AECOM

Renewable Energy for Kent

Baseline carbon emissions and projected domestic electricity and gas demands

2017 Update

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Executive Summary

Kent County Council has commissioned AECOM to support them in updating key components of the Kent Renewable Energy Action Plan (REAP), produced by AECOM and published in 2012, which set out the following:

- Existing energy demand and supply profiles in Kent and an associated carbon emissions baseline,
- Potential for deployment of various renewable energy sources in Kent,
- Scenarios for how new renewables could be deployed; and
- An action plan to help unlock this potential.

This update report:

- Provides a **revised carbon emissions baseline** based on updated energy supply data and including all fuel types and sectors for which data is available
- Presents an estimate for the **projected gas and electricity demand for future domestic developments**, based on the most recent targets for new dwelling completions in Kent and Medway.
- Sets out the current level of **installed renewable energy and Combined Heat and Power (CHP) capacity** in Kent and Medway.
- Provides updated **future energy scenarios**, drawing on the data reviewed, market and technology trends and making assumptions to set out a business as usual and aspirational outlook to 2020.

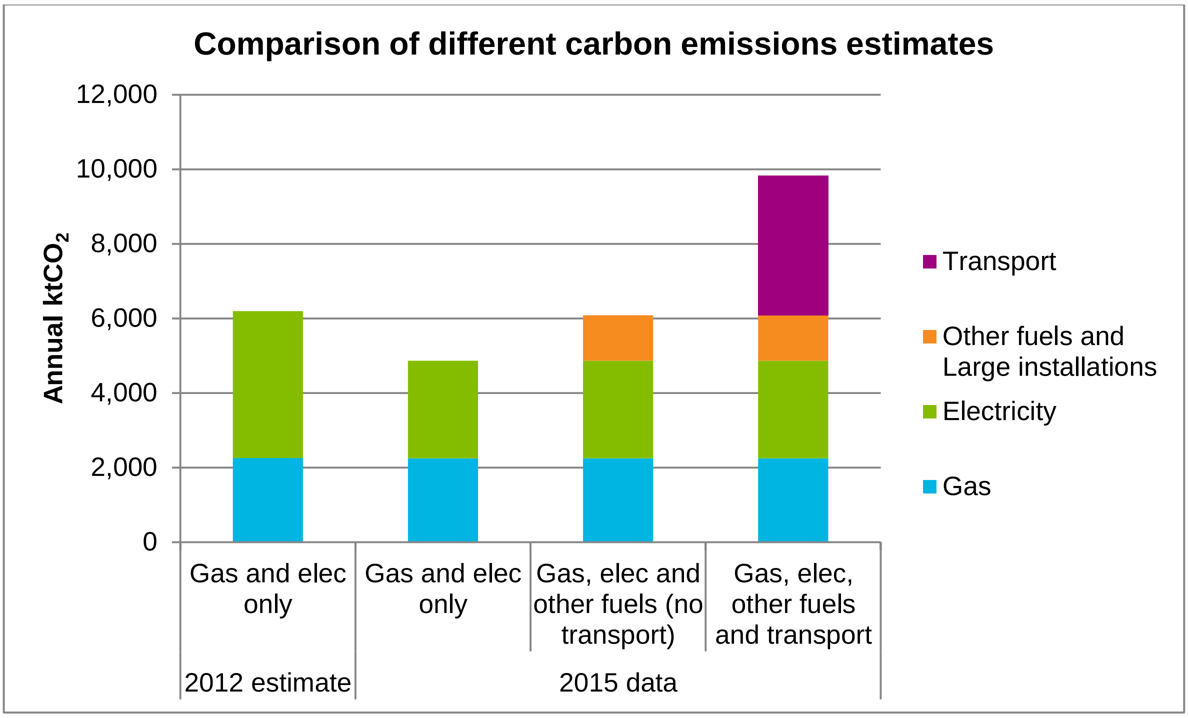
Updated carbon emissions baseline

Since the 2012 report was published, carbon emissions associated with gas and electricity consumption only in Kent appear to have decreased by approximately 21%, from 6,191 ktCO_2 per year to 4,868 ktCO_2 per year. This change is partially attributed to:

- Differences in energy consumption – gas consumption decreased by approximately 10% while electricity consumption increased by approximately 1%.
- Differences in the fuel emissions factors – the carbon intensity of gas has remained relatively stable, while that of electricity has dropped by nearly 30%, from 0.521kgCO_2/kWh to 0.345kgCO_2/kWh, which has a significant impact on the results.

However, note that the findings cannot be used to assess progress against carbon emissions reductions targets, as both consumption and emissions may be influenced by many factors (e.g. *'new industrial or commercial establishments or the closure or downsizing of existing businesses'*) which are outside the scope of this analysis.

A new carbon baseline has been set as part of this update which, in addition to gas and electricity, incorporates additional fuel types, large industrial installations, and carbon emissions arising from transport. Data for these additional fuels types and sectors were sourced from the 2005-2015 UK local and regional CO_2 emissions statistics. Using this method, the total carbon emissions for Kent and Medway are estimated to be approximately 9,837 ktCO_2 per year. This is significantly higher than the previous estimate, as would be expected due to the inclusion of additional carbon emissions sources.

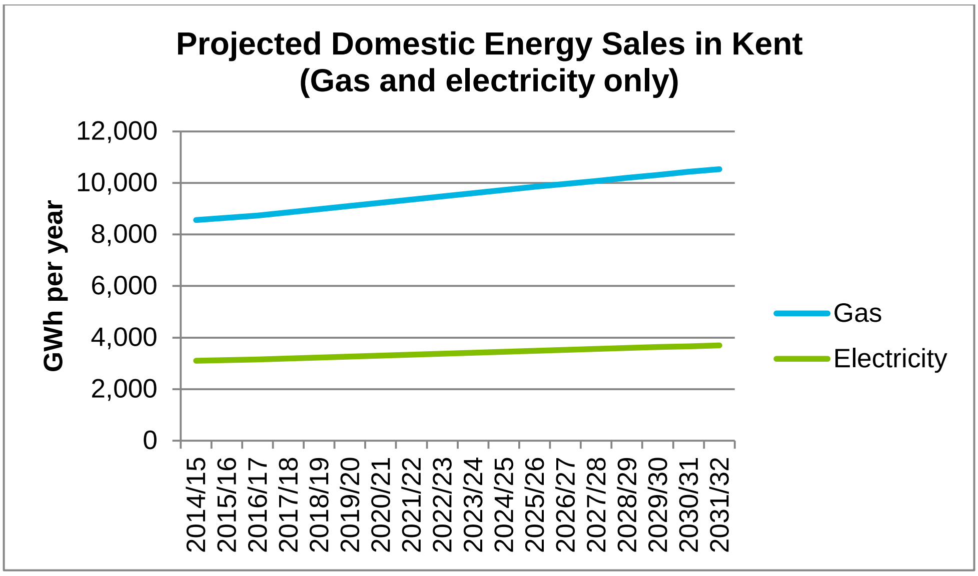


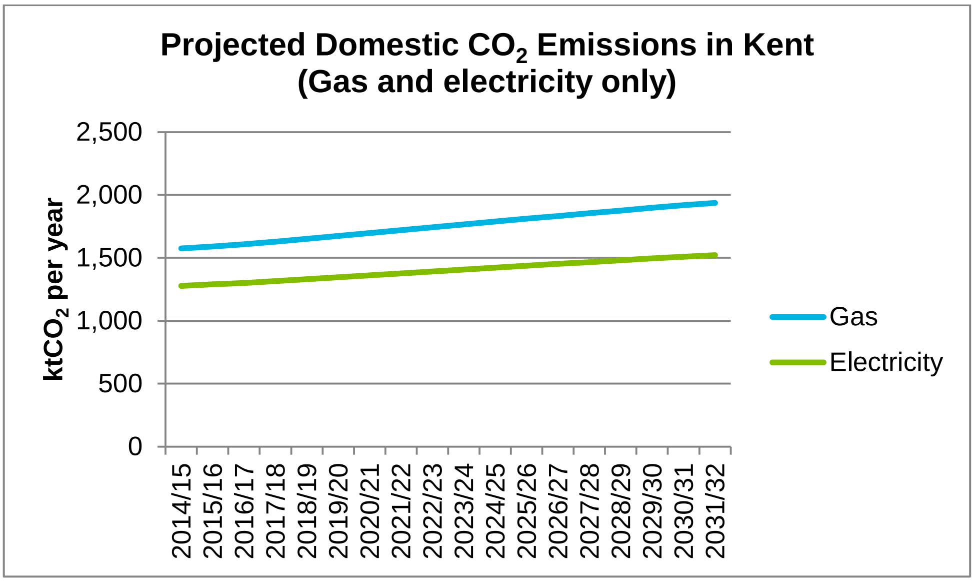
Projected gas and electricity demands for future domestic developments

An estimate is made of the projected energy demands for new domestic construction and associated carbon emissions through the year 2031/32. The calculation assumes that there will be no change in energy demands or fuel emissions factors in this period, and therefore represents a 'business as usual' scenario.

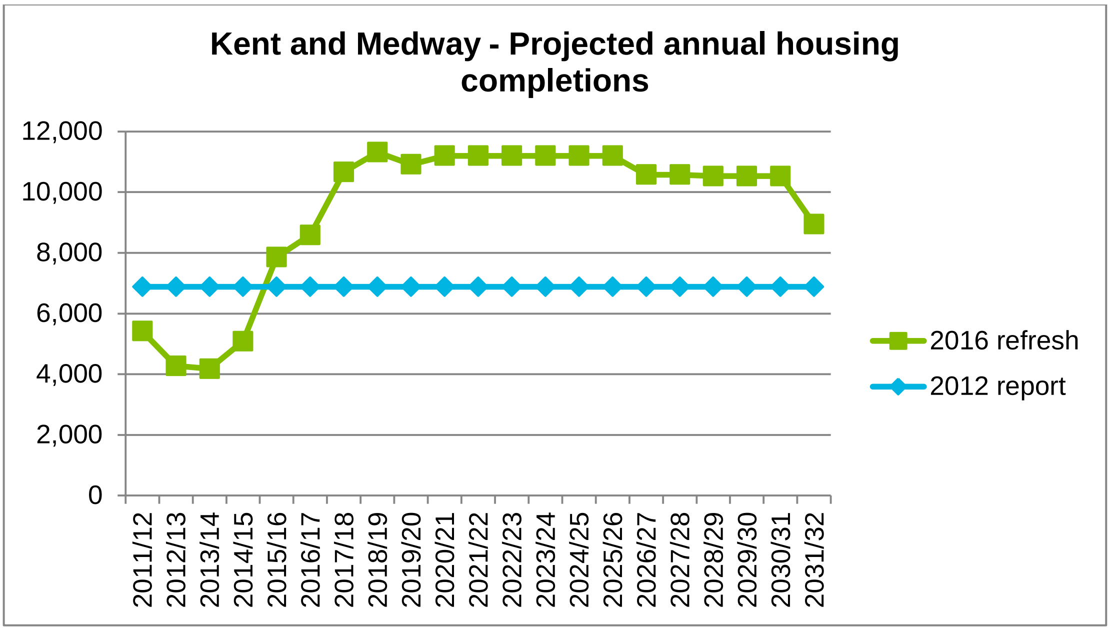
With the above caveat in mind, in the scenario described, gas demand across the domestic sector in Kent and Medway will increase by approximately 23% (from 8,556 GWh per year to 10,520 GWh per year) and domestic sector electricity demand will increase by approximately 19% (from 3,101 GWh per year to 3,693 GWh per year).

Based on the most recent projections provided in the '*Kent and Medway Growth and Infrastructure Framework (KMGIF) Interim Refresh*' (June 2016), new dwellings (i.e. those completed since 2015) could represent nearly 1 in 5 homes in Kent and Medway by the year 2032. This suggests that any effort to reduce energy demands and carbon emissions in the domestic sector will be highly sensitive to the energy efficiency of new homes.



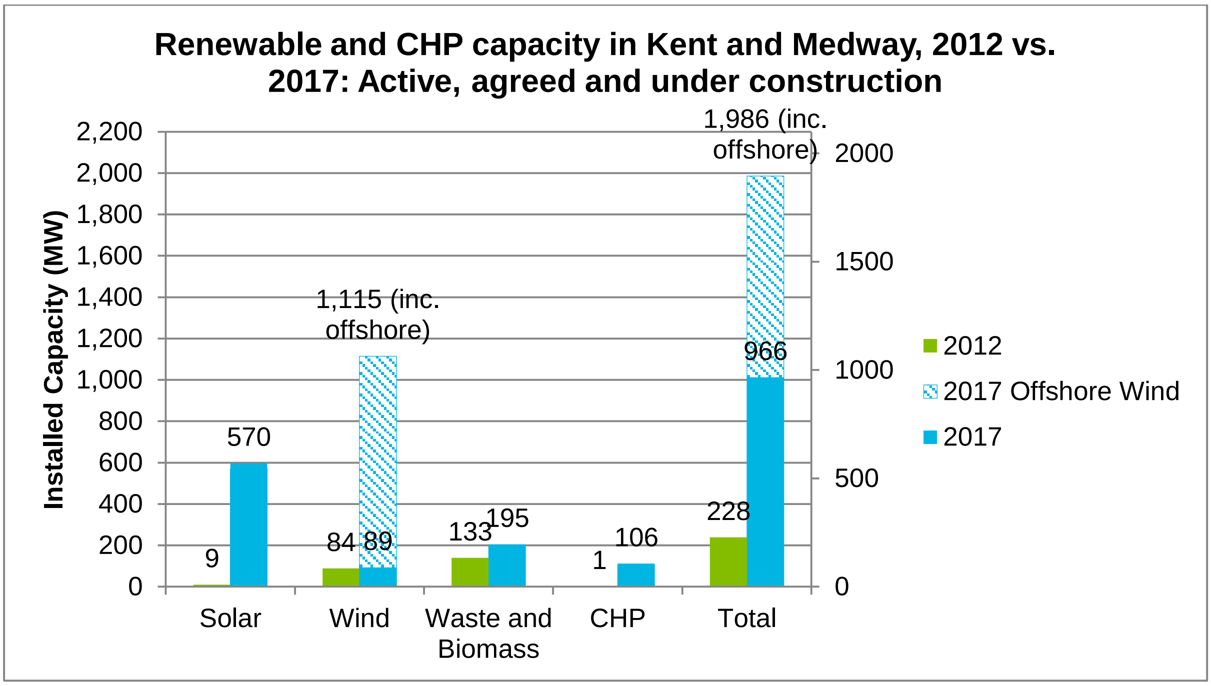


However, results based on projected new dwelling completions should be interpreted with caution. Since the 2012 report was completed, the number of projected annual completions has increased significantly, from roughly 6,500 per year to roughly 10,000 per year, and further changes are possible. Between 2012 and 2016 it was observed that the annual numbers of actual completions within Kent were, on average, below the number projected in the 2012 report, highlighting that the actual completions differed somewhat to the projected trend.



Installed renewable energy and CHP generation capacity

Installed renewable and CHP generation capacity in Kent has increased significantly since the previous report was issued in 2012. The currently installed capacity of solar, wind, waste, and CHP combined (including macro and microgeneration) is over 1,900 MW, compared with approximately 230 MW in 2012. The majority of this increase has been delivered through solar and wind installations, with wind (including large scale offshore arrays) contributing over 1,100 MW and solar over 550 MW.



Future energy scenarios

The following have been identified as key factors which are likely to affect the uptake of each renewable technology as well as how each of the delivery partners will impact the renewable energy sector in Kent in the future:

- Grid decarbonisation;
- Reducing costs of renewable technologies;
- Electricity grid capacity limits;
- Electric vehicle uptake;
- Increasing technology efficiency; and
- The phasing out of incentive schemes

An improving financial case is expected to promote the installation of renewable technologies in future with the improved economics of various technologies offsetting the loss of incentive schemes.

The likely main barriers to future renewable installations could become competition for grid connections to sell generated electricity and, therefore, the key drivers for installing renewables may move away from electricity sales and towards local generation; displacing the need for grid supplied electricity. This case may be increasingly likely if more expensive forms of electrical generation are introduced to the UK energy mix over time.

1. Introduction

Kent County Council has commissioned AECOM to support them in updating key components of the Kent Renewable Energy Action Plan (REAP), produced by AECOM and published in 2012, which set out the following:

- Existing energy demand and supply profiles in Kent and an associated carbon emissions baseline,
- Potential for deployment of various renewable energy sources in Kent,
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2. Methodology

This section of the report describes the methodology used to estimate the current (total) and future (domestic) energy demands and carbon emissions for Kent and Medway, along with the current installed renewable energy and CHP capacity. A rough estimate of the amount of electricity that could be generated from renewables in 2017 is also provided.

2.1 Baseline energy consumption and carbon emissions

2.1.1 Energy consumption

Figures for gas and electricity consumption for domestic and non-domestic uses (excluding transport) are taken from *'Sub-national electricity sales and numbers of customers'* and *'Sub-national gas sales and numbers of customers'* (2015), which provide total energy sales figures for each local authority.

Figures for fuels other than electricity and gas were taken from *'Sub-national total final energy consumption data 2014'* (published 2016).[1] Note that the data may exclude one or more large industrial installations and/or power stations. Transport consumption figures were available within this dataset and were categorised by fuel type. Coal, manufactured fuels and petroleum fuel usage across the rail and road transportation sectors were combined to give the total transportation consumption figures reported.

2.1.2 CO_2 emissions

Emissions for all fuels, including those used within the transportation sector, were taken from *'UK local authority and regional carbon dioxide emissions national statistics: 2005-2015'* (published 2017).[2] Note that this includes point source estimates for some consumers (e.g. large industrial installations) which are excluded from the fuel consumption statistics described above. Therefore, it is not possible to make a direct comparison between fuel consumption and carbon emissions for some fuel types.

The categories reported in the DBEIS carbon emissions dataset include figures for 'agriculture' which exclude electricity and gas, although no fuels are specified. 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 details, refer to the *'2005 to 2015 UK local and regional CO_2 emissions technical report'* (DBEIS, 2017).[3]

2.2 Projected gas and electricity demands for new domestic developments

Domestic energy consumption: Median gas and electricity consumption figures for different dwelling types are derived from the National Energy Efficiency Database (NEED) *'Domestic energy consumption – Gas and electricity consumption by property attributes'* (2014), filtered by age (post-1999), region (Southeast) and electricity tariff (standard).

Note that the categories for 'bungalow' and 'detached' homes are combined and weighted by number of units in the sample, as are those for 'end terrace' and 'semi-detached'. Also note that it has been assumed that all new build homes will utilise a standard tariff; based on AECOM's experience in the region, this is currently the most common approach to meeting Building Regulations requirements for carbon emissions.

Dwelling type	Electricity Consumption (kWh/yr)	Gas Consumption (kWh/yr)
Detached/bungalow	4,428	16,143
Semi-detached/end-terrace	3,292	10,692

[1] For further details, see https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/609332/Sub-national_Methology_and_Guidance_Booklet_2016.pdf
[2] For further details, see https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/533671/Technical_Report_2014.pdf
[3] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/623020/2005_to_2015_UK_local_and_regional_CO2_emissions_technical_report.pdf

Mid-terrace	3,129	9,983
Flats/maisonettes	2,092	5,892

Projected numbers of new homes: Taken from the '*Kent and Medway Growth and Infrastructure Framework (KMGIF) Interim Refresh'* (June 2016) estimates. Forecasts for future dwelling completions are agreed with each district through the Housing Information Audit. The number of completions projected per year for each of the Kent districts has been cumulatively totalled to give the phased increased energy demand up to 2032. For further information, see Appendix A.

Split of new homes by dwelling type: As the KMGIF figures do not provide estimates by dwelling type, the split has been taken from March 2014 council tax records, which are the most recent available at the time of writing.[4] (The figures have been cross-checked against 2011 Census data[5] and are broadly aligned.)

Dwelling type	Proportion
Detached	28%
Semi-detached/end-terrace	24%
Mid-terrace	30%
Flats/maisonettes/other	19%

Projected gas and electricity demands for new domestic developments in each Local Authority are found by multiplying the projected number of new dwellings by the estimated energy consumption figures for each dwelling type.

2.3 Installed renewable energy and CHP capacity

The data used to assess the current amount of renewable capacity installed in Kent was taken from three 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. It aims to provide the fullest possible account of all renewable electricity installations in the UK, including wind, solar, waste and hydro power installations. The full Renewables Map dataset for Kent was extracted as .csv data files on 11/07/2017.

  Note that the Renewables Map only lists larger installations, typically above 0.6 MW in size.

- **OFGEM Feed-in Tariff (FiT) data:** The UK Quarterly statistics are published by OFGEM and give an account of all 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 31 March 2017 Part 1'* (13/07/17)[6] 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 totalising the installed capacity for Kent for 'Photovoltaics' and 'Small Wind' installations.

- **OFGEM Renewable Heat Incentive (RHI) data:** As with the FiT, this dataset has been published by OFGEM but is updated on a monthly basis. This study utilised the *'RHI Monthly Official Statistics Tables 03 June 2017'* (28/07/17)[7], which have been used to determine the number of accredited installations currently active in Kent. Splits by technology type have been calculated using the assumptions listed in Appendix F.

- **BEIS installed CHP capacity:** Information about installed CHP capacity was taken from 'BEIS CHP Focus Database' (13/07/17)[8]. It is available in regional format and was processed down to county level for Kent.

[4] http://www.kent.gov.uk/__data/assets/pdf_file/0017/7352/Housing-stock-by-size,-type-and-tenure.pdf
[5] http://www.kent.gov.uk/__data/assets/pdf_file/0016/7351/Housing-stock-by-tenure.pdf
[6] https://www.ofgem.gov.uk/publications-and-updates/feed-tariff-installation-report-31-march-2017
[7] https://www.gov.uk/government/collections/renewable-heat-incentive-statistics
[8] http://chptools.decc.gov.uk/app/reporting/index/viewtable/token/2

2.4 Estimate of electricity generated from renewable sources

Capacity factors were derived for offshore wind, onshore wind, solar and bioenergy/waste using information from the Digest of UK Energy Statistics *'6.4: Capacity of, and electricity generated from, renewable sources'* (2017).[9] These were applied to the installed capacity as described in the UK Renewables Map to obtain a rough estimate of the amount of potential renewable electricity generation in 2017. For further information about capacity factors, see Appendix C.

Some technologies or generation categories were excluded from the estimate; see Section 2.6.6 for further details and caveats.

2.5 Future energy scenarios – Revised assumptions

2.5.1 Data collection

In setting out the future renewables uptake potential for Kent the previous report presented various assumptions relating to the uptake of renewable energy among five agreed delivery partners: Individuals/Communities, Housing Developers, Business Sector, Public Sector, and Energy Developers. These were based on considerations such as analysis of past trends, workshops and consultations with stakeholders, market analysis and research, and AECOM's expertise in energy consulting. In this update, we have re-evaluated these assumptions in a variety of ways, both qualitative and quantitative:

- Where possible, a direct comparison has been made between the current installed renewable capacity (see above) and the estimates provided in the 2012 report.
  - Where specific energy installation proposals were identified in the 2012 report, research has been carried out to establish whether these have progressed as planned. The UK Renewables Map data has been consulted as it contains information about energy installations that are in progress, proposed, rejected and/or cancelled.
  - A meeting was held between AECOM and Kent County Council on 19th July to discuss key observations and any specific actions taken since the 2012 report was published.
  - Specific estimates have been tested, where possible, against the currently installed renewables data. For example, the 2012 report suggests that the number of solar thermal installations could increase from 100 to 1000 in the period 2012-2020; this was checked against the number of RHI accreditations for this technology during that time period.
- A qualitative assessment has been carried out, based on AECOM's experience in helping to deliver housing and energy infrastructure across the country, to identify key industry trends, technology changes and policy developments that may have affected uptake.

For further details of the assumptions made in processing the above data, see Appendix F.

2.5.2 New projections for 2020

The previous report presented two estimates of potential energy generating capacity by 2020, represented as 'Business as Usual' (BAU) and 'All Actions Adopted' (AAA) scenarios. This report provides updated estimates of potential 2020 energy generating capacity based on installations which are active, have been agreed, or are currently being built, according to their designation as listed in the UK Renewables Map database.

It will also provide an indication of the total generation capacity that would be installed if all currently *proposed* installations were to be built and brought forward by 2020. Note that such estimates are only available for the technologies described in the UK Renewables Map database.

[9] https://www.gov.uk/government/statistics/renewable-sources-of-energy-chapter-6-digest-of-united-kingdom-energy-statistics-dukes

Given that this update has been commissioned in 2017, only three years away from 2020 and the Growth and Infrastructure Framework (GIF) runs to 2032, it may be more appropriate if undertaking a full review and update of the Kent REAP to extend the timeframe to 2032 or beyond.

2.6 Limitations

2.6.1 Understanding changes in energy sales and associated carbon emissions

Year-to-year changes in energy consumption may result from various causes, including but not limited to changes in energy demand (e.g. reflecting improved efficiency), weather, or other consumer behavioural factors. As noted in the *'Sub-national consumption statistics: Methodology and guidance booklet'*:

> *"It is important to recognise that when making comparisons at local authority level from year to year, total and average consumption levels are influenced by new industrial or commercial establishments or the closure or downsizing of existing businesses […] The impact that these changes have on totals and averages is highly dependent on the size of the businesses."*

Therefore, the findings presented in this report cannot be used to assess whether (or how) progress has been made against carbon emissions reductions targets.

2.6.2 Combining 2014 and 2015 energy consumption data

The carbon baseline described in the 2012 report was derived from DECC 2009[10] estimates for carbon emissions arising from gas and electricity consumption only. The estimate excluded other fuels, the transportation and agricultural sectors and large industrial installations. In this report, an estimate is made of CO_2 emissions arising from all fuel types and sectors (where data is available).

At the time of writing, the most recently available datasets published by the Department for Business, Energy & Industrial Strategy (DBEIS) are as follows:

- Figures for the **carbon emissions** arising from all fuel types and sectors reported (gas, electricity, other fuels, large installations and transport) are from 2015 (published in 2017)[11]
- Figures for gas and electricity **consumption** are from 2015 (published 2017)[12]
- Figures for other fuels, including transportation, **consumption** are from 2014 (published 2016)[13]

Note: It has been assumed that 'energy sales' (the term used in the DECC/DBEIS publications) is equivalent to 'energy consumption'.

In order to produce the most up-to-date estimates of energy consumption by fuel type, this report has combined the 2014 and 2015 data, as described above to ensure data coverage across all energy types and sectors. This is expected to have a small impact on the results where energy consumption by fuel type is reported. For the purpose of this report, the substitution is not considered to be significant as it arises from year-on-year fluctuations in energy sales.

2.6.3 Projecting energy demands and carbon emissions arising from new domestic development

This analysis assumes that the split of dwelling types, the associated gas and electricity consumption, and fuel emissions factors will remain at current levels over this time period. It does not account for potential changes in energy efficiency standards, development densities, energy delivery methods (e.g. switching to primarily electric heating) or grid decarbonisation. Therefore, the results do not allow for an in-depth analysis of the impact of new dwelling completions on energy consumption and carbon emissions.

[10] https://www.gov.uk/government/collections/uk-local-authority-and-regional-carbon-dioxide-emissions-national-statistics
[11] https://www.gov.uk/government/statistics/uk-local-authority-and-regional-carbon-dioxide-emissions-national-statistics-2005-2015
[12] https://www.gov.uk/government/collections/sub-national-electricity-consumption-data, https://www.gov.uk/government/collections/sub-national-gas-consumption-data
[13] https://www.gov.uk/government/collections/total-final-energy-consumption-at-sub-national-level

The above refinements could be applied to this analysis in future, subject to agreement upon modelling assumptions and methodology. Doing so would likely have the following impacts on the results (these predictions do not account for the potential development and uptake of alternative fuels):

- Changes in energy efficiency requirements would tend to reduce energy demands for space heating overall.
- Gas sales to all dwellings would decrease in the event of a large-scale shift towards electricity as a preferred heating fuel.
- Carbon emissions associated with each unit of electricity consumed are projected to decrease due to the decarbonisation of the grid supply. The carbon intensity of grid electricity reported by BEIS was 0.345kgCO_2/kWh in 2015, significantly lower than the figure used in 2012. This trend of decarbonisation is expected to continue with a potential factor for grid electricity of 0.3-0.1kgCO_2/kWh by 2032, approximately 40-80% lower than the 2012 figure. The effects of a decarbonising grid are discussed in section 3.4.

2.6.4 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 from e.g. the Planning Portal website.

Because this database was not compiled by AECOM, the company cannot take responsibility for the 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 satisfactory.

2.6.5 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. Data for the smaller installations were taken from the FiT and RHI materials. 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.

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 a significant proportion of all renewable generation installation in Kent and will give an accurate representation of the current capacity installed within the county. 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.

2.6.6 Renewable electricity generation: Developing an estimate

Note the following:

- Figures are presented in order to provide a **rough** comparison between (a) electricity consumed and (b) the potential amount of renewable electricity that could be generated in 2017. For the purpose of this exercise it was assumed that sales are to equal consumption. Some electricity consumed may not be captured in this data (e.g. wind/solar microgeneration); the impact has not been quantified but it likely to be relatively small.
- This report endeavours to present the most recent data available at the time of writing. However, available data from different sources covers a range of time periods. Capacity factors are derived from 2016 data that was published in 2017; renewable energy installations are current (autumn 2017) and the electricity sales

data is from 2015. This is not considered significant for the purpose of this exercise as the figures shown are intended only as rough estimates.

- Note that capacity factors have been derived from UK-wide data and would be expected to differ year-to-year and according to the specific site in question. Therefore, they can not necessarily indicate the actual amount of electricity that will be generated in 2017, but provide an estimate of what might be possible based on the technologies installed.
- In addition to the capacity factors, another potential constraint on the amount of renewable electricity that could be generated is insufficient capacity in the electrical grid. This report has not examined whether and to what extent grid capacity has or may impact upon renewable electricity generation.

Some technologies or generation categories were excluded from the estimate, as described below:

- PV and wind microgeneration (FiT) were excluded on the assumption that electricity from these sources would primarily be used at the generation site, and would also not necessarily be captured in the electricity sales data.
- Electricity generated from CHP was also generally excluded. Although in some instances it would be classed as renewable (i.e. when fuelled by biomass), there was insufficient data about individual systems to determine the proportion of renewable fuels used. Project-specific information would also be required in order to develop a sensible generation estimate as they are not electrically-led systems (i.e. they are operated depending on heat demand).

  The exception to this is the Ridham Dock Biomass CHP (24.5 MWe) which is included in the 'waste and biomass' category. This is because, on the basis of available information, it is understood to run entirely on biomass.[14] If, like other CHP installations, it was excluded, this would lower the estimated renewable electricity generation by a small amount (approx. 3%). This difference is small compared to other sources of uncertainty (e.g. those related to capacity factors).

2.6.7 Future energy scenarios – Revised assumptions

The process of estimating the installed renewable capacity developed by each of the 5 of delivery partners required differing methodologies for each of the datasets. This was due to differing reporting formats across the dataset used. All assumptions applied to the process of allocating the total capacity attributed to each delivery partner are outlined in Appendix F.

It has been assumed that all installations in the UK Renewables Map with the project status listed as agreed/building will be live by 2020. As a result the final projected 2020 installed capacity figure is sensitive to project cancellation, postponement or alterations; therefore, actual 2020 figures could differ from those reported.

The results also include an indication of the total capacity including installations which have been proposed but not agreed. This only covers technologies listed in the UK Renewables Map database; therefore, whilst it represents a relatively higher estimate, it may not represent the potential total capacity across all technology types. No assumptions have been made regarding the relative likelihood of these projects being progressed and therefore it is assumed that all proposed projects will progress to completion.

The future energy scenarios are sensitive to a variety of issues such as the relative cost of technologies, the rate of grid decarbonisation, other technology improvements such as battery storage, among other factors. These are discussed in more detail in Section 3.4.3.

[14] https://www.mvv.de/en/mvv_energie_gruppe/mvv_umwelt/beteiligungen/mvv_environment_1/ridham_dock_1/plant/index.jsp

3. Results and discussion

This section of the report provides updated estimates for the current (total) and future (domestic) energy demands and carbon emissions for Kent and Medway, along with the current installed renewable energy and CHP capacity. Differences with the 2012 report and differences are discussed where relevant.

3.1 Baseline carbon emissions

3.1.1 Comparison with previous (2012) report

In the 2012 report, a carbon baseline was set for Kent and Medway as follows:

Carbon emissions: Original 2012 estimate Gas and Electricity only (2009 data)	Non-domestic ($ktCO_2/yr$)	Domestic ($ktCO_2/yr$)
Emissions associated with gas use	695	1,562
Emissions associated with electricity use	2,171	1,764
Total gas and electricity	2,866	3,325
Total gas and electricity both sectors	**6,191**	

The most recent gas and electricity sales data for 2015 have been used to produce updated carbon emissions estimates for comparison with the previous issue:

Carbon emissions: Revised 2017 estimate Gas and Electricity only (2015 data)	Non-domestic ($ktCO_2/yr$)	Domestic ($ktCO_2/yr$)
Emissions associated with gas use	635	1,610
Emissions associated with electricity use	1,553	1,069
Total gas and electricity	2,188	2,679
Total gas and electricity both sectors	**4,868**	

In this time period, the estimated carbon emissions **arising from gas and electricity consumption only** appear to have decreased by approximately 21% overall, dropping from 6,191 kt CO_2 per year to 4,868 $ktCO_2$ per year. Differences are expected to primarily arise from changes in reported gas and electricity sales, and changes in the fuel emissions factors used. These are described below.

Carbon emissions factors: The 2012 report used 2011 fuel emissions factors from the Department for Environment, Food and Rural Affairs (DEFRA). In this update, we have used 2015 fuel emissions factors applied within the *Local and Regional Carbon Dioxide Emissions for 2005-2015* (DBEIS). The fuel factor for gas remained similar, increasing by less than 3%, whereas for electricity it decreased by approximately 30%.

Fuel Emission Factors ($kgCO_2/kWh$)
Changes since 2012 report

Fuel type	DEFRA 2011	DBEIS 2015
Gas	0.183	0.188
Electricity	0.521	0.345

Gas sales and associated carbon emissions: Reported gas sales decreased by roughly 10% overall, as shown in Figure 1 below.[15] As the fuel emission factors have not changed significantly, carbon emissions associated with gas consumption over this period would tend to decrease roughly in proportion to gas sales.

[15] . Note that the data is weather-corrected and there may have been changes to the correction factors or methodology used in the intervening period. For further information, see https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/369933/Overview_of_Weather_Correction_of_Gas_Industry_Data.pdf

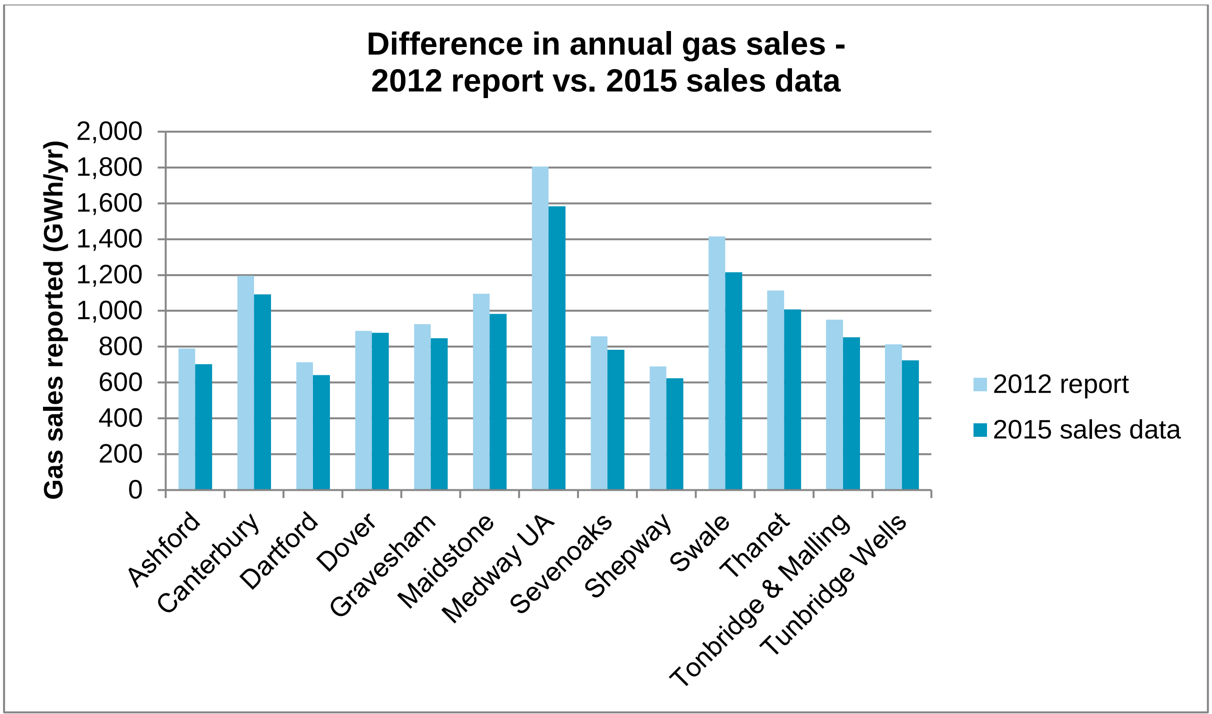


Figure 1. Difference in total annual gas sales, 2012 vs. 2015 sales data

Electricity sales and associated carbon emissions: Differences in reported electricity sales are shown in Figure 2 below. Total sales were similar in the years assessed. However, because the fuel emission factor for electricity decreased by approximately 30%, carbon emissions from electricity are significantly lower.

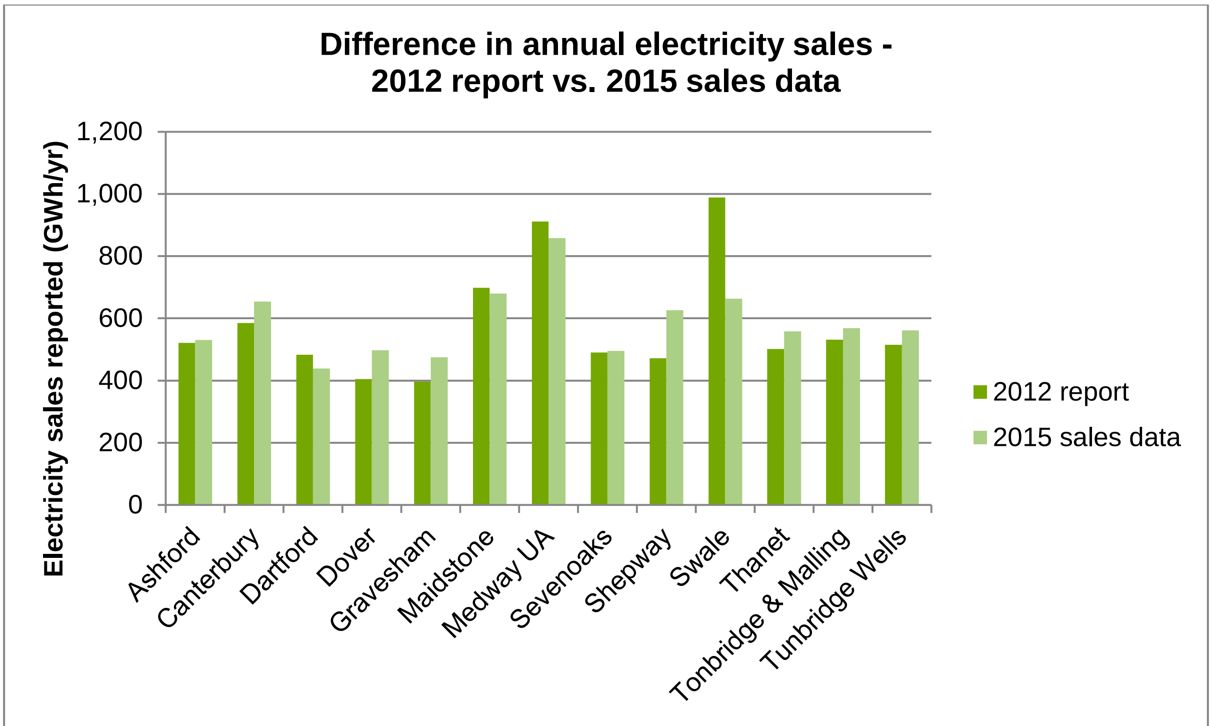


Figure 2. Difference in total annual electricity sales, 2012 vs. 2015 sales data

As discussed Section 2.6.1, the above results should be treated with some caution. In particular, recall that year-to-year changes in energy sales may arise from many factors, including changes in business operations and large consumers. This may explain the anomalously large apparent decrease in electricity consumption in Swale for the years evaluated, which is the result of lower reported sales in the non-domestic sector. No similar drop is seen in gas sales for Swale; it is worth noting that gas consumption figures are accompanied by a note which says, *'This area contains at least one major power station or large industrial consumer whose consumption has not been included in the data.'*

Further details of electricity and gas sales (broken down by sector and Local Authority) are provided in Appendix A and Appendix B, respectively.

3.1.2 Total fuel consumption and carbon emissions

This section describes the total fuel consumption and carbon emissions for Kent and Medway by fuel type and sector. As discussed previously, this data has been collated from 2014 and 2015; for the purpose of this report, it is considered sufficient to give an approximate indication of the energy consumption of Kent and Medway using the most up-to-date figures for each fuel type.

As shown in Figure 3 below, gas and electricity combined account for approximately 54% of total fuel consumption. Petroleum products account for 41% of total consumption, the large majority of which is associated with road and rail transportation (see table below). Bioenergy and waste, manufactured fuels, and coal combined account for just over 4% of total fuel consumption.

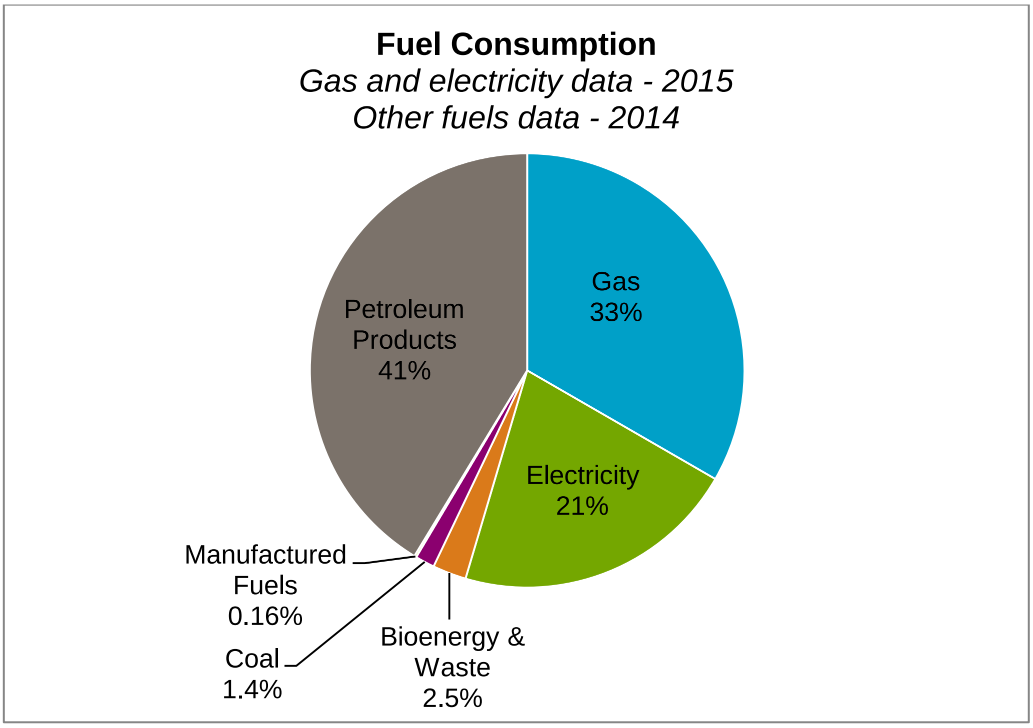


Figure 3. Total fuel consumption for Kent and Medway.

Further information is provided in the table below.

Fuel consumption (GWh)	Non-Domestic	Domestic	Road Transport	Rail	Bioenergy & Waste *(sector not specified)*	Total by fuel type
Gas*	3,380	8,565	-	-	-	**11,945**
Electricity*	4,501	3,099	-	-	-	**7,600**
Bioenergy & Waste	-	-	-	-	897	**897**
Coal	455	53	-	9	-	**516**
Manufactured fuels	41	16	-	-	0	**56**
Petroleum products	1,102	609	13,034	43	0	**14,788**
Total by sector	**9,478**	**12,342**	**13,034**	**51**	**897**	**35,801**

** indicates 2015 data. All other figures use 2014 data.*

Figure 4 and Figure 5 show the total carbon emissions for Kent and Medway by fuel type and sector (where reported), respectively. Results indicate that, for the years specified:

- Total carbon emissions in Kent and Medway for all fuel types, including transport, are estimated to be approximately 9,837 ktCO_2 per year.
- Transport-related carbon emissions account for the largest proportion of the total, at 38%, followed by non-domestic emissions at 33%. (Note that transport-related emissions are reported by DBEIS[16] according to road type, not fuel type.) Domestic carbon emissions account for the remaining 29%.
- Electricity and gas combined account for approximately 50% of total emissions; when transport is excluded, this figure increases to 80%. Note that this figure may be higher or lower as some sectors did not specify consumption by fuel type.
- Notably, in the domestic sector, nearly 94% of emissions are associated with gas and electricity use and only 6% are associated with other fuels.

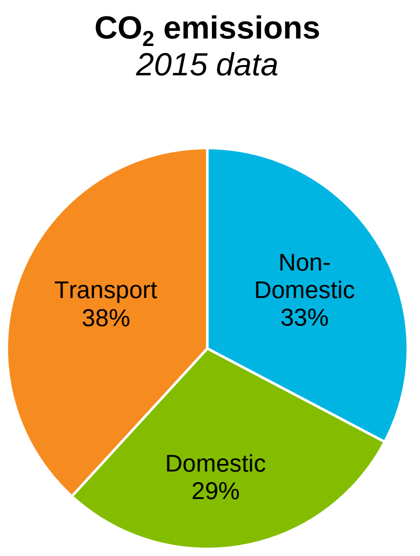


Figure 4. CO_2 emissions by sector.

[16] *'UK local authority and regional carbon dioxide emissions national statistics: 2005-2015'* (DBEIS, 2017)

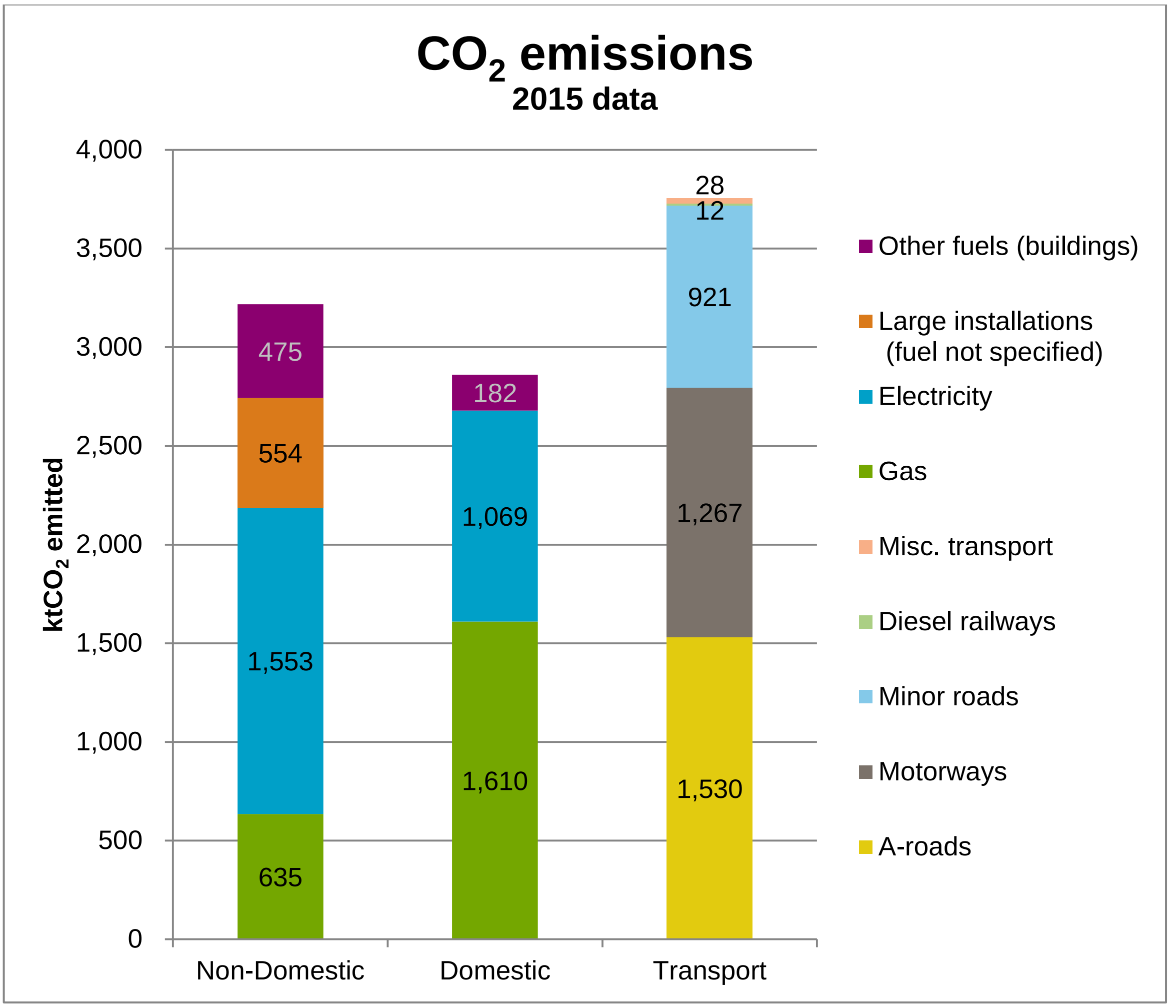


Figure 5. CO_2 emissions by fuel type.

Further details are provided in the table below.

Carbon emissions	Non-Domestic ($ktCO_2$)	Domestic ($ktCO_2$)	Transport ($ktCO_2$)	Total by fuel type ($ktCO_2$)	% of total (%)
Electricity	1,553	1,069	-	2,622	27%
Gas	635	1,610	-	2,246	23%
Large installations	554	-	-	554	6%
Other fuels (buildings)	475	182	-	658	7%
Transport	-	-	3,757	-	38%
A-roads	-	-	*1,530*	-	*16%*
Motorways	-	-	*1,267*	-	*13%*
Minor roads	-	-	*921*	-	*9%*
Diesel railways	-	-	*12*	-	*0.1%*
Misc. transport	-	-	*28*	-	*0.3%*
Total by sector	**3,218**	**2,862**	**3,757**	**9,837**	100%
Percent of total	33%	29 %	38%	100%	

3.1.3 Comparison of different methods of estimating carbon emissions baselines

The 2012 report established a carbon baseline using gas and electricity sales data only. In this update, we have presented updated figures for gas and electricity for the purpose of comparison, in addition to new estimates which include other fuel types and transport. As shown in Figure 6 below, these produce very different results, which is to be expected given the inclusion of additional emissions sources. A direct comparison between the 2012 estimate and 2015 data shows that the annual consumption of gas and electricity has decreased by approximately 20%.

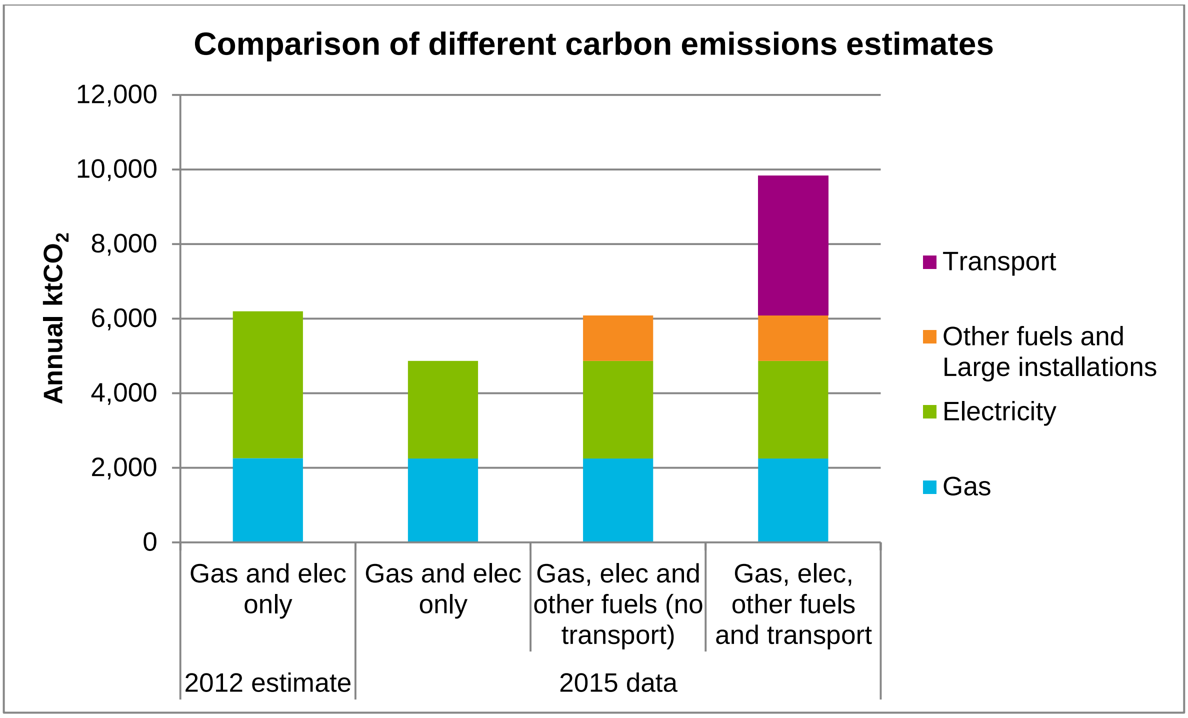


Figure 6. Comparison of different carbon baseline estimates

3.2 Impact of new domestic developments

3.2.1 Projected energy demands and associated carbon emissions

Figure 7 shows the projected annual gas and electricity sales from 2015 (the most recent year for which figures are available) to 2032, for current dwellings and projected new dwellings in Kent and Medway. Figure 8 shows the projected annual CO_2 emissions arising from domestic gas and electricity sales over the same period. Further details are provided in Appendix D.

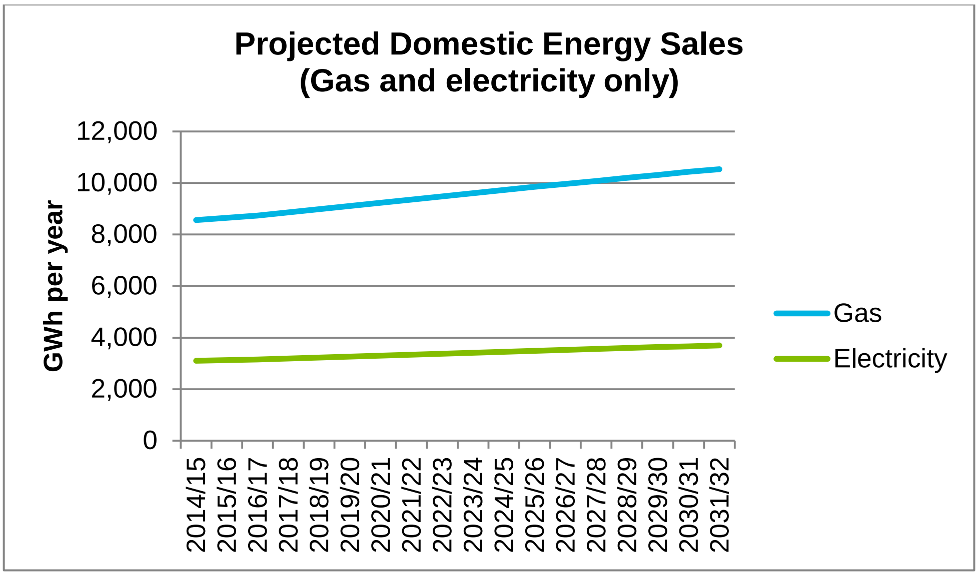


Figure 7. Projected annual domestic energy sales, gas and electricity only.

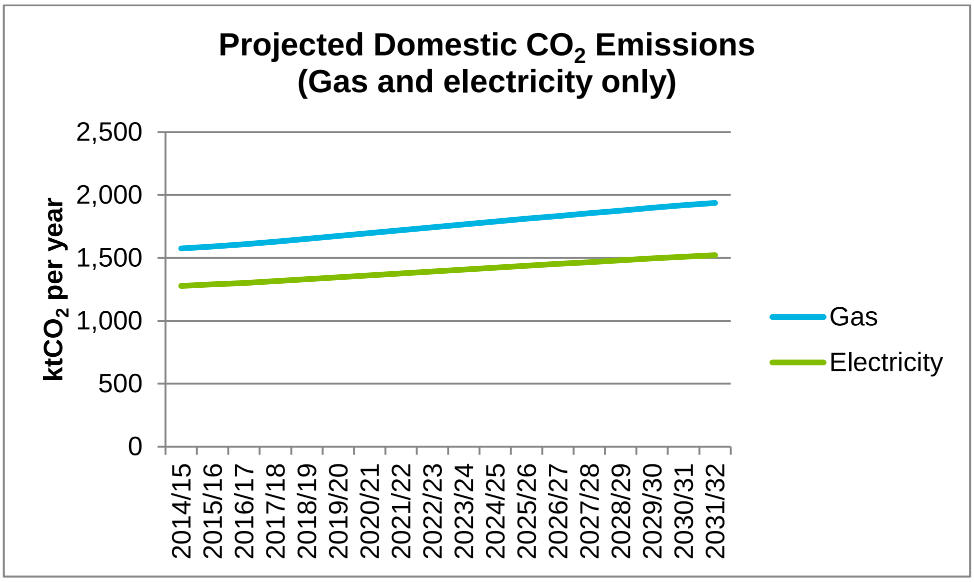


Figure 8. Projected annual domestic CO_2 emissions arising from domestic gas and electricity sales.

As these figures demonstrate that although the majority of energy consumed is gas, due to the higher fuel emissions factor for electricity, the latter accounts for a relatively large proportion of the total carbon emissions.

Over this period of time, in the scenario presented, gas demand in Kent and Medway would be expected to increase by approximately 23% (from 8,556 GWh per year to 10,528 GWh per year) and electricity demand would be expected to increase by approximately 19% (from 3,101 GWh per year to 3,694 GWh per year).

3.2.2 Comparison with 2012 report

The 2012 report did not include estimates of future energy demands resulting from new development, and therefore a direct comparison with earlier figures is not possible. However, by considering the number of total new dwelling completions, it is possible to put the impact of new domestic development into perspective. As of 2014/15 there were approximately 756,400 dwellings in Kent and Medway, and based on current projections, this is expected to increase by 178,600, for a total of approximately 935,000 by 2031/32.

In other words, by 2031/32, nearly 1 in 5 homes would have been completed post-2015. Therefore, the rate at which Kent and Medway minimise energy demands in the domestic building sector is likely to be highly sensitive to the energy efficiency of those new buildings. The future carbon emissions associated with the domestic building sector may not represent a rise in energy demand due to increasing dwelling number. Decarbonisation of the grid may drive a move to electrically lead heating systems and therefore the carbon emissions associated with domestic heating will also decrease over time. However, increasing numbers of electrical heating systems is likely to cause significant increases in regional power demand and have implications for local power infrastructure.

It is also worth noting, however, that the projected number of new dwelling completions has changed considerably since the previous issue, as highlighted in Figure 9. Such projections should be interpreted with caution as they are sensitive to many factors including market forces, policy changes, shifts in overall patterns of housing demand, etc. which are difficult to forecast. For further information about the projected new dwelling completions, see Appendix A.

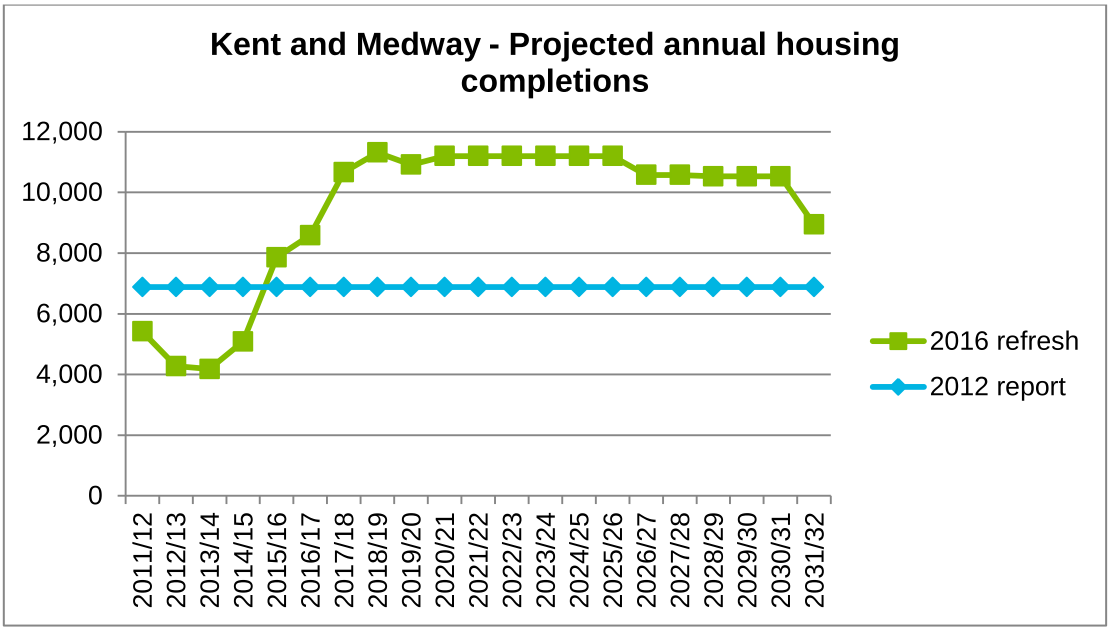


Figure 9. Projected annual dwelling completions, 2012 vs. 2017

Further discussion of future scenarios along with sources of uncertainty are provided in Section 3.4.

3.3 Renewable energy and CHP capacity

3.3.1 Installed capacity

Renewable and CHP generation capacity in Kent has increased significantly since the previous report was issued in 2012. The capacity of solar, wind, waste, and CHP combined that is active, agreed or under construction is over 1,900 MW (including offshore wind farms), compared with approximately 230 MW in 2012. The majority of this increase has been delivered through solar and wind installations, with wind contributing over 1,100 MW and solar over 550 MW.

Solar generation installations include a high number of small-scale renewables (defined as those <0.5 MW) which account for 113 MW (approx. 20%) of the total solar capacity. The majority of installed solar capacity comes from larger installations (>0.5 MW) which represent deliver 457 MW (approx. 80%) of solar capacity.

Wind energy capacity almost entirely comprises large scale offshore installations (>2 MW), accounting for 1,020 MW (approx. 91%) of the total installed capacity. Onshore large scale installations make up 84 MW (approx. 8%) of wind capacity, and small scale wind energy represents the remaining 5.5 MW (approx. 0.5%).

Figure 10 (below) shows all of the renewable generation capacity that this study has identified in Kent. 'Active (macro)' installations are those listed in the UK Renewables Map and CHP-related databases, whereas 'Active (micro)' installations have been identified via the FiT database. 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. 'Refused' and 'Cancelled' capacity refers to projects that may have been included as proposed or agreed previously, but are now no longer going forward. Due to the limitations in the data, micro generation has only been included in the active data; it has not been considered for proposed or cancelled projects.

Note that Ridham Dock Biomass CHP is included in the 'Waste and Biomass' category (24.5 MWe) as it is understood to run entirely on biomass; see Section 2.6.6).

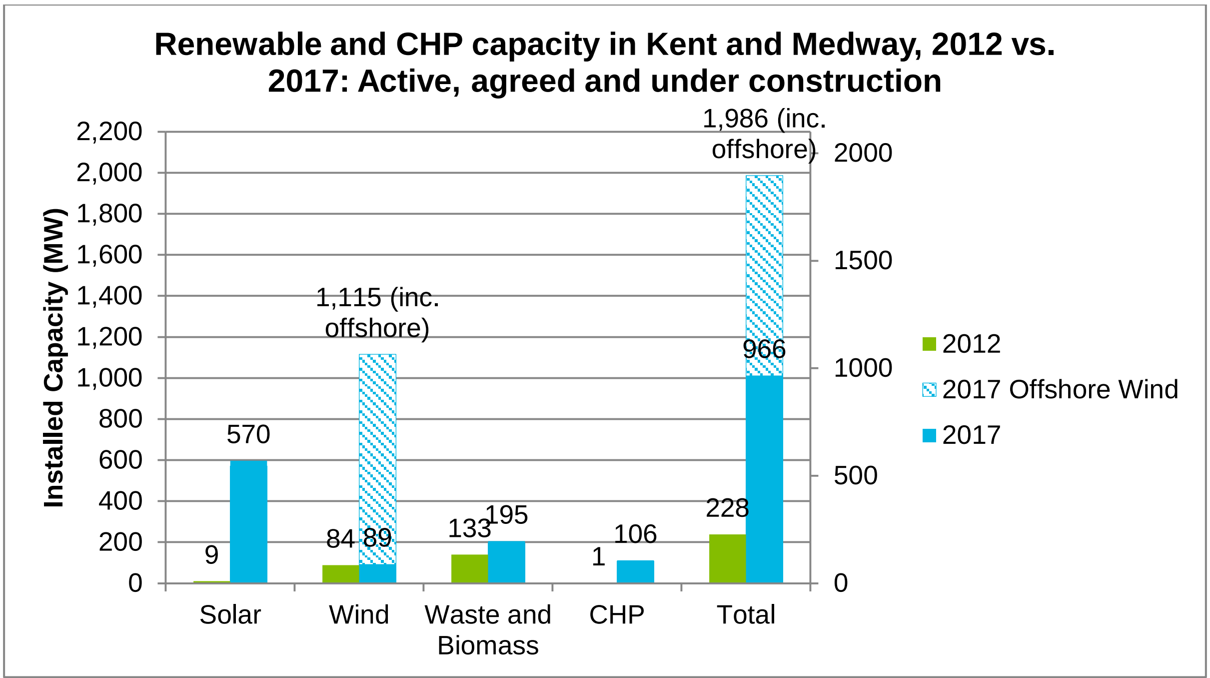


Figure 10. Renewable energy and CHP, 2012 vs. 2017

The table below shows the breakdown of all installations for which data was available, including those that are proposed, applications refused, and projects that have been cancelled, based on their classification in the UK Renewables Map database.

Status as of 2017	Solar (MW)	Wind (MW)	Waste (MW)	CHP (MW)	Total (MW)
Active (macro)	451	1,020 *(offshore)* 84 *(onshore)*	144	106	1,805
Active (micro)	113	6	4	<1	123
Agreed/Construction	6	0	47	0	53
Proposed	110	49	19	0	178
Refused	32	31	35	0	97
Cancelled	16	0	25	0	41

Figure 11 shows the geographic distribution of large-scale renewable installations in Kent and Medway.

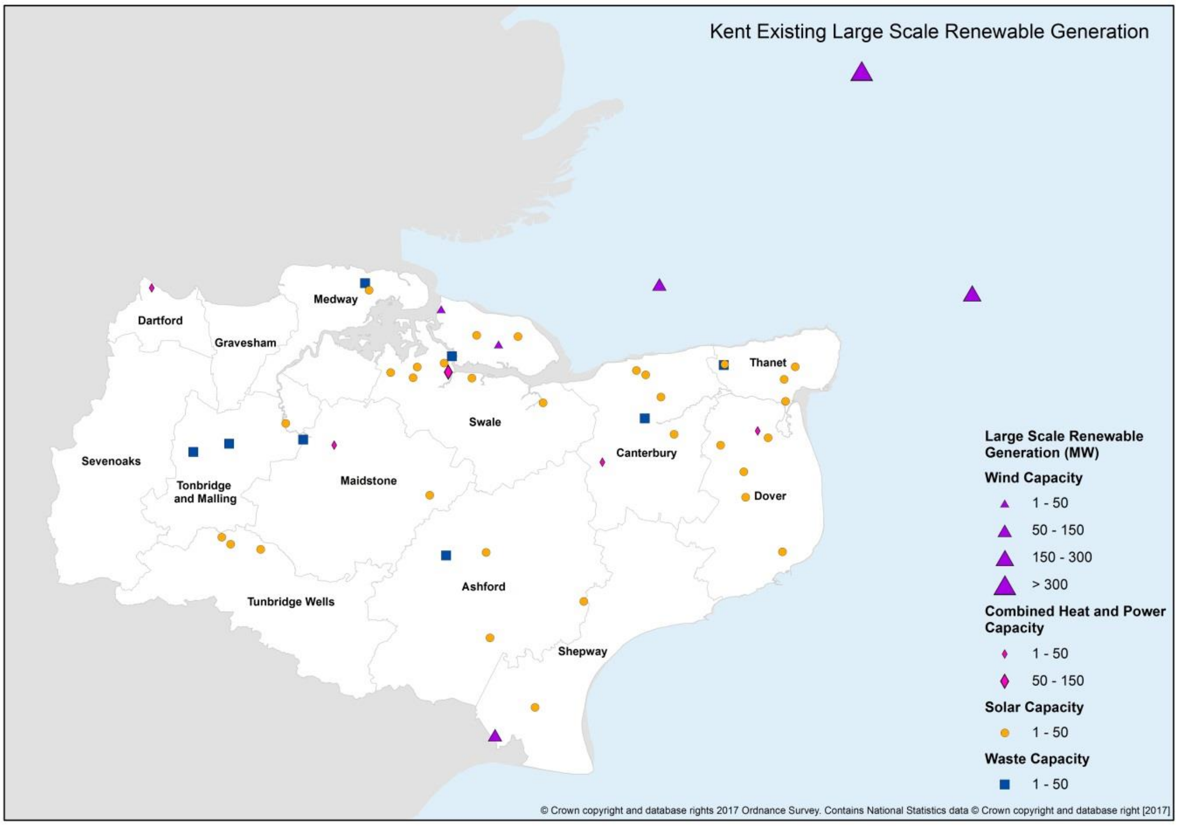


Figure 11. Existing large-scale renewable generation.

Figure 12 shows the distribution of small-scale renewable installations in Kent and Medway, by Lower Super Output Area (LSOA).

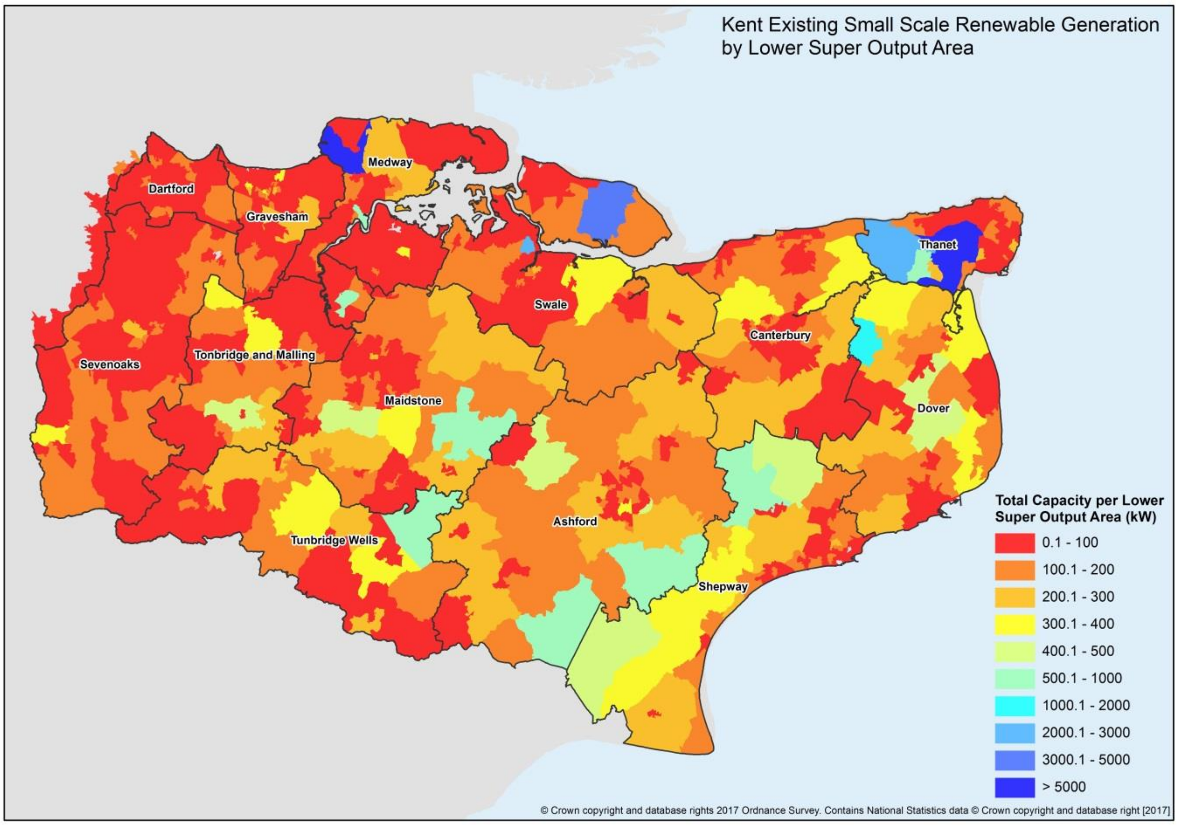


Figure 12. Existing small-scale renewable generation.

3.3.2 Proportion of electricity from renewable sources

Figure 13 (below) shows the total electricity consumed in Kent and Medway in 2015, compared with the **estimated** renewable electricity that could be generated in 2017 based on active installations and derived capacity factors.

Note: These figures are presented only to provide a sense of relative scale and should not be taken to represent the proportion of electricity consumed in Kent and Medway that comes from renewable sources. For instance, there is a large wind capacity reflected in the data due to the offshore fleets, but this electricity feeds into the grid and may be consumed elsewhere. The proportion of electricity consumed that is renewable is therefore likely to be lower than the chart suggests, but estimating the true figure is beyond the scope of this report.

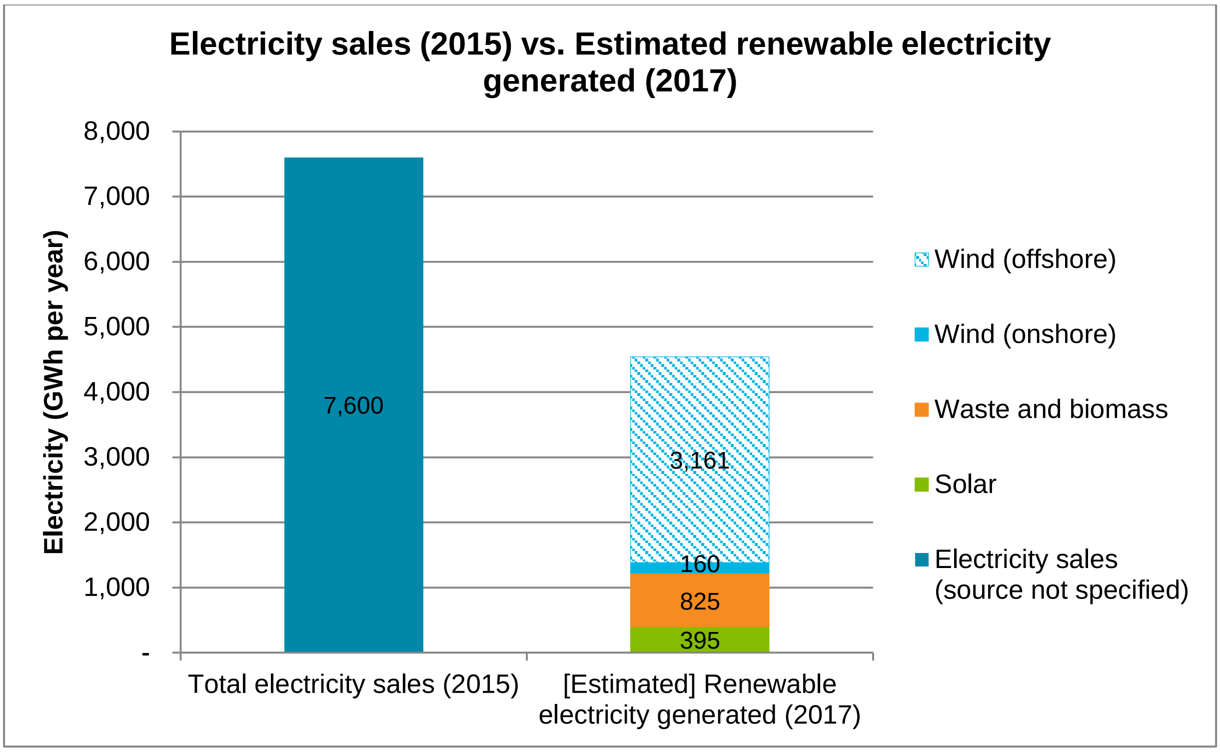


Figure 13. Electricity sales (2015) vs. Estimated renewable electricity generated (2017)

Further details are provided in the table below.

Status as of 2017	Solar	Wind (offshore)	Wind (onshore)	Waste and biomass	Total
Active (macro) (MW)	451	1,020	84	144	1,699
Capacity factor (%)	10%	35.4%	21.9%	65.3%	-
Est. renewable elec. generated (GWh/year)	395	3,161	160	825	**4,541**
Electricity sales 2015 (GWh/year)	-	-		-	**7,600**

Note: Whereas Sections 3.3.1and 3.4 of this report include CHP, microgeneration and installations that have been agreed or are under construction, this section does not; see Section 2.6.6 for further details:

3.4 Future energy scenarios

This section of the report compares the 2012 BAU and 'All Actions Adopted' (AAA) scenarios against revised capacity estimates for the year 2020. Key trends and issues affecting uptake are outlined, first with regards to the different technologies, and then with regards to the different delivery partners, as relevant. This is followed by a brief discussion of some broader trends which may affect future estimates.

3.4.1 Overview

The previous report presented two estimates of potential energy generating capacity by 2020, represented as 'Business as Usual' (BAU) and 'All Actions Adopted' (AAA) scenarios. This report provides updated estimates of potential 2020 energy generating capacity based on installations which are active, have been agreed, or are currently being built (as designated in the UK Renewables Map database). This comparison is shown in Figure 13 below. Figures in italics indicate revised totals which include projects that have been proposed but not agreed.

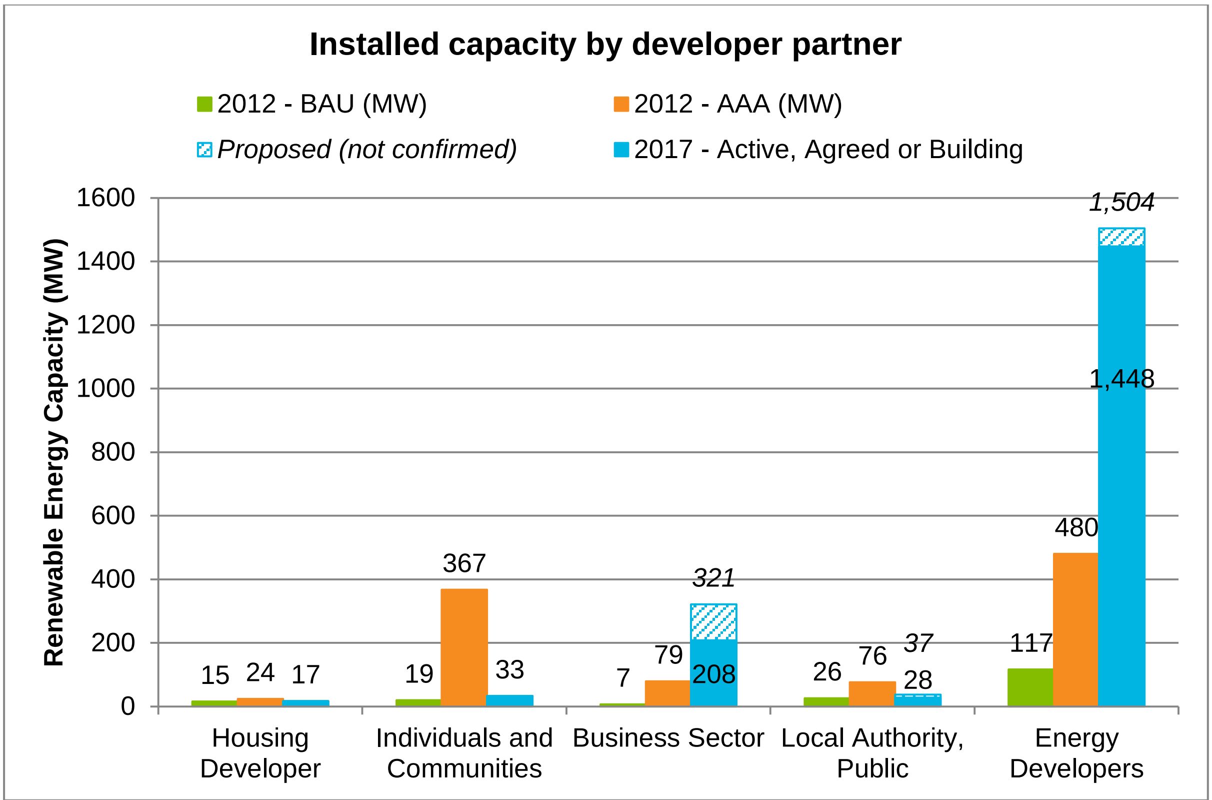


Figure 14. Installed capacity by development partner.

Sector	2012 BAU (MW)	2012 AAA (MW)	2017 Active, Agreed or Building (MW)	2017 Inc. projects proposed (MW)
Housing Developer	15	24	17	17
Individuals and Communities	19	367	33	33
Business Sector	7	79	234	347
Local Authority, Public	26	76	28	37
Energy Developers	117	480	1,448	1,504
Total	**184**	**1,027**	**1,759**	**1,937**

The results indicate that the total renewable energy generation capacity that is active, agreed or being built is 1,759 MW. This is considerably more than the 1,027 MW predicted by the AAA scenario in the earlier report, and nearly ten times higher than the BAU scenario. Note that these figures include multiple offshore wind farms, therefore not all of the capacity is physically within Kent.

Three out of the five delivery partners have delivered renewable energy at a rate slightly above, but roughly in line with, the BAU scenarios. It can be seen that most of the exceedance results from the business sector and energy developers. This is primarily due to a high uptake for solar farms and large-scale wind turbines, as shown in Figure 14 below.

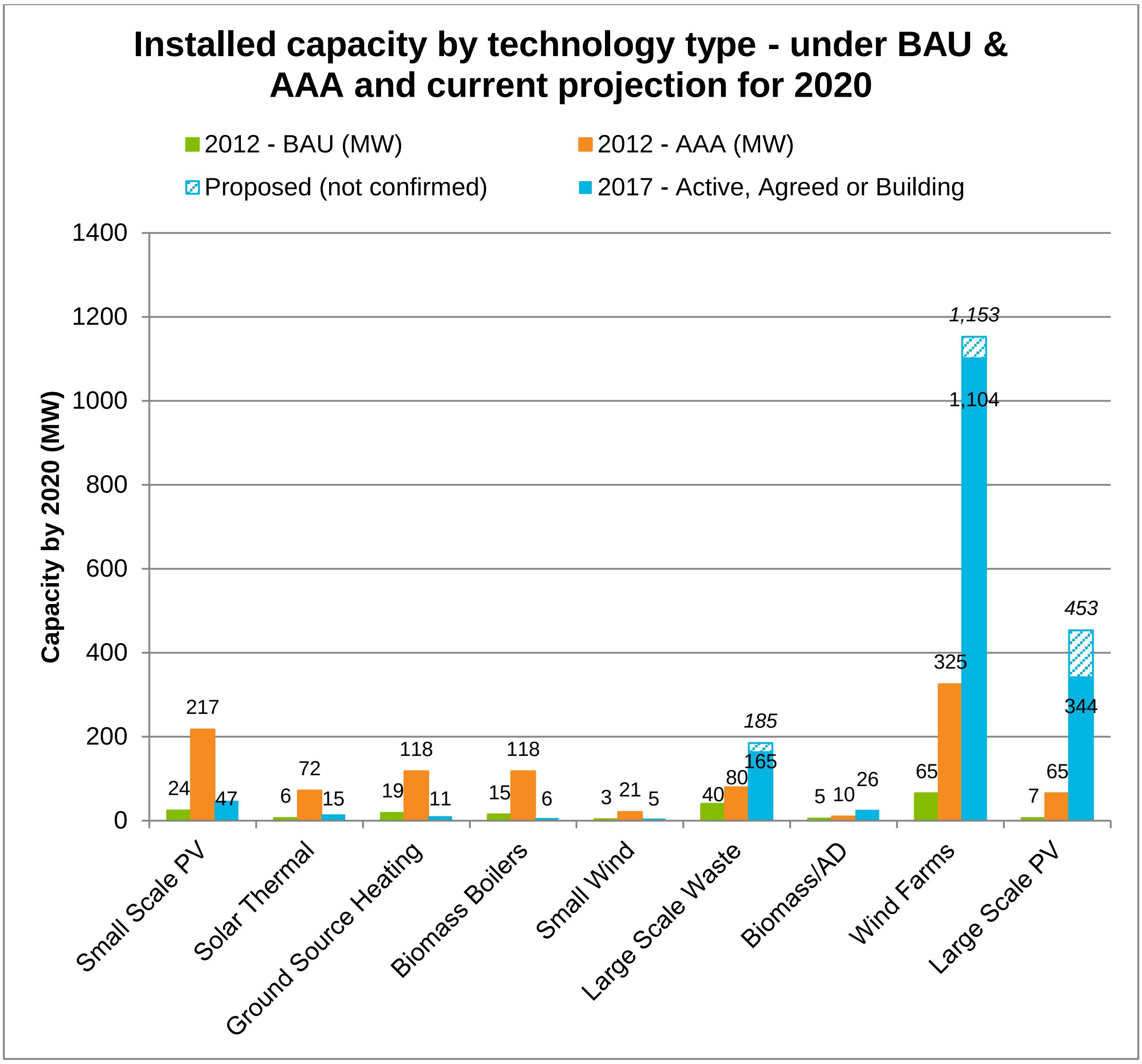


Figure 15. Installed capacity by technology type.

Results indicate that:

- **Small-scale PV** uptake is nearly double the BAU projections, likely due in large part to rapidly falling costs partnered with incentive schemes being available between 2012 and 2017.
- **Solar thermal**: RHI data suggests only 7-8 installations have taken place, for which the total installed capacity of these installations is higher that the BAU projection. As discussed in Section 2.5.5 it is likely that there are a number of solar thermal installations that are not accounted for within the RHI dataset and of

these most would typically boast small amounts of installed capacity. It is more likely that smaller schemes would not be registered with an incentive scheme as the financial returns of the scheme would be smaller for this installation type – therefore reducing the attractiveness of registering the installation. As a result, the number of actual installations is likely to be significantly greater than reported by the RHI data. However, the total capacity for Kent may not be significantly different if these additional installations are accounted for due to the anticipated size of the installations.

- **Ground source heating (GSHP) uptake is considerably lower than BAU projections. This is likely due to various factors. GSHPs** are generally difficult to site, expensive to install, and can be difficult to maintain in the event of a fault or poor installation practice. The cost-effectiveness of heat pumps is also highly sensitive to the price of electricity; electrical heating products compete with natural gas for which prices have been relatively low.
- Uptake of (small-scale) **biomass boilers** is also below BAU projections. At present, the price of such boilers is still high compared to gas boilers, whereas the cost of natural gas has been low. Other barriers to uptake include the need to transport and store large amounts of fuel and increasing concerns around air quality impacts, especially in urban areas.
- **Small-scale wind** uptake has been higher than expected. The cost per kW installed for small scale wind has decreased over time, which in conjunction with the availability of FiT means that small scale installers may have greater opportunities to benefit from this technology.
- **Large-scale waste**: The vast majority of the installed capacity results from several large EfW plants, including those at Riverside (EfW - 66 MW), Allington (EfW - 43 MW) and Kemsley (EfW – under construction – 45 MW). Policy drivers to reduce the amount of waste going to landfill and increasing numbers of examples within the county operating successful business models may be encouraging the uptake of EfW sites. A further 20MW of capacity is currently proposed.
- **Biomass/Anaerobic Digestion (AD)**: The 2012 AAA scenario assumed that large-scale biomass installations would be constructed at Ridham and Richborough Energy Centre, but restricted the AAA total capacity to 10MW due to presumed limitations in fuel availability. The Richborough Energy Centre project appears to have stalled, but Ridham (Biomass - 24.5 MW) is now active. There is also a smaller AD plant at St Nicholas Court (1.2 MW). Barriers to biomass uptake have been discussed above; for large-scale installations, air quality is a particular concern and the current policy trend is to reduce amounts of combustion within key Air Quality Management Areas.
- Large-scale **wind farms** account for the largest increase in renewable generation capacity by far, despite the fact that the anticipated Phase 2 of the London Array was cancelled in 2014. The 2012 report mentioned planned projects at the Isle of Sheppey (10 MW) which is now active, and Harringe Brooks (15 MW) which is still under consideration.
- Finally, there has also been a large increase in the number of **solar farms**. As noted above, this is likely related to falling costs per kW of PV.

3.4.2 Delivery partners

This section reviews the key assumptions made in the 2012 report in regards to the potential renewable energy delivery by five identified delivery partners.

Individuals/communities		
Technology	**2012 assumptions**	**2017 observations/updates**
Solar thermal (existing homes) [17]	Assumed 100 in Kent in 2012, increasing to 1000 by 2020, based on population and total market size.	Data suggests that a very small number (perhaps <10) have been accredited or applied for since the previous report was issued. It is anticipated that a greater number of installations, such as retrofits, have occurred but have not be accredited with the RHI scheme. The cost per square meter is considerably higher than for PV, and solar thermal is a mature technology, meaning that costs are not expected to fall as quickly. It has been proposed to remove solar water heating from RHI eligibility which may further reduce public interest in this technology.
PV (existing homes)	Assumed 1% of homes would have PV by 2020	FiT data indicates that there have been roughly 7,800 individual PV installations since November 2011. The total number of homes in Kent is roughly 756,500 (see Section 3.2) so the 1% estimate appears to be in line with the observed trend.
Heat Pumps (existing homes)	0.1% of homes to install - AECOM assumption	The cost-effectiveness of heat pumps is highly sensitive to the price of electricity; at present, these compete with natural gas for which prices have been relatively low. The UK-wide RHI figures indicate that ASHPs are more common than GSHPs. Barriers to ASHP uptake include the need to locate external kit, and noise concerns. GSHPs are expensive and difficult to site; there is also a risk of poor performance due to incorrect

[17] The RHI database does not provide sufficient detail to determine the precise number of applications per technology. In this case, estimates are based instead on the UK-wide technology split and total number of RHI accreditations in Kent.

Individuals/communities		
Technology	**2012 assumptions**	**2017 observations/updates**
		installation.
Biomass Boilers (existing homes)	0.1% of homes to install - AECOM assumption	Biomass uptake has likely been lower than previously anticipated, due to factors such as the low cost of natural gas, challenges in sourcing and transporting the fuel, and air quality concerns.
Community wind	Assumed increase from 15 to 30 community wind projects by 2020	No new information
Community solar	As above	No new information

Housing Developers		
Technology	**2012 assumptions**	**2017 observations/updates**
Solar thermal	Assumed 20% of homes would have solar water heating installed to meet Building Regulations	Based on AECOM's experience in large-scale housing developments, solar thermal technology tends to be seen as too expensive and complex for new developments. Where it is necessary to reduce carbon emissions in order to meet Building Regulations or other planning requirements, PV offers a cheaper route to compliance. RHI data suggests that a very small number of solar thermal installations (perhaps <10) have been accredited or applied for since the previous report was issued.

Housing Developers

Technology	2012 assumptions	2017 observations/updates
PV	Assumed 30% of new homes would have solar PV installed	In general, PV still tends to be installed as a means of meeting Building Regulations or planning requirements. It is considered a viable route for compliance in many cases due to improvements in the efficiency of the technology, along with a dramatic cost decrease in the past few years.
Heat Pumps	Assumed 20% of homes would have heat pumps installed	See note on heat pumps above.
Biomass Boilers	Assumed 10% of new homes would have biomass boilers	See note on heat pumps above.

Business Sector

Technology	2012 assumptions	2017 observations/updates
PV	Original report assumed close to zero uptake across all technologies. Assumed slightly higher uptake for farmers and landowners due to availability of space and FiT.	As noted above, much more PV has been installed than was previously assumed. Aside from one installation on a Morrisons warehouse and one currently agreed or being built, most other installations are located on farms, as expected.
Heat pumps		RHI data does not indicate the number of installations.
Biomass boilers		RHI data does not indicate the number of installations.
Small wind		Two small wind installations are proposed (Agney Farm and Engine Shed) but it appears that neither one is currently in use.

Public Sector

Technology		2012 assumptions	2017 observations/updates
Solar thermal	Education buildings	Assumed 'some installation'; approx. 5% uptake under BAU	Requires confirmation from KCC
	Hospitals	Assume 1 hospital with solar	

Public Sector

Technology		2012 assumptions	2017 observations/updates
		water heating	
	Libraries, Emergency services, etc	Assumed 'some installation'; approx. 10% uptake under BAU	
PV	Education buildings	Assumptions as for solar thermal	Requires confirmation from KCC
	Hospitals		
	Libraries, Emergency services, etc		
Heat Pumps	Education buildings	Assumed 'some installation'; approx. 1% uptake under BAU	Requires confirmation from KCC
	Hospitals	Assumed 1 hospital with heat pumps	
Biomass Boilers	Primary/secondary schools	Assumed 22 schools with boilers approaching end of life would convert to biomass	Requires confirmation from KCC
	Universities	Assumed zero uptake under BAU	
	Health and Hospitals	Assumed zero uptake under BAU	
	Community Buildings	Assumed 10 community buildings would switch to biomass	

Energy Developers

Technology	2012 assumptions	2017 observations/updates
Large Scale Biomass Power Stations	1 5MWe power station as BAU scenario	Ridham Rock biomass plant is now in use (approx. 24MW)
Large Scale EfW	Assumes that the equivalent of one 40MWe plant will be installed by 2020	Richborough Energy Park appears to have stalled. Kemsley Paper Mill (EfW CHP 45 MW) is listed as ‘Agreed/Building.’
Onshore Wind Farms	Generally assumes that onshore wind will get planning permission by 2020	Little Cheyne Court is still active. Smaller onshore wind farms now active at Standford Hill, Tilbury and Isle of Sheppey. Harringe Brooks is still under consideration and listed as ‘Proposed’

Energy Developers		
Technology	**2012 assumptions**	**2017 observations/updates**
		but not active.
Offshore Wind Farms	AECOM assumption	Extension to Kentish Flats has been completed (15 turbines). London Array Phase 2 was scrapped in 2014.
Large Scale PV	Thanet and Ebbsfleet were installed and others were in planning but there was uncertainty surrounding incentive schemes	Cancellation of the RO and changes to FiT could impact uptake; however, this is likely to be outweighed by decreasing costs, particularly relative to gas-fired generation technologies. See Section 3.4.3 below.

3.4.3 Future trends

There are a range of projected trends which are likely to affect the uptake of each renewable technology and potentially impact how each of the delivery partners will influence the renewable energy sector in Kent in the future. This section briefly describes the projected trends and outlines how these may favour or obstruct the uptake of the renewable technologies within Kent.

- **Grid decarbonisation –** A nationwide trend of increasing renewable energy capacity, low carbon fuels and phasing out of the more pollution fossil fuels such as coal and oil is leading to the decarbonisation of the national electricity grid.[18] This trend is expected to continue however, the rate of decarbonisation is sensitive to policy, economics and consumer choice.

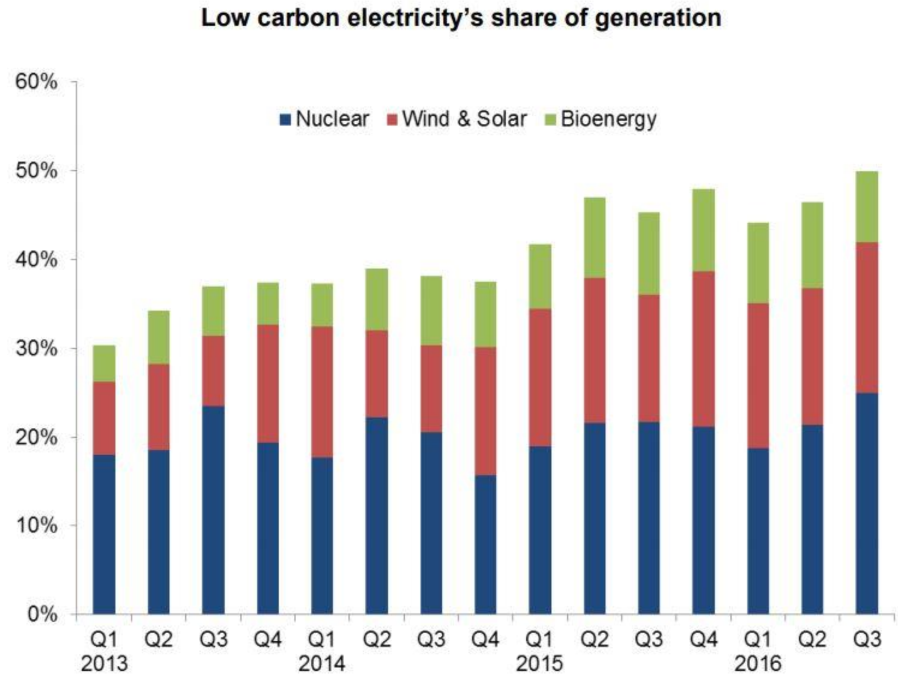


Figure 16. Low carbon generation share of the UK energy mix. Source: *'UK Energy Statistics, Q3 2016 Statistical Press* Release' (BEIS 2016)

As the energy grid continues to decarbonise, the marginal rate of return on new renewable installations will tend to decrease, both in terms of costs and carbon emissions. This may be offset by decreasing costs of renewable technologies (see next page). Anticipated effects on specific technologies are as follows:

- **PV**: the carbon savings of PV are expected to decrease due to the reducing carbon factor of the grid electricity displaced. This is expected to reduce the favourability of the technology among housing developers who consider using PV to meet local planning policy targets and Building Regulations.
- **Heat Pumps**: the carbon savings associated with the heating provided by heat pumps will increase due to a reducing grid electricity carbon factor, making heat pumps more competitive with gas boilers and CHP for individual and community heating scenarios.
- **Solar Thermal**: Due to the reduced carbon savings of PV discussed above, solar thermal may become and more popular choice for the displacing of heating demand that would be served either by a gas or electrical heating system. However, the carbon saving benefits of having a solar thermal installed with an electrically lead heating system also would decrease over time.

[18] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/579543/Press_Notice_December_2016.pdf

- **Cost of renewable technologies -** BEIS produces levelised cost estimates which permit comparison of different generation technologies. The report *'Electricity generation costs'* (BEIS, 2016)[19] indicates that there has been a considerable drop in the projected lifecycle costs of on- and offshore wind and large-scale solar installations. This report, along with estimates from the Committee on Climate Change[20], indicate that onshore wind and solar could be roughly equivalent to gas by 2020, and cheaper by 2025. The commercial case for renewables is also becoming more favourable due to advancements in the technology efficiencies.

  The cost of electricity is likely to increase due to the issues around increasing amounts of intermittent power generation and infrastructure upgrades then individuals and communities may opt to install onsite renewables in combination with micro-grids to reduce utilities costs. The increasing viable commercial case for renewables is diving changes to existing incentive schemes such as the FiT, RHI and Renewables Obligation.

  - The **Feed-in Tariff** (FiT) was introduced in 2010. Incentives for PV were initially high, which drove high uptake; subsequently, these were cut in order to manage costs. In 2016 there were large decreases in the rate of new PV installations which corresponded with the reduced incentives.[21] There is considerable uncertainty around future FiT tariffs, which could negatively affect uptake among some consumers.
  - The **Renewable Heat Incentive** (RHI) was introduced for non-domestic buildings in late 2011. Initially, the majority of incentives were paid for biomass boilers, as these received favourable rates; this may help to explain the lower uptake for heat pumps and solar thermal technologies. The RHI was not extended to domestic buildings until 2014.
  - As of this year solar thermal technology no longer receives subsidies, and therefore installations would be expected to decrease. Notably, however, the consultation indicated that many of those who installed solar water heating were likely to have done so regardless of the RHI. It is therefore difficult to comment on the impact this will have. In general, as for the FiT, there is considerable uncertainty around the future of the scheme.
  - The **Renewables Obligation**[22] required UK electricity suppliers to source an increasing proportion of their electricity from renewable sources. As of early 2017, the RO closed to all new generating capacity.

  The phasing out of incentive schemes is not expected to significantly impact the uptake of renewables as the effects of it removal are likely to be offset by the economics of renewables becoming increasingly favourable over time.

- **Grid capacity limits –** An aging electrical distribution network invokes capacity issues if significant upgrades are not viable within a timescale that matches local generation capacity. The cost of network connections and limitation on installation size are beginning to impact the viability of renewable installations, which may reduce the rate of uptake in renewables in future. However, with the limitations that this presents other technologies such as battery storage may further boost the viability of renewables in the future. In the 2012 report, the lack of appropriate energy storage technology was identified as a significant barrier to renewable energy deployment. Since then, battery technologies have improved and are becoming more competitive; the industry is expected to see considerable growth in the next few years, with the government announcing funding of the technologies development in July 2017.
- **Electric vehicles:** The past few years have seen an increasing shift towards the use of electric vehicles and transport. The British government (following a similar pledge in France) intends to ban all new petrol and diesel cars from 2040[23] and several major companies have publically committed to stop producing traditional petroleum-fuelled cars within the next few years.[24] Such actions would result in a very large increase in electricity demand. These impacts are not examined quantitatively in this report. Further information can be found in the National Grid's *'Future Energy Scenarios'* report (July 2017).[25]

[19] https://www.gov.uk/government/publications/beis-electricity-generation-costs-november-2016
[20] https://www.theccc.org.uk/wp-content/uploads/2015/10/Power-sector-scenarios-for-the-fifth-carbon-budget.pdf
[21] https://www.ofgem.gov.uk/publications-and-updates/feed-tariff-fit-deployment-caps-reached-tariff-period-1-0
[22] https://www.ofgem.gov.uk/environmental-programmes/ro/about-ro
[23] https://www.gov.uk/government/news/plan-for-roadside-no2-concentrations-published
[24] https://www.theguardian.com/business/2017/jul/05/volvo-cars-electric-hybrid-2019
[25] http://fes.nationalgrid.com/fes-document/

The likely main barriers to future renewable installations could become competition for grid connections to sell generated electricity and, therefore, the key drivers for installing renewables may move away from electricity sales and towards local generation; displacing the need for grid supplied electricity. This case may be increasingly likely if more expensive forms of electrical generation are introduced to the UK energy mix over time.

Note: Policy has not been discussed within this section, but it is assumed that the UK will continue to have progressive policy targeting major national carbon emission reductions; alongside policies to continue to allow intermittent renewable power to securely deliver electricity to the national grid.

4. Conclusions and Summary

Updated carbon emissions baseline

- Carbon emissions associated with gas and electricity consumption only have decreased by approximately 21%, from 6,191 $ktCO_2$ per year to 4,868 $ktCO_2$ per year.This is primarily due to changes in gas and electricity sales, as well as changes in the fuel emissions factors used. In particular, the fuel emissions factor for electricity has decreased from 0.521kgCO_2/kWh to 0.345kgCO_2/kWh, which has a significant impact on the results.
- A new carbon baseline has been set which incorporates additional fuel types, large installations, and transport. Total carbon emissions for Kent and Medway are estimated to be approximately 9,837 $ktCO_2$ per year. This is significantly higher than the previous estimate, which is to be expected due to the inclusion of additional carbon emissions sources.
- However, note that the findings cannot be used to assess progress against carbon emissions reductions targets, as both consumption and emissions may be influenced by many factors (e.g. *'new industrial or commercial establishments or the closure or downsizing of existing businesses'*) which are outside the scope of this analysis.

Projected gas and electricity demands for future domestic developments

- An estimate has been made of the projected energy demands for new domestic construction and associated carbon emissions through the year 2031/32. The calculation assumes that there will be no change in energy demands or fuel emissions factors in this period, and therefore represents a 'business as usual' scenario. This analysis could be refined to incorporate anticipated changes in energy demands and fuel emissions factors upon agreement of modelling assumptions and methodology.
- With the above caveat in mind, in the scenario described, gas demand in Kent and Medway would be expected to increase by approximately 23% (from 8,556 GWh per year to 10,528 GWh per year) and electricity demand would be expected to increase by approximately 19% (from 3,101 GWh per year to 3,694 GWh per year)
- Based on the most recent projections, new dwellings (completed since 2015) could represent nearly 1 in 5 homes in Kent and Medway by 2031/32. This suggests that any effort to reduce energy demands and carbon emissions in the domestic sector will be highly sensitive to the energy efficiency of new homes.
- However, results based on projected new dwelling completions should be interpreted with caution. Since the 2012 report was completed, the number of projected annual completions has increased significantly, from roughly 6,500 per year to roughly 10,000 per year, and further changes are possible.

Installed renewable energy and CHP capacity

- Installed renewable and CHP generation capacity in Kent has increased significantly since the previous report was issued in 2012. The currently installed capacity of solar, wind, waste, and CHP combined is over 1,900 MW, compared with approximately 230MW in 2012. The majority of this increase has been delivered through solar and wind installations, with wind contributing (including large scale offshore arrays) over 1,100MW and solar over 550MW.

Future energy scenarios

- The following have been identified as key factors which are likely to affect the uptake of each renewable technology as well as how each of the delivery partners will impact the renewable energy sector in Kent in the future: Grid decarbonisation; reducing costs of renewable technologies; electricity grid capacity limits; electric vehicle uptake; increasing technology efficiency; and the phasing out of incentive schemes
- An improving financial case is expected to promote the installation of renewable technologies in future with the improved economics of various technologies offsetting the loss of incentive schemes.

Appendix A Electricity sales

2015 electricity sales *Source: 'Sub-national electricity sales and numbers of customers' (2015)*

	Electricity Sales (GWh)		
Local Authority	**Domestic**	**Non-domestic**	**Total**
Ashford	226	304	530
Canterbury	255	399	654
Dartford	167	272	439
Dover	188	309	497
Gravesham	167	308	474
Maidstone	286	394	679
Medway UA	435	423	858
Sevenoaks	248	248	496
Shepway	197	428	626
Swale	240	423	663
Thanet	243	315	558
Tonbridge & Malling	223	346	569
Tunbridge Wells	226	335	562
Kent and Medway	**3,101**	**4,504**	**7,605**

2009 electricity sales *Source: 'Sub-national electricity sales and numbers of customers' (2009)*

	Electricity Sales (GWh)		
Local Authority	**Domestic**	**Non-domestic**	**Total**
Ashford	225	296	521
Canterbury	258	327	585
Dartford	167	316	483
Dover	192	213	405
Gravesham	170	226	396
Maidstone	288	410	698
Medway UA	443	469	911
Sevenoaks	253	237	490
Shepway	201	271	472
Swale	240	749	989
Thanet	248	254	502
Tonbridge & Malling	223	309	531
Tunbridge Wells	232	283	515
Kent and Medway	**3,137**	**4,362**	**7,499**

Appendix B Gas sales

[Note: Gas data is weather-corrected; electricity data is not.]

2015 gas sales *Source: 'Sub-national gas sales and numbers of customers' (2015)*

	Gas Sales (GWh)		
Local Authority	**Domestic**	**Non-domestic**	**Total**
Ashford	502	201	703
Canterbury	763	329	1,091
Dartford	501	142	642
Dover	538	340	878
Gravesham	495	352	848
Maidstone	765	218	982
Medway UA	1,264	319	1,583
Sevenoaks	662	121	783
Shepway	503	120	624
Swale	644	570	1,214
Thanet	699	309	1,008
Tonbridge & Malling	642	210	852
Tunbridge Wells	578	146	723
Kent and Medway	**8,556**	**3,376**	**11,932**

2009 gas sales *Source: 'Sub-national gas sales and numbers of customers' (2009)*

	Gas Sales (GWh)		
Local Authority	**Domestic**	**Non-domestic**	**Total**
Ashford	535	254	790
Canterbury	848	348	1,196
Dartford	541	173	714
Dover	603	285	888
Gravesham	561	364	925
Maidstone	843	252	1,095
Medway	1,439	366	1,805
Sevenoaks	710	149	859
Shepway	557	132	689
Swale	734	682	1,416
Thanet	809	304	1,113
Tonbridge & Malling	707	243	950
Tunbridge Wells	620	194	814
Kent and Medway	**9,507**	**3,746**	**13,253**

Appendix C Renewable electricity generation

A capacity factor is the ratio of actual energy output to the maximum possible energy output over a given amount of time, usually expressed as a percentage (%).

Capacity factors were estimated from the Digest of UK Energy Statistics *'6.4: Capacity of, and electricity generated from, renewable sources'* (2017) using the following formula:

$$Capacity\ factor\ (\%) = \frac{Total\ electricity\ generation\ per\ technology\ (GWh/year) \times 1000}{Installed\ capacity\ (MW) \times 24 \times 365}$$

These were then applied to the active installed capacity in Kent and Medway to estimate the total renewable electricity generation for 2017 as follows:

Technology	Active installed capacity (MW)	Assumed capacity factor (%)	Estimated electricity generated	Units
Solar	451	10.00%	394,780	MWh
Wind (onshore)	78	21.9%	149,870	MWh
Wind (offshore)	1020	35.38%	3,161,267	MWh
Waste/biomass	144	65.25%	824,683	MWh
Total renewable electricity generated (MWh)			4,530,600	MWh
Total renewable electricity generated (GWh)			**4,531**	**GWh**

Note that the derived capacity factors rely on UK-wide data and actual figures would change over time depending on the performance of the specific installation in question. Also note that technologies were aggregated according to the source of energy (onshore wind, offshore wind, solar and waste/biomass). This is not considered significant for the purpose of this report, which intends only to provide a relative sense of scale of renewable electricity generation versus electricity consumption.

Appendix D Projected annual new dwelling completions

Projected new dwelling completions

The table below shows the projected annual new dwelling completions for Kent and Medway from 2011/12 through 2031/32. Annual estimates used in the 2012 report, which were based on average completions between 2006/07 through 2009/10, are also shown.

	2012 report	Recent completions				Projected new completions																
Local Authority	***All years***	**2011/12**	**2012/13**	**2013/14**	**2014/15**	**2015/16**	**2016/17**	**2017/18**	**2018/19**	**2019/20**	**2020/21**	**2021/22**	**2022/23**	**2023/24**	**2024/25**	**2025/26**	**2026/27**	**2027/28**	**2028/29**	**2029/30**	**2030/31**	**2031/32**
Ashford	*490*	633	284	137	405	1398	754	917	1131	1239	695	695	695	695	695	695	695	695	695	695	695	457
Canterbury	*798*	624	524	475	285	182	387	1073	1672	1626	832	832	832	832	832	832	832	832	832	832	832	599
Dartford	*506*	323	422	602	565	1201	1521	1687	1784	1732	833	833	833	833	833	833	833	833	833	833	833	448
Dover	*300*	227	228	193	344	591	611	960	724	773	908	908	908	908	908	908	283	283	283	283	283	283
Gravesham	*291*	177	401	153	246	167	274	704	567	564	365	365	365	365	365	365	365	365	322	322	322	322
Maidstone	*682*	873	630	412	422	763	1025	1342	1540	1414	922	922	922	922	922	922	922	922	922	922	922	647
Medway	*815*	809	565	579	483	577	899	937	859	924	1937	1937	1937	1937	1937	1937	1937	1937	1937	1937	1937	1937
Sevenoaks	*226*	174	141	224	199	318	567	384	327	346	772	772	772	772	772	772	772	772	772	772	772	772
Shepway	*323*	207	206	165	330	367	621	567	495	445	372	372	372	372	372	372	372	372	372	372	372	308
Swale	*699*	397	291	336	618	419	269	525	1028	985	850	850	850	850	850	850	850	850	850	850	850	573
Thanet	*626*	320	194	311	380	499	341	395	199	215	1168	1168	1168	1168	1168	1168	1168	1168	1168	1168	1168	1168
Tonbridge & Malling	*738*	444	394	608	487	842	1012	750	648	508	706	706	706	706	706	706	706	706	706	706	706	588
Tunbridge Wells	*387*	212	-5	-16	323	535	304	427	341	145	839	839	839	839	839	839	839	839	839	839	839	839
Kent & Medway	***6,879***	**5,420**	**4,275**	**4,179**	**5,087**	**7,859**	**8,585**	**10,668**	**11,315**	**10,916**	**11,199**	**11,199**	**11,199**	**11,199**	**11,199**	**11,199**	**10,574**	**10,574**	**10,531**	**10,531**	**10,531**	**8,941**

New dwellings as a proportion of total dwellings (projected)

The table below shows the increase in dwelling numbers as a result of new construction. Note that the baseline figure for 2014/15 is taken from the number of electricity MPANs for that year, as per the *'Sub-national electricity sales and numbers of customers'* (2015). These have been cross-checked against the number of dwellings in council tax records for 2013/14 to confirm that the figures broadly align (see *'Housing stock by size, type and tenure for Kent 2013-14'* available at www.kent.gov.uk).

Year	**2014/15**	**2015/16**	**2016/17**	**2017/18**	**2018/19**	**2019/20**	**2020/21**	**2021/22**	**2022/23**	**2023/24**	**2024/25**	**2025/26**	**2026/27**	**2027/28**	**2028/29**	**2029/30**	**2030/31**	**2031/32**
Baseline no. dwellings	756,443	756,443	756,443	756,443	756,443	756,443	756,443	756,443	756,443	756,443	756,443	756,443	756,443	756,443	756,443	756,443	756,443	756,443
New completions (cumulative)	-	7,859	16,444	27,112	38,427	49,343	60,542	71,741	82,940	94,139	105,338	116,537	127,111	137,685	148,216	158,747	169,278	178,219
Total dwellings	756,443	764,302	772,887	783,555	794,870	805,786	816,985	828,184	839,383	850,582	861,781	872,980	883,554	894,128	904,659	915,190	925,721	934,662
Increase from 2014/15 baseline (%)	-	1%	2%	3%	5%	6%	7%	9%	10%	11%	12%	13%	14%	15%	16%	17%	18%	19%

Appendix E Projected energy demands and carbon emissions associated with new domestic development

Energy Sales (MWh/yr)

The table below shows the predicted energy sales for domestic consumers in Kent and Medway from 2014/15 to 2031/32 (as presented in Figure 7).

Year	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31	2031/32
Gas - current dwellings	8,556,229	8,556,229	8,556,229	8,556,229	8,556,229	8,556,229	8,556,229	8,556,229	8,556,229	8,556,229	8,556,229	8,556,229	8,556,229	8,556,229	8,556,229	8,556,229	8,556,229	8,556,229
Gas - new dwellings	-	87,921	183,963	303,308	429,892	552,012	677,298	802,584	927,870	1,053,155	1,178,441	1,303,727	1,422,021	1,540,315	1,658,128	1,775,941	1,893,753	1,993,779
Elec - current dwellings	3,101,150	3,101,150	3,101,150	3,101,150	3,101,150	3,101,150	3,101,150	3,101,150	3,101,150	3,101,150	3,101,150	3,101,150	3,101,150	3,101,150	3,101,150	3,101,150	3,101,150	3,101,150
Elec - new dwellings	-	26,350	55,134	90,903	128,840	165,440	202,988	240,537	278,085	315,634	353,183	390,731	426,184	461,637	496,946	532,255	567,564	597,542

Carbon Emissions (tCO_2/yr)

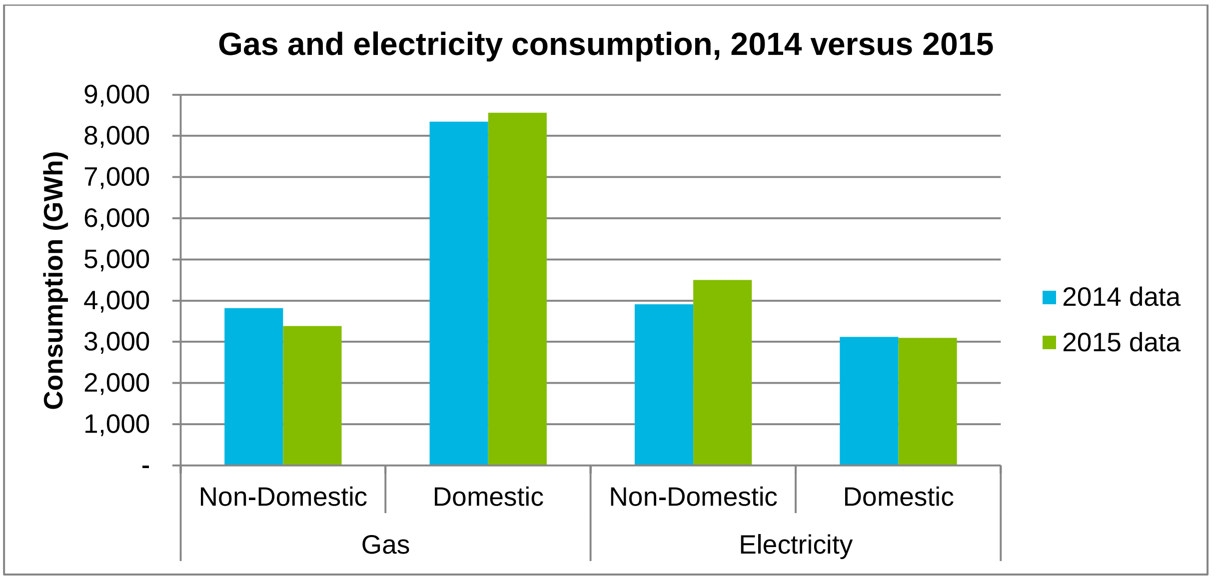
The table below shows the predicted carbon emissions arising from gas and electricity consumption for domestic consumers in Kent and Medway from 2014/15 to 2031/32 (as presented in Figure 8).

Year	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31	2031/32
Gas - current dwellings	1,574,319	1,574,319	1,574,319	1,574,319	1,574,319	1,574,319	1,574,319	1,574,319	1,574,319	1,574,319	1,574,319	1,574,319	1,574,319	1,574,319	1,574,319	1,574,319	1,574,319	1,574,319
Gas - new dwellings	-	16,177	33,849	55,808	79,099	101,568	124,621	147,673	170,725	193,777	216,829	239,882	261,647	283,413	305,090	326,767	348,445	366,849
Elec - current dwellings	1,277,829	1,277,829	1,277,829	1,277,829	1,277,829	1,277,829	1,277,829	1,277,829	1,277,829	1,277,829	1,277,829	1,277,829	1,277,829	1,277,829	1,277,829	1,277,829	1,277,829	1,277,829
Elec - new dwellings	-	10,858	22,718	37,456	53,089	68,169	83,641	99,113	114,585	130,057	145,529	161,001	175,609	190,218	204,767	219,316	233,865	246,217

Appendix F Gas and electricity consumption and carbon emissions, 2014 versus 2015

For fuels other than gas and electricity, the most recently available energy consumption estimates from the Department for Business, Energy & Industrial Strategy are from 2014 (published in 2016). For gas and electricity, the most recent figures are from 2015 (published in 2017). In this report, these have been combined to produce the most up-to-date estimates of total energy consumption by fuel type.

The figure below shows the gas and electricity consumption in 2014 compared with 2015. Total gas consumption in 2015 was approximately 2% lower than in 2014, and electricity consumption was approximately 8% higher. This difference is not considered significant for the purpose of this report.



Fuel	Gas (GWh)		Electricity (GWh)	
Year	Non-Domestic	Domestic	Non-Domestic	Domestic
2014	3,820	8,343	3,912	3,117
2015	3,380	8,565	4,501	3,099

Appendix G Future Energy Scenarios – Data Handling

General comments

- Active, agreed/building, proposed statuses for installation have been counted within the 2020 projection on the premise that all proposed/built schemes will be online by 2020. There is risk that proposed schemes will not go ahead for a range of reasons. Therefore, the final figures for the projected 2020 installed capacity are sensitive to refusal, cancellation or postponing.
- FiT/RHI data reports to March/June 2017 respectively, no assumption has been made on future installation (i.e. between 2017 and 2020) for this report. As a result there may be a shortfall in the total 2020 installed capacity figure, however, with the data available it is not possible to project future uptake levels and is not appropriate to make any assumptions on future trends.

Renewable heat map data

- Solar – All registered sites where the OFGEM name contains a limited company or the site description is a solar farm/solar park have been assumed to be established by energy developers.
- Any farms, industrial estates, privately owned landfill sites or docks containing renewable installations have been assumed to belong to the business sector category.
- Any community owned projects listed within the dataset was categorised as individual/community.
- Any public building types outlined in the DECC/OFGEM descriptions of the installations were flagged up and investigated on a case by case basis to determine if the site was publicly owned;
- 3 cases from the renewable map data did not contain sufficient information to determine the delivery partner category – these have been listed as “unknown”.

Feed In Tariff data

- Solar – installation have been grouped by delivery partners according to the “Description” and “Installation type” data entries for each installation recorded.

Photovoltaic assumptions

Developer Partner	Installation Type	Description
Individual/Community	Domestic Community	PV (<=4kW (retrofit)) All description types
Housing developer	Domestic	All descriptions excluding PV (<=4kW (retrofit))
Business sector	Non-domestic	Total x 0.8*
Public sector	Non-domestic	Total x 0.2*

*0.8/0.2 split has been assumed based on the renewable map data entries and the split of non-domestic installations and has been corrected based on the installation size from the 0.9/0.1 split observed in installation >600kW.

Wind assumptions

Developer Partner	Installation Type	Description
Individual/Community	Domestic Community	All description types All description types
Business sector	Non-domestic	Total * 0.8*

Developer Partner	Installation Type	Description
Public sector	Non-domestic	Total * 0.2*

*0.8/0.2 split has been assumed based on the renewable map data entries and the split of non-domestic installations and has been corrected based on the installation size from the 0.9/0.1 split observed in installation >600kW.

Renewable Heat Incentive data

- Table 1.8 of the RHI monthly Official Statistics Tables was consulted to determine the UK wide split by delivery partner. The Standard Industrial Classification Code (SIC) and description was used to reference the industry practice that accredited RHI installation had been register. Based on the description a delivery partner group was allocated and a UK wide split was calculated. The RHI split calculated was: Individual/Community (1%), Public sector (13%), Business sector (68%), Housing developer (18%), Energy developer (0%). Kent was not deemed to provide any significantly favourable conditions to a particular partner, through either geography or local planning policy. Therefore, differentiation in the split of delivery partners in Kent with the rest of the UK was not expected and the UK split was applied to the Kent & Medway data.
- Table 2.3 was used to determine the split of renewable technology type, the data provided the installed capacity within all accredited installations in the South east region for each technology type (ASHP, GSHP, Biomass Boilers and Solar Thermal). Again, Kent was not deemed to provide any factors that would cause a significant difference in the county level split in comparison to the rest of the region. Therefore, the South East technologies splits (ASHP (54%), GSHP (16%) Biomass boiler (9%), Solar thermal (22%)) were applied to the Kent and Medway totals.