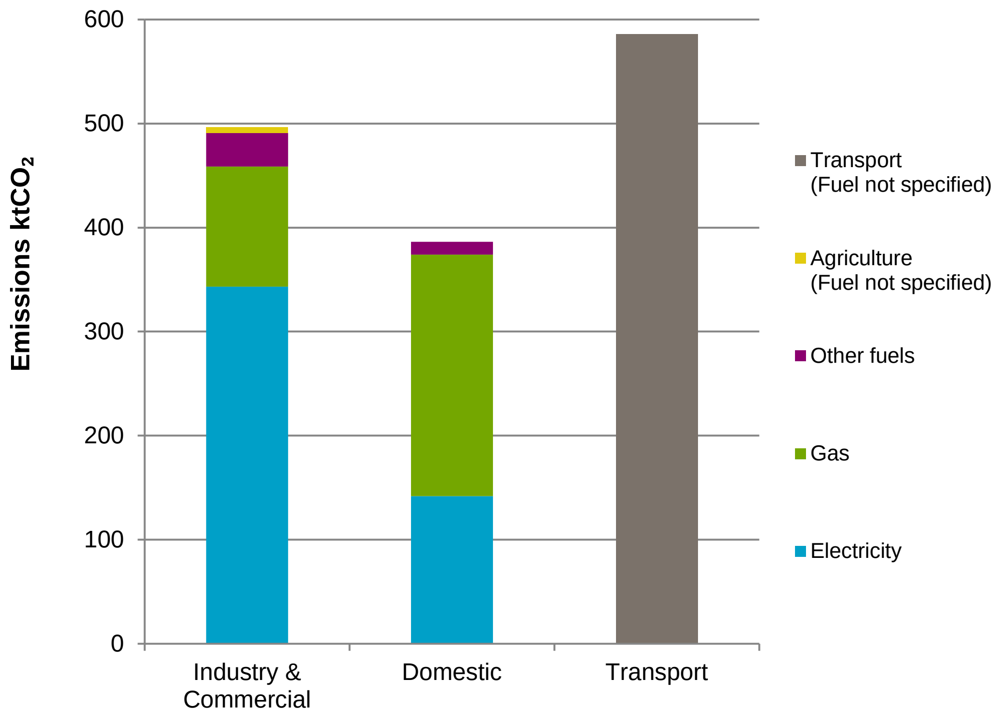

Figure 11: Carbon emissions by sector and fuel type ($ktCO_2$) 2015 data

3.3.2 Historic emissions trends

On aggregate, as shown in Figure 12, total CO_2 emissions in Milton Keynes have fallen by nearly 25% between 2005 and 2015. This is the result of changes in fuel consumption, and changes in the carbon intensity of the fuels consumed. Note that because carbon emissions statistics use a different methodology and include some point-source estimates (e.g. large industrial consumers), these may not necessarily align directly with fuel consumption statistics given.

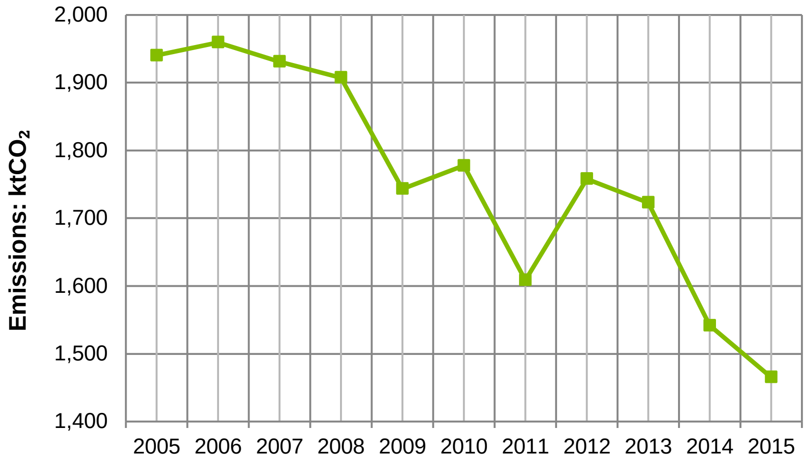

Figure 12: Historical emission trend in Milton Keynes 2005-2015

As shown in Figure 13, CO_2 emissions associated with domestic and non-domestic buildings in Milton Keynes have been falling on average over the last decade. Transport emissions, on the other hand, have been more stable at around 550-600 $ktCO_2$. This likely relates, in part, to the fact that emissions from grid electricity have exhibited more variability (i.e. decarbonised) than emissions from petroleum.

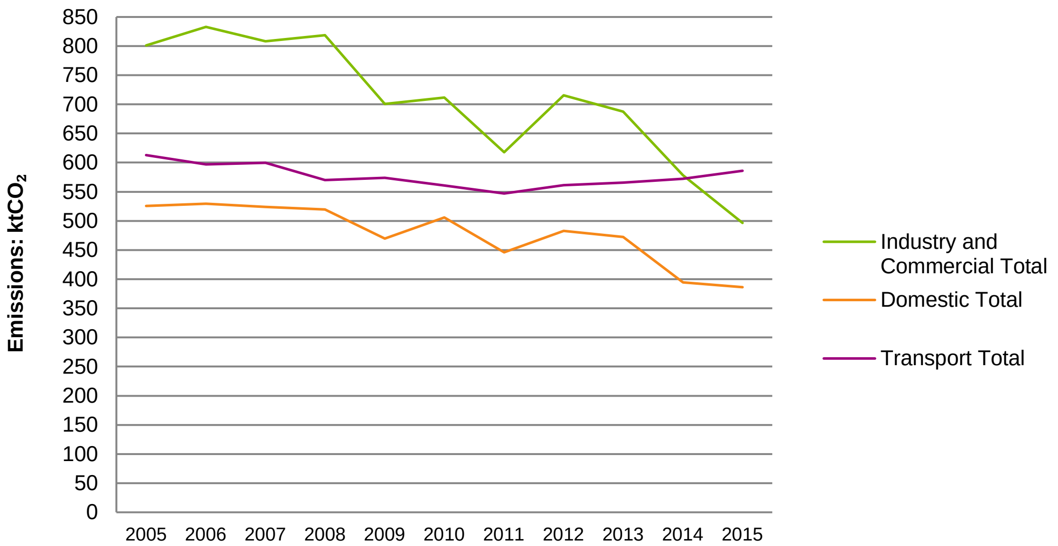

Figure 13: Historical emission trend by sector

These following issues are important when assessing the results presented above:

- Fuel emissions factors are significantly determined by the fuel input to the grid. As a result, changes in carbon emissions do not necessarily reflect changes in fuel consumption or energy efficiency.
- Similarly, single-year snapshots and year-to-year changes relate to factors such as weather and should therefore be interpreted with caution. To give another example, if a single large industrial consumer goes offline, fuel consumption might appear to drop significantly, even if the average consumer increases their fuel consumption.

4. Energy demand and CO_2 emissions projections

This section describes the potential future gas and electricity demand in Milton Keynes, and the changes that may arise due to new domestic and non-domestic development. Then, there is a primarily qualitative discussion of some of the key trends that may affect these estimates, including some high-level analysis on electric vehicle uptake and its impacts.

4.1 Methodology and assumptions

4.1.1 Domestic development

The projected number of new dwelling completions is shown in Figure 14 below. The *'Strategic Housing Market Assessment'* (February 2017) (SHMA) suggests that a total of 26,500 dwellings would be added over this period. Annual completion levels from 2017 to 2026 are based on the *'Assessment of Five Year Land Supply'* (July 2017) report, with an average of 1,135 dwellings allocated per annum thereafter. It is noted that *'Proposed Submission Plan:MK'* (October 2017) allocates land for approximately 29,000 dwellings and therefore a land supply buffer of 3,500 dwellings (roughly 9% annually) has been included to bring the SHMA figures into alignment.

From the draft submission *'Proposed Submission Plan:MK'* (October 2017), pg. 15:

> ***Regeneration:*** *additional homes may be provided through the regeneration of the seven priority areas under the Council's Regeneration Programme, led by Your:MK. The time scales for the regeneration programme and its delivery mean that only limited information on the potential for this to provide extra dwellings is currently available.*

These additional homes could, in principle, provide an opportunity to deliver more carbon efficient buildings with a lower environmental impact than are currently being built. However, due to lack of information this has been excluded from the analysis.

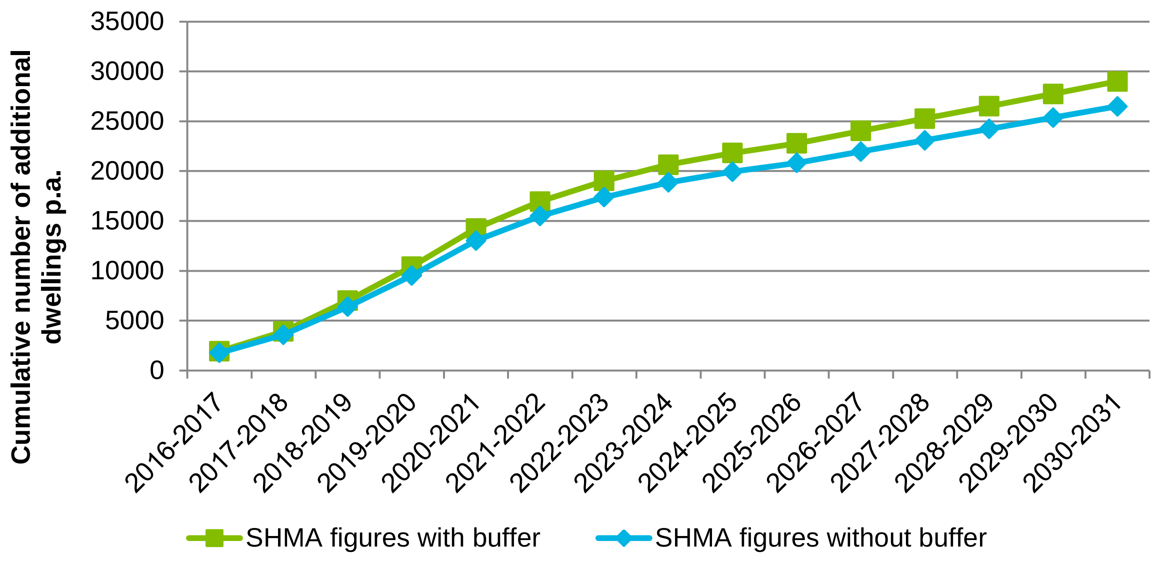

Figure 14: Milton Keynes Council Yearly Housing Commitments, 2017-2031

Projected energy demands are based on the above new dwelling completions, and the median domestic gas and electricity demand in Milton Keynes as of 2015 (the most recent year for which data is available). Domestic CO_2 emissions have been estimated by multiplying the projected energy demand by fuel emission factors for gas and electricity as provided in the BEIS publication, '*Conversion factors 2017'* (August 2017).[6]

[6] https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2017

4.1.2 Non-domestic development

Energy demand projections for non-domestic buildings were based on projected changes in the total floor area per building use category, as follows:

- **Floorspace sources:** Multiple Milton Keynes Council sources were used to gather data on the existing and future floor areas for non-domestic buildings. This included data on non-residential development commitments with planning permission from the Council's Employment Commitments Monitoring System (ECMS) Employment floorspace completions for 2004-2017 and the *'Economic Growth and Employment Land Survey 2016-2031'* (GVA, June 2017).
- **Forecast of change in floorspace by 2031:** The ECMS extract, correct as of 30th September 2017, provided the near future net gain in floor area for buildings with planning permission that were either under construction, or not yet started. Buildings were listed by use category. The net gain for each category was averaged over a three year period (2018 to 2020) to estimate the additional floor area per annum through 2031.
- **Net change in energy:** CIBSE Guide F (2012) and CIBSE TM46 (2008) energy consumption benchmarks were used to calculate the additional electricity and fossil fuel demand by 2031. These benchmarks provide a kWh/m^2 value of energy consumption for both electricity and fossil fuels, depending on the type of building. The values used are the 'good practice' figures, as these should be indicative of consumption levels for modern buildings. Multiplying the additional total floorspace (m^2) with the respective benchmark gives the increase in energy demand per use category (kWh).

4.2 Results and discussion

Table 3 summarises the projected changes in electricity and gas demand, and carbon emissions, associated with new development in Milton Keynes, based on the assumptions listed above.

Table 3: Projected changes in gas and electricity consumption and CO_2 emissions

	Electricity (GWh)	Gas (GWh)	Total (GWh)	CO_2 emissions ($ktCO_2$)[7]
Domestic				
Baseline - 2015	412	1,233	1,645	386
Projections - 2031	526	1,563	2,089	487
% increase	28%	27%	27%	26%
Non-Domestic				
Baseline - 2015	995	614	1,610	497
Projections - 2031	1,163	695	1,858	537
% increase	17%	13%	15%	8%
TOTAL				
Baseline - 2015	1,407	1,847	3,255	883
Projections - 2031	1,689	2,258	3,947	1,024
% increase	20%	22%	21%	16%

Projected annual changes in domestic gas and electricity demand are shown in Figure 15.

[7] Carbon emission factors were based on BEIS *'Conversion factors 2017'*

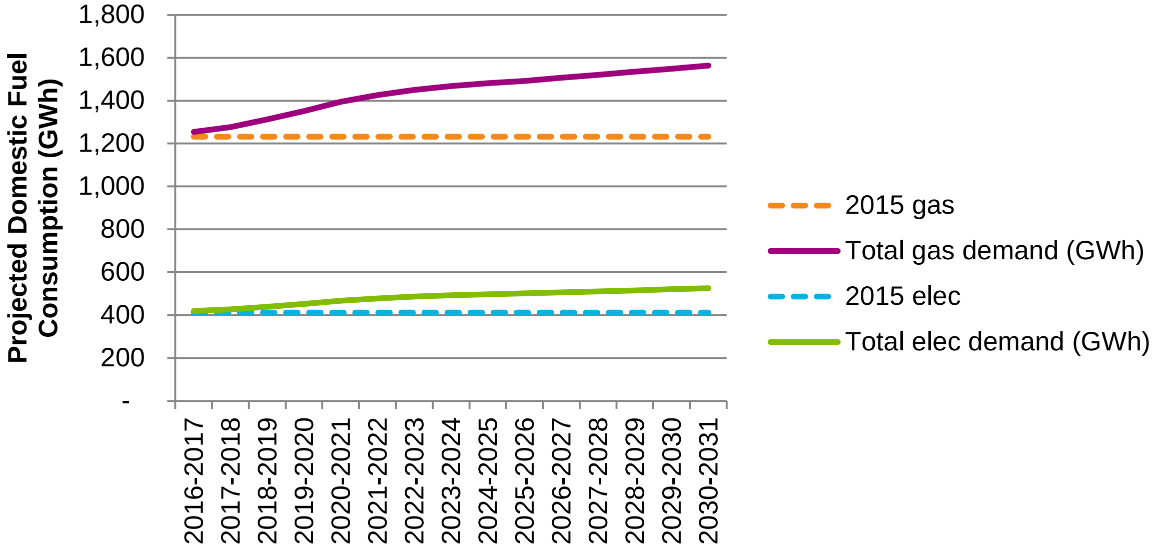

Figure 15: Domestic electricity and gas demand projections

The figures presented above assume that the above housing numbers and non-domestic floor space requirements are delivered on time and in line with projections, and should therefore be interpreted with some caution. The analysis also assumes that the energy consumption patterns of existing buildings are predictive of those in new and future buildings. In reality, it is anticipated that the energy demands of an average new building would be lower than the existing stock due to a variety of factors including: higher energy efficiency standards; a higher proportion of flats compared to houses; greater site density; greater opportunities to utilise passive design strategies such as optimising site layout and designing to incorporate renewable and low-carbon technologies from the outset; and the introduction of energy demand reduction and management strategies. The figures are therefore likely to represent a worst-case scenario in regards to increases in energy consumption.

4.3 Future trends

This section briefly discusses some key trends which have not been assessed quantitatively, but are likely to impact future energy demands and CO_2 emissions.

4.3.1 Energy efficiency improvements

The impacts of new development on energy consumption will depend, at least in part, on the energy efficiency of the new building fabric and services.

It is difficult to anticipate future changes in the energy efficiency standards when one considers, for instance, the introduction of the Zero Carbon Homes policy (see Section 2.1.5) in 2006 and its last-minute withdrawal in 2015, just before it was due to come into full effect. There is also considerable uncertainty surrounding the UK's future adherence to the EU Energy Performance of Buildings Directive. Nonetheless, broadly speaking, in order to meet the legally binding targets of the Climate Change Act 2008 it is likely that energy efficiency standards will improve as time goes on.

4.3.2 The performance gap

The operational energy consumption of a building depends on a large number of factors, ranging from the quality of construction, to occupant habits and preferences. As a result, there is often a gap between the design energy performance of a building and its actual energy performance. In some instances the discrepancy can be large, with buildings consuming much more or much less energy than predicted. This is known as the performance gap.

Within the construction industry, knowledge of how to reliably deliver more efficient buildings is improving. It is nonetheless worth noting that stricter energy efficiency standards would not necessarily correspond to changes in energy demand as, at this time, there is no guarantee that the designs will be effectively delivered in reality. This issue is being actively addressed by the construction industry and it is anticipated that in the future the performance gap due to quality of construction will reduce.

4.3.3 Decarbonised electricity grid

The emissions from grid supplied electricity are expected to fall progressively over time in response to a changing mix of generation capacity on the electricity network, including less coal, more renewable energy and a potential renewal of baseload nuclear power stations.

Projected fuel emissions in the HM Treasury/BEIS *'Green Book Supplementary Guidance: Toolkit for valuing changes in greenhouse gas emissions'* (2017) suggest that the CO_2 emissions for domestic grid electricity could fall from the current levels of approximately 0.35 $kgCO_2$/kWh to 0.13 $kgCO_2$/kWh by 2030 (henceforth referred to as the 'IAG' scenario).[8] Thus, even if electricity consumption increases as a result of future development, it is possible that the resultant CO_2 emissions could decrease.

This is illustrated in Figure 16 below, which shows the CO_2 emissions arising from domestic electricity consumption only. Baseline 2015 missions are shown as a flat line. The rising series and falling series both assume that domestic electricity consumption will increase as per Section 4.2, but the former series uses a constant fuel factor of 0.35 and the latter uses IAG projected fuel factors for electricity. The chart demonstrates how domestic CO_2 emissions in Milton Keynes could be considerably more sensitive to grid decarbonisation than new dwelling completions.

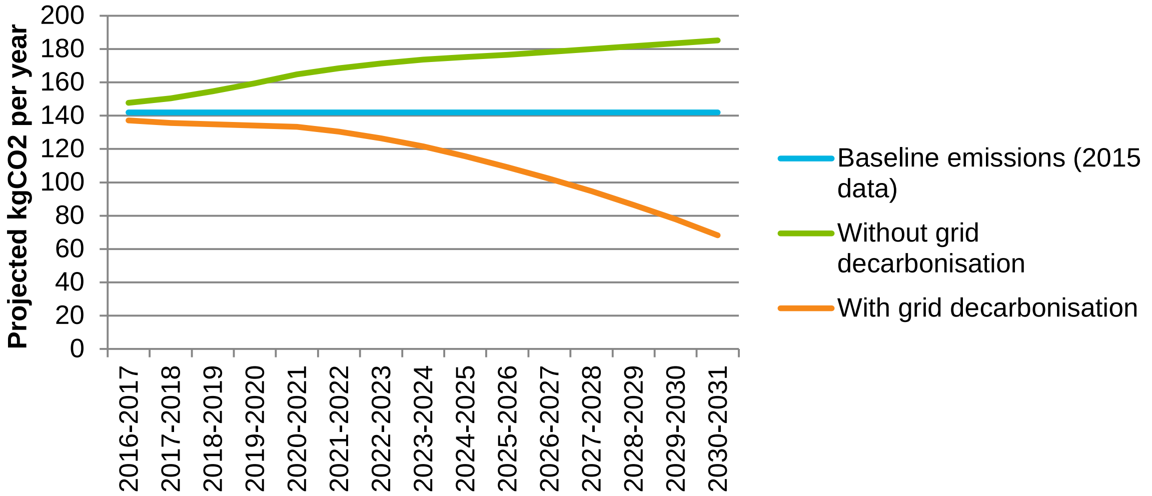

Figure 16. CO_2 emissions arising from domestic electricity use under the IAG decarbonisation scenario

4.3.4 Decarbonised gas grid

According to the Parliamentary Office of Science and Technology *'POSTNOTE: Decarbonising the Gas Network'* (November 2017), at present over 90% of all UK households are supplied with natural gas and roughly 14% of all carbon emissions in the UK arise from the use of natural gas for heating.[9] It is generally assumed that natural gas will continue to play an important role in delivering heating in the UK in the foreseeable future, but in order to meet the carbon emissions requirements of the Climate Change Act 2008, it will be necessary to significantly decarbonise the gas grid in the longer term.

This could be done in a variety of ways, notably by increasing the use of either biomethane or hydrogen gas. Both of these options could potentially deliver significantly lower carbon emissions. Biomethane is presently injected into the grid in small quantities, but its use is limited by the availability of wet feedstocks and it would likely be unable to meet more than 5-20% of the current gas demand. Assessments of a potential transition to hydrogen gas indicate that there are a range of cost

[8] https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal
[9] http://researchbriefings.parliament.uk/ResearchBriefing/Summary/POST-PN-0565

and technical issues to overcome, which would require a considerable increase in the amount and speed of research being undertaken. The use of hydrogen would incur additional costs due to the need to convert appliances and infrastructure for compatibility.

Therefore, decarbonising the gas grid is considered a significant challenge and, barring a technological step-change, it is anticipated that greater opportunities for decarbonisation will relate to the electricity grid and energy efficiency rather than the gas grid.

4.3.5 Potential shift in heating delivery method

One inevitable impact of electricity grid decarbonisation is that the emissions from technologies that use electricity to produce heat will go down over time, and the carbon savings from technologies that displace grid electricity will be reduced. This will make ground source heat pumps and air source heat pumps that use mains power to 'extract' heat from local ambient heat sources, usually displacing gas heating fuel, more attractive as their net carbon emissions fall. Conversely the carbon savings of combined heat and power (CHP) that generate power locally, displacing grid electricity will reduce, making them less attractive options for cutting emissions.

In response to this challenge, the BEIS '*Clean Growth Strategy'* (2017) suggests that low carbon heating options in the coming decades will necessitate a shift in the way that heat is delivered, including:

- Development of heat networks; and
- Use of heat pumps.

Gas-fired heat networks are likely to play a role in the short to medium term due to the efficiencies they deliver, and this is supported by draft policies within the *'Proposed Submission Plan:MK'* (October 2017). However, eventually, the Committee on Climate Change suggests that, *'gas-fired combined heat and power (CHP) will […] become incompatible with national carbon budgets.'* [10] Therefore, it is anticipated that many heat networks will begin to transition to alternative heat sources, most likely including some form of electrical input as the grid continues to decarbonise.

4.3.6 Uptake of smart metering and control systems

The Clean Growth Strategy includes a target of making smart meters available to all homes by 2020. The Government has been working with energy suppliers to ensure that these are offered to customers. According to BEIS *'Smart Metering Statistics'* (Quarter 2, 2017), as of June 2017 it is estimated that approximately 7.7 million smart meters were in operation around the UK, in domestic and non-domestic buildings.[11]

One of the key benefits of smart meters is by improving transparency and user access to their own energy data, making it easier to identify areas of waste. Although it is not clear whether or to what extent this affects user behaviour in the long term,[12] the improved data collection could also facilitate the introduction of demand side response and, on a broader scale; help to balance energy demand and supply, particularly important at peak times.[13] In principle, therefore, these have the potential to reduce energy consumption, although the impacts in Milton Keynes have not been quantified.

4.3.7 Battery storage

There have been significant improvements in battery storage in recent years with implications for both domestic and non-domestic energy consumption. Battery storage could facilitate uptake of LZCs because it would help to moderate periods of intermittency for generation from solar and wind. As stated above, increasing EV uptake and the introduction of vehicle-to-grid systems could have a

[10] Committee on Climate Change, *'How local authorities can reduce emissions and manage climate risk'* (May 2012) https://www.theccc.org.uk/wp-content/uploads/2012/05/LA-Report_summary.pdf
[11] BEIS, *'Smart Metering Statistics'* (Quarter 2 2017) https://www.gov.uk/government/statistics/statistical-release-and-data-smart-meters-great-britain-quarter-2-2017
[12] http://fes.nationalgrid.com/media/1253/final-fes-2017-updated-interactive-pdf-44-amended.pdf
[13] BEIS, *'Smart Meters and Demand Side Response'* (December 2016) https://www.gov.uk/government/publications/smart-meters-and-demand-side-response

transformative effect on the way that energy is delivered to buildings. This would also have implications for the design of energy infrastructure and allocation of space for plant rooms within buildings, although the space requirements would depend heavily on the types of systems in use.

The National Grid report *'Future Energy Scenarios'* (2017) imagines the impact this might have on the built environment (p. 103):

> *Many buildings in this world would be able to act as mini power stations, with rooftop solar or small wind turbines, a battery and an integrated building control system linked to multiple smart appliances.*

4.4 Looking ahead: Electric vehicles

As stated in Section 3.1, fuels used in transport (and in particular petroleum) account for a large proportion of total fuel consumption and carbon emissions. Switching towards the use of electric vehicles represents one of the key ways in which emissions from this sector may be reduced in coming years. Therefore, although this report is primarily focused on emissions arising from the built environment, this section will consider the potential scale and impacts of such a shift. Other forms of transport such as public transport and goods movement are not discussed in detail.

4.4.1 Market growth

Despite the heavy reliance on petroleum in the transport industry, the electric vehicle market has seen considerable growth in recent years. Figure 17 shows the increase in total licenced plug-in vehicles (cars, vans and quadricycles) licenced at the end of the quarter in the UK since 2011. In Milton Keynes, at the end of Q3 2017 there were 3501 such vehicles, compared with only 97 in Q4 of 2011.

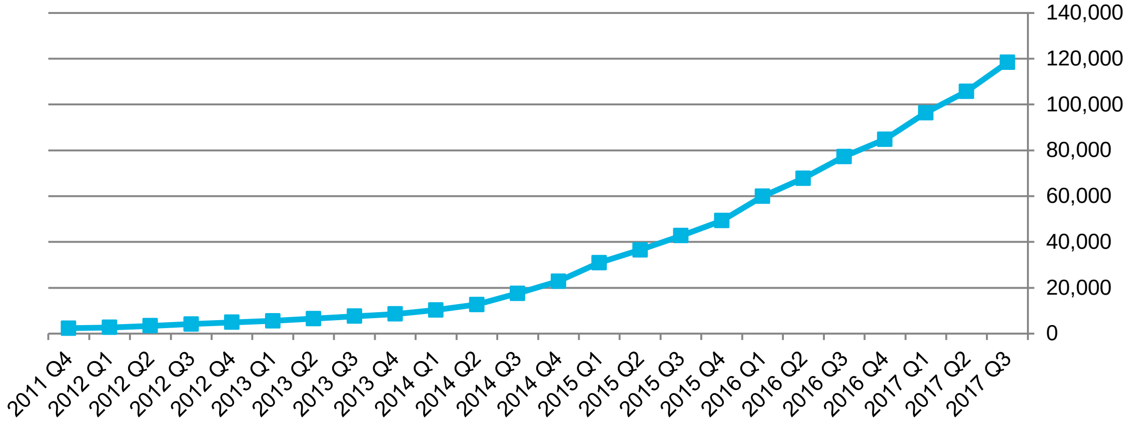

Figure 17: Licensed Plug-in vehicles in the UK (Department for Transport, 2017)

This increase (roughly 36 times the 2011 amount) in licensed plug-in EV's is partially attributed to:

1. A plug-in grant for low emissions vehicles which was introduced in 2011 and is expected to expire in March 2018 (Topham, 2015). Vehicle manufactures and dealerships can be eligible for government grants to reduce the price a consumer pays for a brand new electric or hybrid vehicle. However, not all electric or hybrid vehicles are eligible for a grant - only vehicles that have been approved by the government are eligible. The grant can pay up to £4500 towards the original purchase price of a new vehicle (UK Government). After March 2018 when the plug-in grant expires it is not yet clear if consumers will adopt electric cars at the same rate as recent years.

2. An increase in affordable plug-in vehicles which have lower running costs than petrol or diesel powered cars.

3. The Electric Vehicle Homecharge Scheme which pays for up to 75% towards the cost of installing electric vehicle charge points at domestic properties in the UK (Office for Low Emission Vehicles, 2016).

4. The Workplace Charging Scheme which is a government scheme that provides funding towards the installation and purchase of electric vehicle charge points for eligible businesses, charities and public sector organisations (Office for Low Emission Vehicles, 2016).

5. The On-street Residential Chargepoint Scheme which provides funding for local authorities towards the cost of installing on-street residential chargepoints for electric plug-in vehicles (Office for Low Emission Vehicles, 2016).

4.4.2 Potential EV uptake in Milton Keynes by 2030

With regards to future growth, the National Grid report *'Future Energy Scenarios 2017'*[14] describes several uptake scenarios. Even in the most conservative case, the Steady State scenario, set out by the FES, shows that the total number of electric vehicles on UK roads by 2050 could be approximately 6.9 million. The most extreme scenario, the Two Degrees scenario, estimates that there could be approximately 25.13 million electric vehicles on UK roads by 2050.

To predict the number of EV's in Milton Keynes in 2030 it was assumed that the rate of EV growth would be the same as the UK predicted by the FES. A scaling factor was applied to the number of EVs in Milton Keynes in 2015. The scaling factor was calculated by dividing the predicted number of EVs in the UK in 2030 by the number of EVs in the UK in 2015, i.e.:

Number of EVs in Milton Keynes by 2030 = $Current\ number \cdot \frac{Predicted\ number\ of\ EVs\ in\ UK\ in\ 2030}{Number\ of\ EVs\ in\ UK\ in\ 2015}$

Assuming that Milton Keynes has the same uptake rate of EVs as the UK up to 2050 and that the National Grid estimation methods are accurate, there could be between 27,800 and 135,000 EVs by 2030 depending on the scenario used for the forecast.

4.4.3 Impacts of electric vehicle uptake

The UK Government has announced that it will stop the sale of all new petrol and diesel cars and vans by 2040 which will almost certainly lead to an increase in the amount of electric vehicles on UK roads (BBC, 2017). Among the many potential impacts of such a shift are:

- An increase in electricity demand; and
- A decrease in carbon emissions associated with the transport sector, though it should be noted that this may move the emissions to areas of electricity generation, rather than eliminating them entirely.

The Future Energy Scenarios study carried out by National Grid has set out four potential pathways for electricity demand and supply until 2050 which includes EVs and has estimated that they could increase the peak electricity demand anywhere between 4 and 10GW by 2050 (National Grid, 2017). The total peak demand is currently around 60GW and the Future Energy Scenarios study predicts that this could increase to a maximum of 85GW by 2050 (National Grid, 2017) . This would mean that the peak demand introduced by EVs could account for between 4.7% and 11.8% of the total peak demand in the UK by 2050.

If this additional peak demand is not managed correctly it is likely to create several challenges across the transmission and distribution network including but not limited to:

- Power bottlenecks throughout the distribution infrastructure especially at the 11kV level when numerous electric vehicles are charging at the same time. This is especially true when 'fast' or 'rapid' chargers are being used which can draw large amounts of current from the grid.
- Distribution infrastructure such as transformers and cables operating closer (or potentially above) their rated power.
- If the existing equipment cannot deal with the increased peak demand, additional equipment may have to be added to the network or existing equipment might need to be upgraded.

In contrast to the potential negative impacts EVs have on the grid stated above, the increased usage of EVs could also be used for demand side management, returning power to the grid when it is required.

Figure 18 compares the carbon emissions associated with new petrol and diesel cars as of 2017, and also provides an illustration of the potential emissions associated with EVs in 2030 based on the IAG decarbonisation scenario. For traditional fuel vehicles, emissions (gCO_2e) are taken from the BEIS *'Conversion factors 2017'* (August 2017) for average petrol and diesel cars.[15] Emissions arising from

[14] http://fes.nationalgrid.com/media/1253/final-fes-2017-updated-interactive-pdf-44-amended.pdf
[15] https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2017

EVs have been calculated assuming an average of 5.1 miles driven per kWh, applying fuel emission factors for electricity of 0.325 (2017 levels), and 0.130 in 2030 (IAG projections).

Note that the miles per kWh may vary depending on several factors such as driving style, age and condition of battery, usable capacity of battery, driving terrain, environmental and climate conditions, use of in-car electronics, etc. Therefore, the statistics in Figure 18 should only be used as an approximate guideline and are only intended to highlight the potential scale of change in emissions per vehicle.

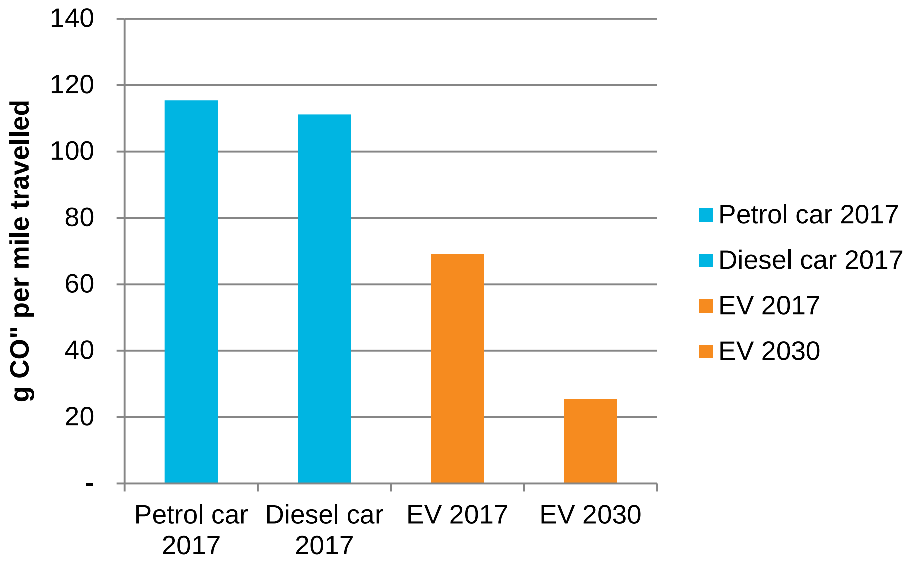

Figure 18. Carbon emissions for different vehicle types

It can be seen that, as of 2017, EVs emit roughly 40% less CO_2 per mile than petrol cars. Under the IAG grid decarbonisation scenario, they could emit roughly 78% less, with a potentially large impact on overall carbon emissions.

The introduction and growth of autonomous vehicles in the future also needs to be taken into consideration when looking at the usage statistics of EVs. This new technology will allow consumers to share journeys more easily. Ride sharing may reduce the amount of miles a car travels per person but may increase the amount of miles travelled per car.

5. Baseline renewable energy capacity

This section describes the installed renewable energy capacity in Milton Keynes, examining different technology types including wind, solar, combined heat and power (CHP), anaerobic digestion, and small-scale renewable heat sources such as solar thermal, biomass boilers, and heat pumps.

5.1 Methodology and assumptions

The data used to assess the current amount of renewable capacity installed in Milton Keynes was taken from the following sources:

- The UK Renewables Map
- OFGEM Feed-in Tariff (FiT) data
- OFGEM Renewable Heat Incentive (RHI) data
- BEIS installed CHP capacity

For the purpose of this report, small-scale installations are defined as those up to 50kW in size, and those above are considered large-scale. This is how microgeneration is defined by OFGEM for the purpose of assessing eligibility for FiT and other incentive schemes.

Potential annual renewable electricity generation was estimated using national average load factors as described in DUKES 6.5 (2016). It should be noted that load factors vary depending on factors such as geographic location and the operation of each plant, and therefore these figures are presented as rough estimates only. Micro CHP and small-scale wind are excluded from the generation estimate; this does not have a statistically significant impact on the results.

For further details of the above sources and methodology, see Appendix C.

5.2 Results and discussion

Table 4 summarises the renewable energy installations believed to be currently active in Milton Keynes. A more detailed breakdown of the data is provided in Appendix B.

This review has identified the presence of large- and small-scale PV installations, large- and small-scale onshore wind, energy from waste (EfW), an anaerobic digestion (AD), and combined heat and power (CHP). These represent roughly 120 MW of renewable, low and zero carbon energy capacity, which could potentially generate around 171 GWh of electricity per year. It is likely that there are heat pumps, biomass boilers, and/or hydroelectric turbines also present which were not captured by available datasets, and therefore true figures may be higher.

Table 4. Renewable energy capacity identified within Milton Keynes

Technology	Number of installations	Capacity (MW)	*Active installations only:* Potential electricity generation (GWh/yr)
Large-scale renewables			
PV	18	83.4	81
Wind	2	14.5	30
EfW	1	2.2	6
AD	2	1.3	7
CHP	3	6.8	36
Small-scale renewables			
Micro PV	3103	11.9	11
Micro Wind and CHP	4	0.02	-
Total	**3133**	**120**	**171**

In addition to active installations, Figure 19 shows those that are proposed, or are agreed/under construction, according to how they are listed in the UK Renewables Map database. Numbers in italics indicate the potential total capacity assuming all such installations are operational.

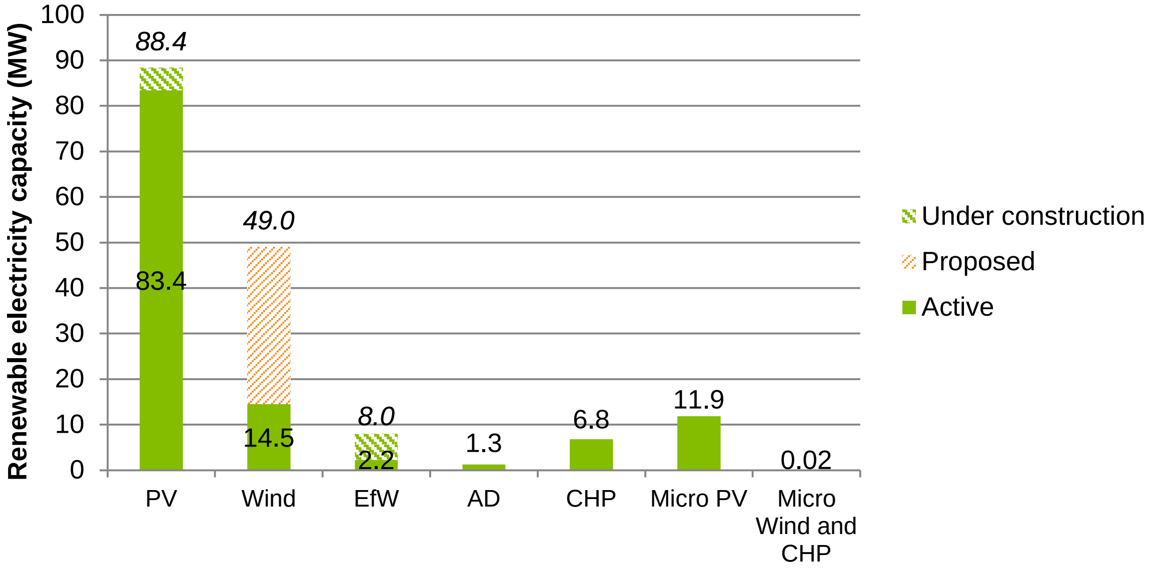

Figure 19. Active, approved/under construction and proposed renewable energy installations

The number of solar installations is mainly comprised of small-scale installations, which account for around 11.9 MW of installed capacity. This is likely a reflection of the decreasing cost of PV in recent years, and the fact that it is suitable for roofs in a range of conditions and building types, which makes the technology more accessible for domestic users. Small-scale PV uptake is also supported by local initiatives such as the Milton Keynes Community Action Platform for Energy. Although there are fewer large solar installations (18 identified by this review), these account for around 88.4 MW of renewable energy capacity, which is around half of the total renewable capacity for Milton Keynes.

Case study: Rectory Farm – Solar PV – 9 MW - Active

This solar farm is located on a 37 acre site of low-grade agricultural land. The array is sheltered by planting to reduce its visual impact on the landscape, and was designed to preserve an area containing Roman architectural remains.

By contrast, data indicates that there are a limited number of wind installations within Milton Keynes. There are 3 accredited schemes listed in the FiT database which total around 18kW and two large-scale wind farms totalling 14.5 MW. The energy company Ecotricity has proposed an additional large-scale wind installation at Stoke Heights, which is understood to be in the pre-planning stage.

Case study: Stoke Heights Wind Farm - Large-scale wind - 34.5 MW - Pre-planning

A large-scale wind farm is currently proposed for Stoke Heights, near Stoke Goldington. According to the energy developer, Ecotricity, the site could produce roughly 84GWh of electricity per year with 15 turbines.

Aside from wind and solar installations, low and zero carbon large scale generation in Milton Keynes includes three combined heat and power (CHP) plants and one anaerobic digestion (AD) plant located at Brayfield Farmhouse. It is understood from MKC that the city centre heat network may be expanded in future, potentially adding further low or zero carbon generation.

To put these results into context, Figure 20 shows the total electricity consumed in Milton Keynes in 2015, compared with the estimated renewable electricity that could be generated in in one year by the large-scale installations listed above. Microgeneration is excluded on the assumption that the energy generated will be used on-site and not reflected in the sales data.

Note that the figures below are intended *only* to provide a sense of relative scale. They should not be taken to represent the proportion of energy consumed in Milton Keynes that comes from renewable sources. For instance, many plants are likely to feed electricity into the grid and this electricity may be used in locations outside of Milton Keynes.

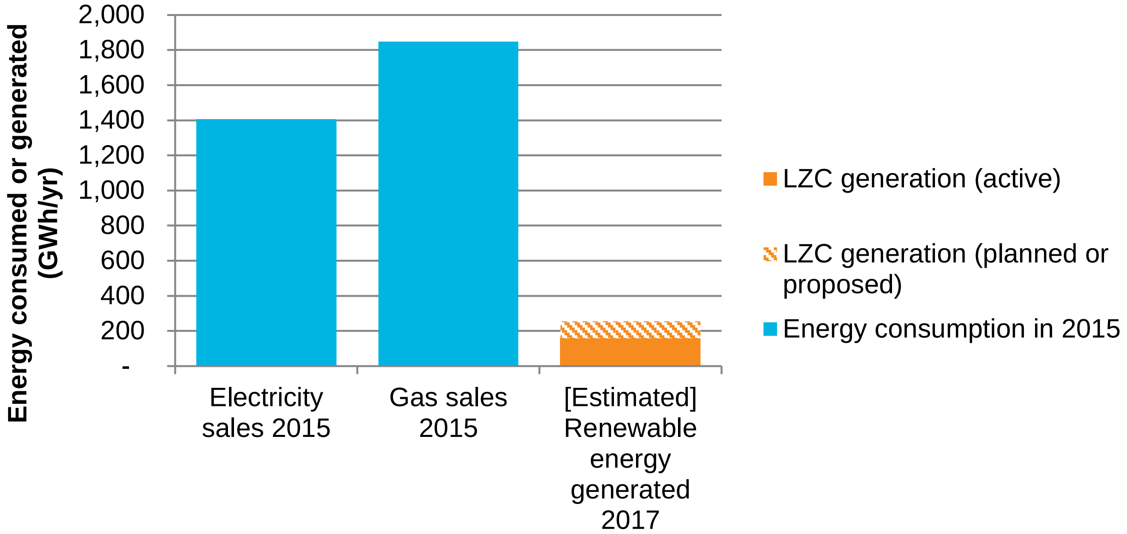

Figure 20. Comparison between energy consumed and the estimated amount of renewable energy that could be generated in Milton Keynes

This comparison suggests that, at present, the amount of renewable energy installations in Milton Keynes would be able to meet a relatively small, though not insignificant, proportion of the total demands if all of the energy generated was consumed within the borough.

Case study: Brayfield Farmhouse – Anaerobic digestion – 165 kW - Active

Located near Home Farm, Cold Brayfield, this AD plant received permission in 2014. Feedstock for the plant is grown on the farm and the waste material provides bio-fertiliser and renewable energy.

5.3 Mapping renewable and low carbon energy in Milton Keynes

The locations of large-scale renewable energy installations are shown in Figure 21. As stated above, information has been consolidated from several datasets; although every effort has been made to ensure that the information presented is accurate, AECOM cannot guarantee that there are no errors or omissions and locations shown are indicative only.

Figure 23 shows the density of accredited small-scale PV installations by LSOA as listed in the BEIS *'Feed-in Tariff statistics'* (August 2017).[16]

[16] https://www.gov.uk/government/collections/feed-in-tariff-statistics#monthly

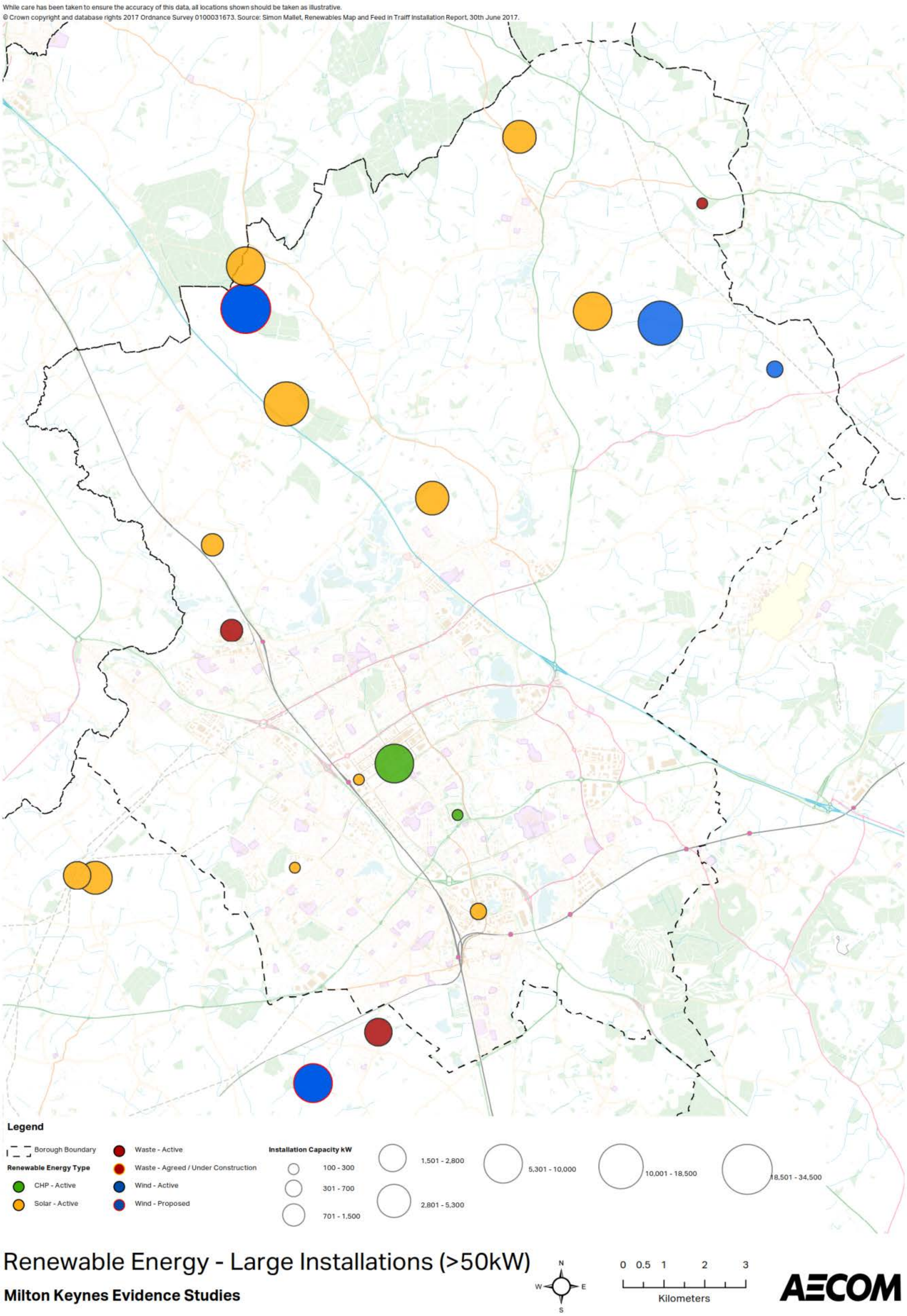

Figure 21: Large scale renewable energy installations within and around Milton Keynes

Figure 21 indicates that in general, larger-scale renewable installations tend to lie outside of the built-up areas of Milton Keynes, which is to be expected due to land use constraints and technical considerations (discussed further in Section 5). By contrast, CHP plants are located in denser urban areas, as the viability of such installations depends in large part on the density and consistency of heat demand in a geographic area. An extract from the National Heat Map is provided in Figure 22 which illustrates how there is a high density of heat demand (shown in yellow/red) in central Milton Keynes, close to where the Thameswey Energy Centre is located.

Figure 22. Extract from the National Heat Map, available at http://nationalheatmap.cse.org.uk/

Case study: Thameswey Central Energy Station – Gas-fired CHP – 6.4 MW - Active

Located on Avebury Boulevard in central Milton Keynes, this energy centre has been operating since 2007. It contains two CHP engines which supply district heating and power to the local area, including Network Rail’s national headquarters.

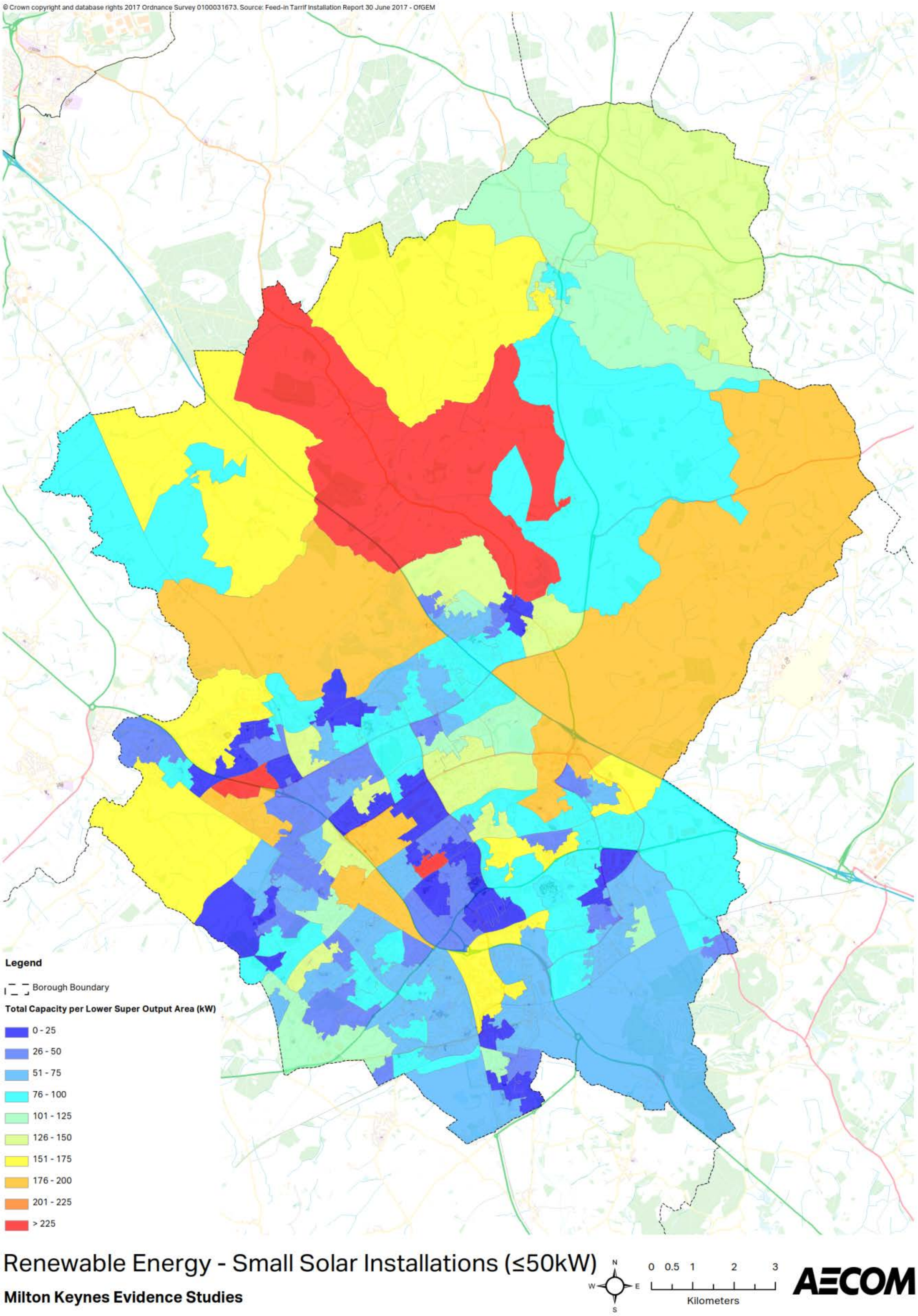

Figure 23. Small-scale solar installations by LSOA. Source: FiT database

6. Potential future renewable energy capacity

This chapter of the report will address the potential for renewable energy installations in Milton Keynes. The approach taken is broadly based on the DECC (now BEIS) *'Renewable and Low-Carbon Energy Capacity Methodology'* (2010). DECC (2010) methodology uses a sequential assessment process to progressively reduce the maximum theoretical opportunity to a practically achievable level. For each technology, consideration has been given to the physical availability of renewable sources, along with their technical and regulatory constraints. Where possible, an indicative quantitative estimate of capacity will be provided, and the discussion will be supplemented with relevant information such as local policies, drivers or uptake rates.

6.1 Potential future renewable energy capacity

The information presented in this report is intended to illustrate the constraints and opportunities that have been identified, based on available GIS data and a high-level review of technical and planning constraints in Milton Keynes. Any maps shown are indicative and it is beyond the scope of this report to determine whether a specific site is suitable for a given use or technology. Also note, depending on the site in question, it may be possible to remove or mitigate the constraints identified, allowing development of renewable generation.

6.1.1 Wind

Commercial-scale wind

The technical potential for commercial scale on-shore wind energy depends primarily on wind speed at hub height and land use constraints, along with several other considerations. A rule of thumb is that, in order to be financially viable, average annual wind speeds at hub height should be around 5-6 m/s. The NOABL database, which provides modelled estimates of wind speed across the UK, indicates that most areas in Milton Keynes meet this threshold.[17] However, the model does not account for local surface roughness (e.g. the presence of tall trees or obstacles) and in practice site-specific assessments would need to be carried out to determine suitability.

The following are described by DECC (2010) and the *'Wind Turbines SPD'* (2013) as important factors to consider when evaluating a potential site:

- Proximity to residential properties (assume a 600-800m setback from residential properties to account for noise, visual amenity, etc.)
- Flood zones
- Exclusion areas around airports, airfields and MOD sites (to be determined in consultation with the relevant bodies depending on the nature of the project)
- Proximity to infrastructure e.g. roads, railways, powerlines, and gas pipelines (a 150 m buffer has been applied in this analysis)
- Practical considerations e.g. grid connections, access and site spacing
- Areas that have been designated for their ecological or historic interest, such as:
  - Ancient woodland;
  - International and national nature conservation designations (including National Nature Reserve, RAMSAR site, Special Area of Consideration, Special Protection Area, and Site of Special Scientific Interest);
  - Site of historic interest (including Listed Buildings, Scheduled Ancient Monuments, Registered Park and Gardens and Registered Historic Battlefields).

The map in Figure 24 shows locations that are *not* subject to the above constraints, and which therefore could be suitable for commercial wind development, albeit subject to further specific feasibility assessments. Note that there may be additional constraints for which GIS data was not

[17] The map can be viewed online at: http://www.rensmart.com/Weather/BERR

available and therefore some areas highlighted may not be suitable. Conversely, depending on the specific location, in some instances it would be possible to remove or mitigate a given constraint.

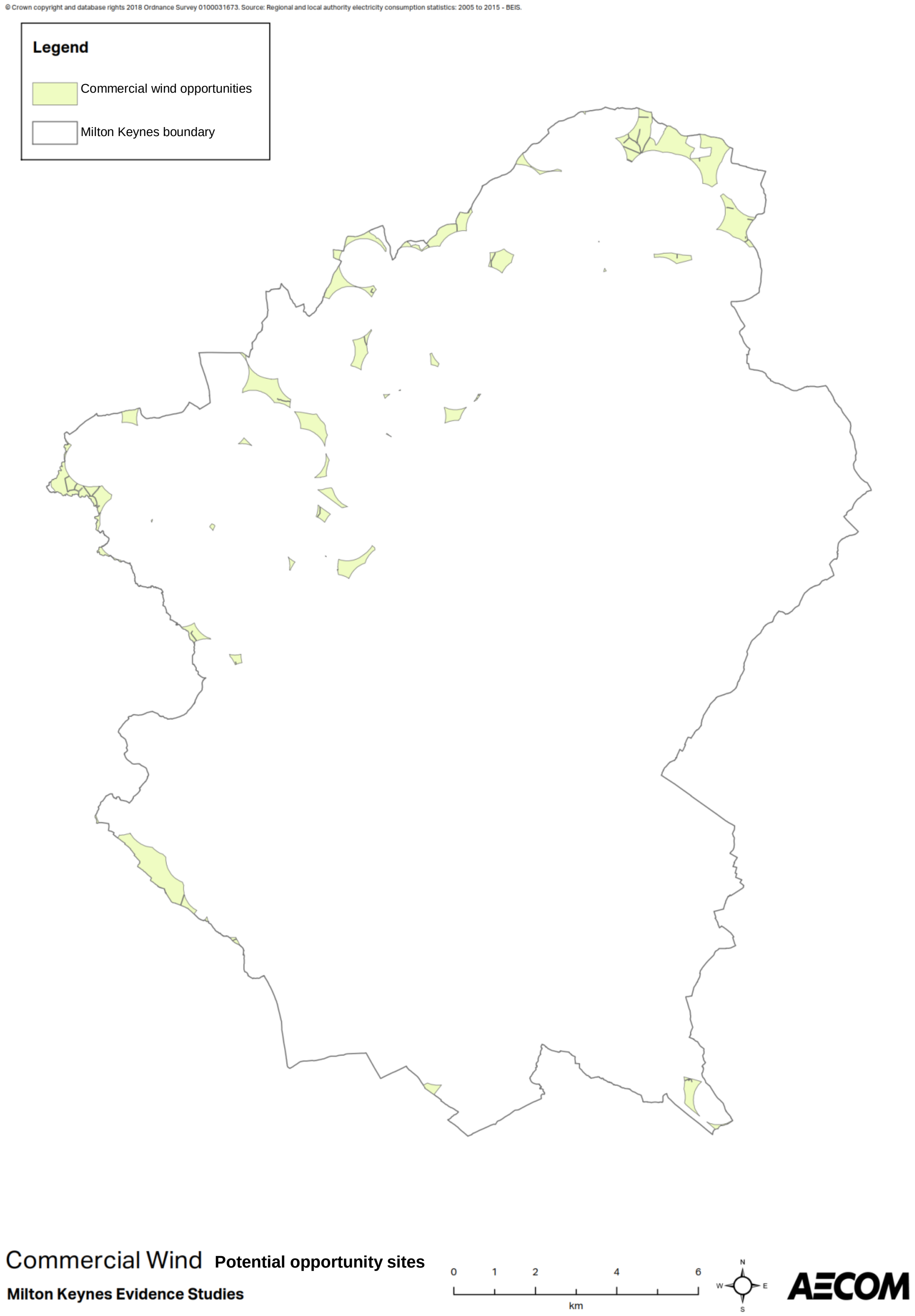

Figure 24. Indicative locations of commercial-scale wind opportunity sites, i.e. those that are not within proximity to buildings, infrastructure, protected/designated land, or air control zones.

The energy company Ecotricity has proposed a 34.5MW wind farm at Stoke Heights, near Stoke Goldington. MKC has confirmed that, at the time of writing, this is the only large-scale wind energy development proposed within Milton Keynes. The Written Ministerial Statement HCWS42 (2015) states that,

> *'local planning authorities should only grant planning permission if […] the development site is in an area identified as suitable for wind energy development in a Local or Neighbourhood Plan.'*

A Landscape Character Assessment was carried out by Gillespies on behalf of MKC in 2016 which identified multiple areas of sensitivity to wind turbine and solar PV development.[18] Those landscapes are protected by MKC planning policy, and the *'Proposed Submission Plan:MK'* (October 2017) states:

> *'The Assessment of the Landscape Sensitivity to renewable energy developments looks at the sensitivity of each landscape character type within the Borough to wind turbine and solar photovoltaic development and identifies where particular areas may have greater or lesser capacity to accommodate such development. Plan:MK does not propose to allocate any sites for wind turbine developments.'*

As a result, it is not likely that further large-scale wind development will take place in the area. Therefore, the Stoke Heights wind farm, should it be approved, is taken to represent the maximum potential additional large-scale wind capacity for the area.

Potential additional capacity: 34.5 MW

Small-scale wind

DECC (2010) methodology assumes that small scale turbines can in principle be located at any address point where the wind speed meets or exceeds 4.5 m/s at 10 m above ground. In practice, site specific constraints vary considerably and include building height, roof shape, neighbouring buildings and other physical obstacles. These have a significant impact on viability because the power output varies cubically with relation to wind speed. Therefore it is usually assumed that these will be more suitable for rural locations where there are fewer obstacles and wind speeds are higher.

As noted in Section 5.1, Feed-in Tariff data (August 2017) suggests that there are few micro wind installations within Milton Keynes and it is therefore assumed that this does not represent a significant proportion of LZC capacity in the area. This aligns with conventional experience, which suggests that typically only a small number of highly suitable locations utilize this technology; sites in Milton Keynes have not been assessed in detail for this reason. It is possible that higher uptake could result from further advances in battery technologies, or increased financial incentives, but these possibilities have not been quantified.

Although, as stated above, there are restrictions on the deployment of large-scale wind turbines due to landscape sensitivity, *'Proposed Submission Plan:MK'* (October 2017) Policy SC4 does encourage proposals for renewable energy including those that 'meet the needs of local communities'. Therefore, it is possible that a locally-driven initiative could develop small sites utilising small, community-scale wind power installations.

Total additional capacity: Not quantified, likely very small.

6.1.2 Solar technologies

Building-mounted

Both building mounted solar PV and solar water heating (SWH) depend largely on two site-specific factors: available roof space, and the solar exposure of the roof area (which relates to orientation, overshading, etc). The feasibility of SWH also depends on the on-site demand for hot water.

At present there is insufficient data on SWH installations to inform a detailed assessment of either

[18] Gillespies, *'Milton Keynes Landscape Character Assessment'* (2016) https://www.milton-keynes.gov.uk/planning-and-building/planning-policy/landscape-character-assessment

current installations or potential future uptake. There is also limited data regarding the number and/or available roof area of commercial and industrial buildings. Therefore, this analysis will focus on solar electricity generation in domestic properties only. SHW competes with PV for roof space and therefore the total capacity would be similar.

Solar energy generation can typically be delivered anywhere there is a suitable surface with adequate solar access (i.e. minimal overshading). For the purpose of making a high-level estimate, it has been assumed that 25% of domestic properties are suitable for PV, which is the figure suggested by the DECC (2010) methodology.

- **Existing domestic properties:** Based on October 2017 statistics published by Milton Keynes, the housing stock in the borough is roughly 111,000 which would equate to around 27,750 suitable properties.[19] If these were fitted with an average 3.5 kWp of PV panels (the median size according to current FiT records for the borough) this would deliver roughly 97MW of domestic-scale solar capacity, an increase of around 85.2 MW.
- **New domestic properties:** There are roughly 29,000 new dwellings planned for the period 2017-2031 which could deliver 23.4 MW of PV capacity, using the same assumptions as for existing dwellings.

The above would equate to roughly 110 MW of additional domestic PV capacity in total, which is close to ten times the current amount. Although this is a large increase, it is noted that the cost of PV has plummeted in recent years while uptake has risen sharply, despite uncertainty surrounding government incentive schemes. This suggests that the technology is viable in practice and it is commonly used by developers in order to meet carbon emissions reduction targets. Furthermore, the advance of battery storage technologies may help to drive uptake by allowing users to store surplus power, helping to moderate deficits and facilitating use on-site. The potential impact of these trends is discussed qualitatively in Section 4.3.

Note the following:

- The 3.5 kWp figure is based on the median size of accredited FiT installations in Milton Keynes. This capacity may be larger than is practical to achieve for the building stock overall. For instance, existing installations might tend to be installed by landlords or private homeowners who own larger properties with greater roof area.
- In practical terms, issues such as ease of access and installation and roof geometry tend to restrict the amount of suitable roof area. Solar panels also have a visual impact and their use is sometimes not permitted in conservation areas or street fronts; this is highly specific to the site in question, the architectural character, and so on; therefore it has not been assessed in detail. The impacts of this have not been quantified and therefore the 25% figure, though only a rough estimate, has been retained.
- Certain types of buildings or sites offer greater opportunities for building-mounted PV and this is not reflected in the estimates. In general, greenfield and large new development sites may offer greater potential for solar energy generation; the relative lack of built environment constraints means that there are more opportunities to maximise sustainable design measures from the outset. Similarly, industrial sites may be more suited to solar technologies as they tend to have large, unshaded roof areas.

Potential additional capacity: Approximately 110 MW (building-mounted)

Opportunities for solar farms

Policy SC4 in the *'Proposed Submission Plan:MK'* (October 2017) states:

> *Proposals to develop solar PV farms should avoid unacceptable visual impact from the effect of glint and glare on the landscape, on neighbouring uses and aircraft safety.*

The *'Milton Keynes Landscape Character Assessment'* (2016) found that, overall, there are very few areas suitable for commercial solar PV due to potential adverse impacts on the landscape. The report noted that several areas which were assessed as having reduced landscape sensitivity already

[19] Online. Available at: https://www.milton-keynes.gov.uk/your-council-and-elections/statistics/housing-statistics

contain solar farms, raising concerns about cumulative impacts. This aligns with the draft text of *'Proposed Submission Plan:MK'* (October 2017) Policy SC4 which states that,

> *'Proposals to develop solar PV farms should avoid unacceptable visual impact from the effect of glint and glare on the landscape, on neighbouring uses and aircraft safety.'*

6.1.3 Energy from Waste (EfW)

Waste covers municipal solid waste (MSW) and commercial and industrial (C&I) waste. Both can be diverted from landfill to EfW facilities and used to derive power via combustion, pyrolysis, gasification or anaerobic digestion. This analysis will focus on municipal solid waste.

The management of Local Authority collected waste in Milton Keynes for 2016/17 is broken down in *Table 5*.[20]

Table 5: Milton Keynes Household Waste Statistics 2016/7

Landfilled (tonnes per year)	Incineration with EfW (tonnes per year)	Incineration without EfW (tonnes per year)	Recycled/ Composted (tonnes per year)	**Total (tonnes per year)**
39,390	24,170	16	70,548	134,123

Applying the DECC (2010) benchmark of 10 kilotons of MSW per 1MW capacity per annum this would suggest that there is a total potential capacity of around 6.4 MW (excluding recycled and composted waste). This figure is slightly lower than the total 8 MW of EfW capacity that will be available within Milton Keynes on completion of the Waste Recovery Park (see Section 5.1) although it is on the same order of magnitude. For the purpose of this report, therefore, it has been assumed that the potential additional capacity from EfW is limited to the 5.8 MW that is already under construction at that location.

Moreover, two of the key goals of the MKC *'Zero Waste Management Strategy'* (2013) are: (1) Achieve 'Zero waste' and (2) No 'mass burn' incineration. The strategy also includes a target of sending a maximum 5% of waste to landfill by 2020.[21] In line with this principle it is preferable for this resource to diminish rather than increase.

Potential additional capacity: 5.8 MW

6.1.4 Hydro

Hydro power is generated by water flow through a turbine and depends on the volumetric flow rate and available head (relates to the vertical distance of the water surface above the turbine). The DECC (2010) methodology recommends using the Environmental Agency's *'Mapping Hydropower Opportunities in England and Wales'* (2009) to identify potential regional sources of hydropower.[22] It is considered that the data resolution of the report is too low to determine the precise number or location of suitable sites within the borough, and more detailed assessment would be outside the scope of this report. However, in broad terms, the report suggests that, across England, the total potential capacity of sites may be 130-185 MW and very few of these are within southern England.

This report has not identified any existing hydro schemes within the borough (see Section 5.1). Due in part to the unavailability of sites, the relatively high cost of the technology, and the need for more detailed environmental assessments compared with other types of renewables, for the purpose of this report it is assumed that there will be no additional capacity installed.

Potential additional capacity: Not quantified but assumed to be very low

6.1.5 Biomass

[20] https://data.gov.uk/dataset/local_authority_collected_waste_management_statistics
[21] https://wasteservices.amey.co.uk/where-we-work/milton-keynes/technology-overview/advanced-thermal-treatment/
[22] http://www.british-hydro.org/UK%20Hydro%20Resource/England%20and%20Wales%20Resource%20Study%20Oct%202010.pdf

Biomass covers a diverse range of fuels derived from plants, animals or human activity. The biomass categories discussed here are energy crops and managed woodland. It is understood that other sources of biomass such as food and garden waste and agricultural arisings (i.e. straw) are handled at existing AD plants and therefore may not offer significant potential additional capacity. Waste wood has been excluded because, in recognition of the zero waste targets for Milton Keynes, it is considered preferable for this resource to diminish rather than increase.

Biomass is usually converted via combustion, pyrolysis, gasification or anaerobic digestion. Direct combustion (burning) to produce electricity or heat is often the most viable approach to energy conversion from a technical and economic standpoint. However, biomass burning emits particulate matter and therefore DEFRA's position is not to encourage this practice in or near urban areas or AQMAs due to air quality concerns.[23] An upwind plume could have acute and long-term effects on sensitive receptors and therefore consideration should be given to whether biomass burning could have an impact on an AQMA, regardless of whether or not it is located within an AQMA. (The main exception to this would be a case where a highly efficient, modern wood pellet burner is used to replace a coal burner.)

Energy crops

The UK government has offered various subsidies or establishment grants to encourage production of energy crops, particularly miscanthus and short rotation coppice (SRC). Maps produced by DEFRA in 2009 indicate that both of these crops would be expected to have medium to high yields in the Milton Keynes area.[24] However, uptake of the scheme was low, and in addition, the Energy Crops Scheme raised concerns about the use of arable land for non-food growing.[25]

At the time of writing, the HM Government website states:

> *'The government's policy is to proceed with caution – taking advantage of the environmental opportunities biomass energy offers, while safeguarding against its potential disadvantages.'*

On this basis, although demand for biofuels is increasing (mainly to supply sustainable road transport), it does not seem likely that there will be a large increase in energy crop growing in the near future without significant additional government support.[26]

Table 6 lists some of the non-food energy crops that are commonly grown in the UK.

Table 6. Examples of crops used in renewable energy generation

Use	Examples
Biofuels	Oilseed rape, sugar beet, wheat
AD	Maize
Biomass	Miscanthus, short rotation coppice, straw crops

In order to estimate the potential for energy crops, note that as of 2016 the nation-wide proportion of arable land used for energy crops is approximately 2%.[27] Applying this figure to Milton Keynes, which includes roughly 18,600 hectares of farming land it could be assumed that around 350-400 ha might

[23] DEFRA, '*The Potential Air Quality Impacts from Biomass Combustion*' (July 2017) https://uk-air.defra.gov.uk/library/reports?report_id=935
[24]The maps are part of an archived HM government webpage last accessed by AECOM on 12/11/17: http://webarchive.nationalarchives.gov.uk/20140605103309/http://www.naturalengland.org.uk/ourwork/farming/funding/ecs/sitings/south_east_region.aspx
[25] DEFRA, '*Industrial Energy and non-food crops: business opportunities for farmers*' (n.d.) https://www.gov.uk/guidance/industrial-energy-and-non-food-crops-business-opportunities-for-farmers
[26] NNFCC on behalf of DECC, *'Domestic Energy Crops; Potential and Constraints Review'* (April 2012) https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48342/5138-domestic-energy-crops-potential-and-constraints-r.PDF
[27] DEFRA, *'Crops Grown for Bioenergy in England and the UK: 2016'* (published December 2017) https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/664991/nonfood-statsnotice2016-6dec17b.pdf

be used for energy crops[28] although this does not account for the economic considerations or local agricultural practices and opportunities specific to Milton Keynes.

Table 7 shows the assumptions used in DECC (2010) guidance to estimate the potential yield, energy content and potential capacity of biomass installations assuming that the fuel is converted to energy via combustion.

Table 7. Energy crops – energy benchmarks and assumptions. Source: DECC (2010)

Energy benchmarks and assumptions	
Electricity	
6,000	Oven dried tonnes (odt) per MWe
Heat	
4722	kWh/odt for SRC wood pellets
3611	kWh/odt for baled miscanthus
80%	Plant conversion efficiency
80%	Plant availability

Based on the assumptions listed above, Table 8 (below) shows the potential yield and energy content for miscanthus (baled) and SRC (wood pellets). This analysis assumes that the current proportion of energy crops nationwide, and farming acreage in Milton Keynes, both represent viable levels of production.

Table 8. Estimated biomass resource – miscanthus and short rotation coppice

Crop	Capacity (odt/ha)	Area (ha)	Yield (odt)	Feedstock (MWh)	Electricity (MWe)	Heat (MWth)
					Potential generating capacity	
Miscanthus	15	350	5250	18,958	0.88	3.38
	15	400	6000	21,667	1.00	3.86
SRC	10	350	3500	16,528	0.58	2.95
	10	400	4000	18,889	0.67	3.37

The figures above are highly sensitive to assumptions about the generation technology used, including plant capacity and availability factors. It is acknowledged that the estimates shown above are lower than those presented in a 2012 study conducted on behalf of MKC by the Centre for Sustainable Energy.[29] However, considering the relatively low historic uptake of energy crops, compared to other sources, energy crops are unlikely to provide significant renewable capacity in the borough.

Potential additional capacity: <1.0 MW

Managed woodland

Although there is some potential to use managed woodland as an energy resource in Milton Keynes, there are several constraints that may make this unfeasible. In particular issues surrounding air quality (discussed above) and transport distances will have a significant impact on the viability of schemes. Figure 25 shows potential woodland sources that, in theory, could be used for sustainable biomass production; however it is considered that due to the constraints within Milton Keynes that there is very little potential for development of schemes based on this resource.

[28] DEFRA, *'Structure of the agricultural industry in England and Wales at June'* (January 2018) https://www.gov.uk/government/collections/structure-of-the-agricultural-industry#2017-publications
[29] Centre for Sustainable Energy on behalf of MKC, *'Milton Keynes Energy Mapping Project: Summary Report'* (2012)

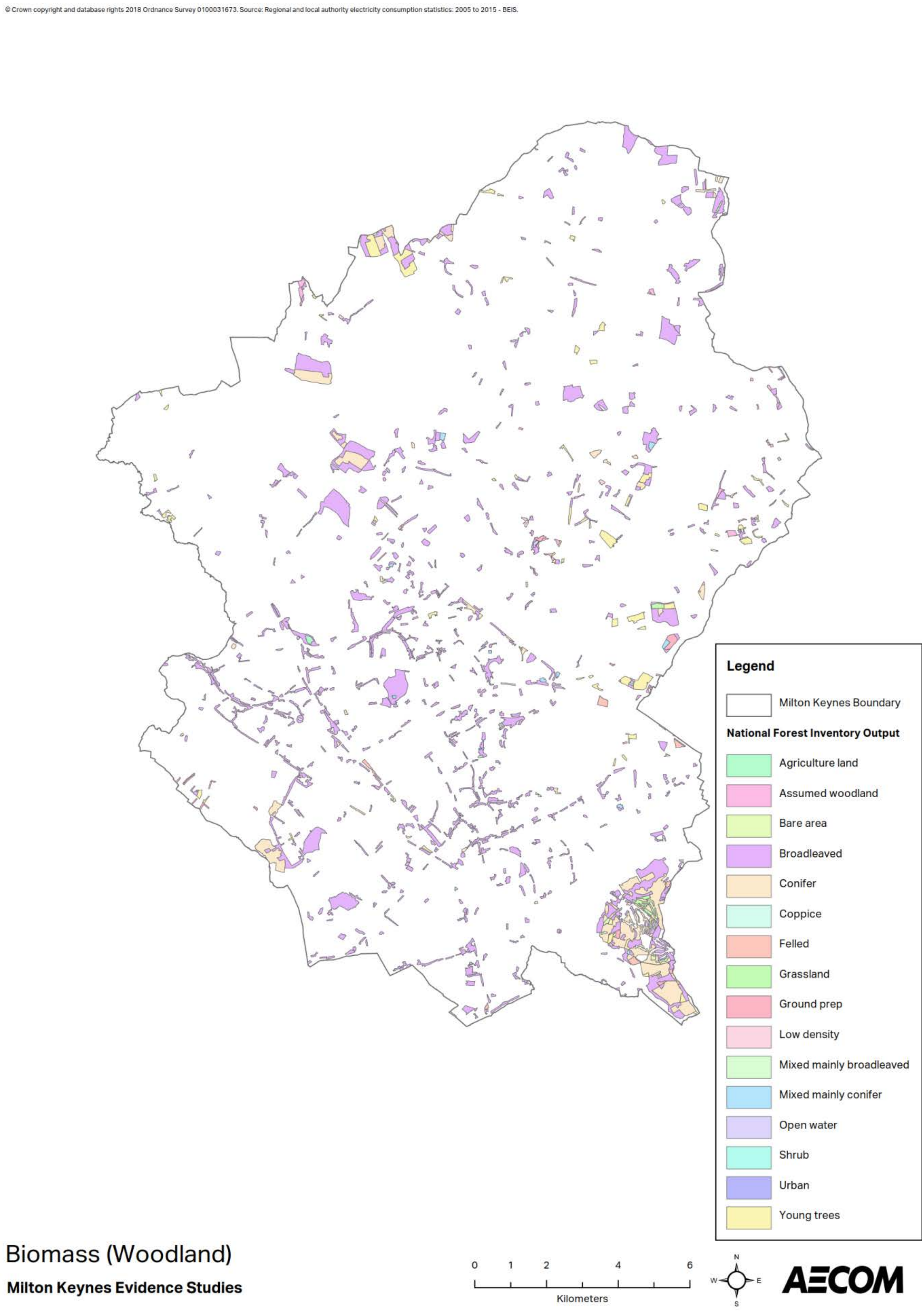

Figure 25. Areas of woodland within Milton Keynes. Source: Forestry Commission

6.2 Summary of renewable energy opportunities

Building-mounted PV likely presents the most opportunities and its suitability is reflected in part by the existing level of uptake. The advance of battery storage technologies and smart grids / energy management systems may help to drive uptake by allowing users to store surplus power, helping to moderate deficits and facilitating and optimising use on-site. The market for SHW is mature as it is a well-established technology so its cost and efficiency is unlikely to change significantly; however it is less flexible than PV, which produces electricity which can be used directly, stored or converted to heat, and the current financial incentives are lower so we would expect to see lower levels of uptake.

In regards to large-scale wind or solar installations, opportunities are significantly constrained. It is considered unlikely that there is significant scope for further development of solar farms due primarily to the sensitivity of the landscape and competition for other land uses. Although in principle the average annual wind speeds in the region make it potentially suitable for large-scale wind farms, in reality the number of suitable sites is minimised due to concerns about impact on the landscape and proximity to built-up areas, infrastructure and the air safety zone around Cranfield Airport.

Milton Keynes currently employs EfW and AD technologies in its handling of MSW, food waste, garden waste and agricultural arisings, with further capacity in development. The Waste Strategy aims to reduce waste arisings over time, and therefore this resource is expected to decrease. In the longer term, therefore, it is not considered to present a significant opportunity for expansion; although this is entirely dependent on local considerations which could not be assessed in this report.

These findings are summarised in Table 9.

Table 9. Renewable energy opportunities - Potential additional capacity within Milton Keynes

Technology		Current active capacity identified (MW)	Potential additional capacity identified (MW)	Comments/ basis for estimate
Wind	*Large-scale/ farms*	14.5	34.5	Assumes completion of Stoke Heights Wind Farm
	Small-scale/ building mounted	*Unknown*	*Not quantified*	Assume installation only on a small number of highly suitable sites
Solar	*Large-scale/ farms*	83.4	*Not quantified*	Consider for low-grade agricultural land
	Small-scale/ building mounted	11.9	>100	Suitable for most unshaded roof areas; have assumed 25% of domestic buildings can accommodate panels
Waste material	*EfW*	2.2	5.8	Assumes completion of Milton Keynes Waste Recovery Park
	AD	1.3		Due to the Milton Keynes' Zero Waste target, waste incineration is considered unsuitable. It is understood that most food and garden waste is handled by AD at present so further capacity is not likely to be installed unless specific opportunities arise.
Biomass	*Managed woodland* *Energy crops*	*Unknown* *Unknown*	*Low* *<1*	Technically suitable on most farming land in the borough but dependent on factors such as availability/structure of economic incentives and political considerations. Due to air quality concerns, biomass burning is not encouraged in/near sensitive receptors.
Hydropower, biomass boilers, SHW		*Unknown*	*Low*	These technologies were not assessed due to insufficient data

7. Summary and Conclusions

The UK is legally obligated to reduce carbon emissions by 80% by 2050, which is reflected in policies at both the national and local level that seek to ensure that future development is economically, socially and environmentally sustainable. Milton Keynes Council has sought to embed sustainability principles into the *'Proposed Submission Plan:MK'* (October 2017) with a presumption in favour of sustainable development (Policy MK1), policies that promote environmentally conscious design and energy systems, and strategic objectives including –

To mitigate the Borough's impact on climate change and reduce carbon dioxide emissions through:

- *Locating development away from areas of flood risk and significant biodiversity value*
- *Promoting community energy networks and strategic renewable energy developments*
- *Reducing waste generation and increasing the amount of material recycled*
- *Sustainable transport initiatives*

This report is intended to contribute to an evidence base that will support future deployment of renewable, low and zero carbon technologies in line with the above goals.

The current baseline energy consumption and carbon emissions in Milton Keynes have been described and mapped using GIS software. According to BEIS statistics, the total fuel consumption in Milton Keynes was approximately 5,650 GWh in 2015 (the most recent year for which data is available) and approximately 1,465 ktCO_2 was emitted. Around 40% of fuel consumption (roughly 2,000 GWh) was attributed to the road transport sector, which primarily uses petroleum products. The total fuel consumption of the domestic and industrial/commercial sectors was similar, both around 1,700 GWh per year, with the latter using a higher proportion of electricity and the former a higher proportion of gas.

The impact of new development on future carbon emissions in Milton Keynes will depend on the number, type and performance of new buildings delivered, in addition to a variety of other factors that include the improvements in energy efficiency; decarbonisation of the electricity and gas grid networks; decarbonisation of the heating supply and increasing use of technologies such as battery storage and smart grids that will help to manage energy demands.

Due to the significant number of variables and level of uncertainty associated with these, it is difficult to predict the impact these will have on energy consumption and CO_2 emissions in Milton Keynes. However two likely trends of particular importance are the likely increase in electricity demand due to the uptake of electric vehicles and the decarbonisation of the electricity grid, both of which have significant implications for how energy demand is managed and delivered within the built environment.

This study has identified the existing large- and small-scale PV, large- and small-scale onshore wind, energy from waste (EfW) and anaerobic digestion (AD) installations within Milton Keynes. Due to the high proportion of built-up areas within the Milton Keynes local authority, opportunities to deliver further large scale renewable energy capacity are relatively small. Of the renewable energy technologies assessed, it is considered that building-mounted solar PV offers the greatest opportunities for expansion because it incurs the fewest technical or planning-related restrictions and has a relatively high level of take-up, stimulated by the FIT and a competitive market of suppliers and products.

The UK government's *'Clean Growth Strategy'* (2016) states that the use of heat pumps (which are suitable for a broad range of building and development types) and CHP heat networks (suitable for areas with consistently high density of heat demand) will play a key role in decarbonisation in the coming years. These technologies were not assessed in detail as they are classified as 'low carbon' rather than renewable, but are often suitable for areas like Milton Keynes that have limited physical resources or capacity for renewable energy deployment.

Appendix A Data sources

All fuels by sector	Department of Business, Energy and Industrial Strategy (BEIS) '*Sub-national total final energy consumption statistics: 2005-2015'* (published in 2017)
Guidance document	*'Sub-national methodology and guidance booklet 2016* (BEIS, December 2016)
CO_2 emissions (total)	*'UK local authority and regional carbon dioxide emissions national statistics: 2005-2015'* (published 2017)
LSOA domestic electricity consumption	*'UK Lower Layer Super Output Area (LSOA) domestic electricity consumption'* (2015)
LSOA Domestic gas consumption	*'UK Lower Layer Super Output Area (LSOA) domestic gas consumption'* (2015)
MSOA Non-domestic electricity consumption	'*UK Middle Layer Super Output Area (MSOA) non-domestic electricity consumption'* (2015)
MSOA Non-domestic gas consumption	*'UK Middle Layer Super Output Area (MSOA) non-domestic gas consumption'* (2015)
Carbon fuel factors	*'Conversion factors 2017 – Full set (for advanced users)'* (August 2017)

Appendix B Estimating the quantity of new non-domestic and associated energy demands

Energy demand projections for non-domestic buildings were based on projected changes in the total floor area per building use category. The methodology is detailed below.

Floorspace sources

Multiple Milton Keynes Council sources were used to gather data on the existing and future floor areas for non-domestic buildings. This included an excel extract of non-residential development commitments with planning permission from the Council's Employment Commitments Monitoring System, Employment floorspace completions for 2004-2017 and the Borough of Milton Keynes Employment Land Survey 2016-2031.

Forecast of change in floorspace by 2031

The ECMS extract, correct as of 30th September 2017, provided the near future net gain in floor area for buildings with planning permission that were either under construction, or not yet started. The buildings were listed by planning use category.

The net gain for each category was averaged over a three year period (2018 to 2020) to estimate the additional floor area per annum. For categories A, C and D this annual estimate was projected up to the year 2031. The assumption that floor area increases at a constant rate per annum was necessary due to a lack of further quantitative data for categories A, C and D. However, the total change by 2031 was sense checked where possible using council reports. Although no obvious disparity to policy was found, it should be noted that this projection may be an over-estimation if those buildings not yet started are stalled or if the rate of development decreases in future periods.

For category B buildings, the Borough of Milton Keynes Employment Land Survey (2016-2031) provided change in floorspace estimates by 2031 for offices (specified as B1a/b), industrial buildings (B1c/B2) and warehouses (B8). Using historic floorspace data (2004-2017), these estimates were split to reflect the individual category, i.e. the change in floorspace for 'offices' was split proportionally into separate totals for B1a and B1b. This assumes that recent proportions of office gains compared to R&D gains will continue, similarly for light and general industry.

Net change in energy

Finally CIBSE Guide F and CISBSE TM46 energy consumption benchmarks were used to calculate the additional electricity and fossil fuel demand by 2031. These benchmarks provide a kWh/m^2 value of energy consumption for both electricity and fossil fuels, depending on the type of building. The values used are the 'good practice' figures, as these should be indicative of upper consumption levels for new design. Multiplying the additional total floorspace (m^2) with the respective benchmark gives the increase in energy demand per use category (kWh).

Appendix C Compiling renewable energy data

Data sources used

The data used to assess the current amount of renewable capacity installed in Milton Keynes was taken from the following sources:

- **The UK Renewables Map:** The UK Renewables Map is an online resource that compiles data from a large range of publications and statistical datasets (accessed 10/10/17). It aims to provide the fullest possible account of all renewable electricity installations in the UK, including wind, solar, waste and hydro power installations. Note that the Renewables Map only lists larger installations, typically above 0.6 MW in size.

  The UK Renewables Map includes installations that are not currently active. Those that are listed as 'Agreed/Construction' are approved and either under construction or soon to begin works. 'Proposed' schemes refer to those that are still concepts or have not yet been through a full planning submission.

- **OFGEM Feed-in Tariff (FiT) data:** The UK Quarterly statistics are published by OFGEM and give an account of the total number of installations and the total capacity of generators registered with the incentive scheme. The publication provides anonymised information relating to all installed renewable schemes claiming the FiT. It is available in regional format. Data was taken from *'Feed-in Tariff Installation Report 30 June 2017 Part 1'* (accessed 05/10/17)[30] and was processed down to a Local Authority level for the purposes of this report. The technology categories used within the FiT dataset were applied when totalling the installed capacity for Milton Keynes for 'Photovoltaics' and 'Small Wind' installations.

- **OFGEM Renewable Heat Incentive (RHI) data:** As with the FiT, this dataset is published by OFGEM. This study utilised the *'RHI Monthly Official Statistics Tables 03 June 2017'* (accessed 05/10/17)[31], which indicated that there are 14 non-domestic and 81 domestic accredited installations currently active in the borough. A breakdown of technology types was not provided and due to lack of detail this data has not been used in the main body of the report.

- **BEIS installed CHP capacity:** Information about installed CHP capacity was taken from 'BEIS CHP Focus Database' (accessed 10/10/17)[32]. It is available in regional format and was processed down to local authority level for Milton Keynes.

Limitations

- Renewable installations not captured in the data

The use of FiT and RHI datasets means that only registered or accredited schemes have been captured by this study. These incentive schemes are widely regarded as the key driver for micro generation installations due to the more favourable financial conditions they create. Therefore, it is anticipated the FiT and RHI data will account for the vast majority of all renewable generation installation in Milton Keynes and will give a reasonably accurate estimation of the current capacity installed within the area. However, in the case of solar thermal installation the technology was typically considered as a mature technology and therefore a number of installations may have been present before the introduction of the RHI. As a result it is likely that of all the technologies analysed in this study, solar thermal has the greatest risk of underestimation of the installed capacity to date.

- Validating data from the UK Renewables Map

The UK Renewables Map is a secondary source; that is, it compiles data taken from a broad number of other sources. It is predominantly composed of statistics published by BEIS/DECC and OFGEM, and supplemented with other project-specific data or information such as from the Planning Portal website.

As this database was compiled by an external source, AECOM cannot take responsibility for the

[30] https://www.ofgem.gov.uk/publications-and-updates/feed-tariff-installation-report-31-march-2017
[31] https://www.gov.uk/government/collections/renewable-heat-incentive-statistics
[32] http://chptools.decc.gov.uk/app/reporting/index/viewtable/token/2

accuracy of the data it contains. However, a spot-checking validation exercise has been carried out to assess the general reliability of the source, which was found to be very high.

- Consolidating renewable energy data sources

The data from the Renewables Map does not include projects with an installed capacity of less than approximately 0.6 MW. Information about the smaller installations was taken from the FiT and RHI published data. However, neither dataset has specific size cut-off points. Therefore, it is possible that some installations may be unaccounted for, if there is a gap between the two datasets (i.e. between 0.5MW and 0.6 MW). This particular capacity range occupies a grey area between micro and macro generation projects and it is not expected that there is a large number of installations which would be overlooked as a result. Discussions regarding the actions of the various delivery partners indicate that this capacity range is not in common use by a particular technology type or delivery partner.

Appendix D Estimating energy generation from installed capacity

All technologies	Number of installations				
Technology	**Total**	***Active***	***Proposed***	***Agreed/ Under Construction***	**% of no.**
PV	19	18	0	1	0.6%
Wind	3	2	1	0	0.1%
EfW	2	1	0	1	0.0%
AD	2	2	0	0	0.1%
CHP	3	3	0	0	0.1%
Micro PV	3103	3103	0	0	99.0%
Micro Wind and CHP	4	4	0	0	0.1%
Total	**3136**	**3133**	**1**	**2**	

All technologies	Capacity (MW)				
Technology	**Total**	***Active***	***Proposed***	***Agreed/ Under Construction***	**% of capacity**
PV	88.4	83.4	0.0	5.0	69%
Wind	49.0	14.5	34.5	0.0	12%
EfW	8.0	2.2	0.0	5.8	2%
AD	1.3	1.3	0.0	0.0	1%
CHP	6.8	6.8	0.0	0.0	6%
Micro PV	11.9	11.9	0	0	10%
Micro Wind and CHP	0.0	0.0	0	0	0%
Total	**165.3**	**120.0**	**34.5**	**10.8**	

All technologies	DUKES 6.5	Potential generation (GWh/yr)		
Technology	**Capacity factor (DUKES)**	**Total**	**Active**	**% of generation**
PV	11.07%	86	81	47%
Wind	23.69%	102	30	18%
EfW	32.14%	23	6	4%
AD	62.83%	7	7	4%
CHP	60.00%	36	36	21%
Micro PV	11.07%	11	11	7%
Micro Wind and CHP	Not assessed	N/a	N/a	N/a
Total		**264**	**171**	