Renewable heat in Scotland, 2016

A report by the Energy Saving Trust for the Scottish Government

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Prepared by Energy Saving Trust

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About the Energy Saving Trust

The Energy Saving Trust is Scotland and the UK's leading impartial organisation helping people save energy and reduce carbon emissions. We do this by directly supporting consumers to take action, helping local authorities and communities to save energy, using our expert insight and knowledge and providing quality assurance for goods and services.

This work was carried out by the Energy Saving Trust on behalf of the Scottish Government. The report draws on various sources of data from the Energy Saving Trust and other organisations working in Scotland and was written by the Energy Saving Trust Insight and Analytics team.

The Energy Saving Trust would like to thank all individuals and organisations who provided data, with particular thanks to the Department for Business, Energy and Industrial Strategy, Gemserv and the Forestry Commission Scotland.

Please note that the methodology used in this report to calculate renewable heat capacity and output for Scotland may not necessarily be in line with that required by the EU Renewable Energy Directive and as such the figures should not be used for any reporting purposes associated with this Directive.

Contents

1 Purpose of report

The Scottish Government has set a target for 11% of non-electrical heat demand in Scotland to be met from renewable sources by 2020[1].

In order to help measure progress towards this target the Energy Saving Trust (EST) maintains a database of renewable heat installations (referred to as the renewable heat database or dataset throughout this report) on behalf of the Scottish Government. The database records installations known to be operating and those currently in various stages of development. It contains data on the capacity and yearly heat output of those installations and is updated annually. The database also includes information on district or 'communal' heating schemes throughout Scotland[2]. However, only the proportion of renewable heat produced from these schemes is included in progress towards the renewable heat target.

The database has now been updated with new information on heat generated from renewable sources during the 2016 calendar year.

This report tracks progress towards the Scottish Government's renewable heat target and includes commentary on accreditations under the domestic and non-domestic Renewable Heat Incentive (RHI) schemes between December 2016 and August 2017.

[1] Renewable Heat Action Plan for Scotland, the Scottish Government, November 2009: http://www.scotland.gov.uk/Publications/2009/11/04154534/0. Replaced by The Heat Policy Statement in June 2015: http://www.gov.scot/Publications/2015/06/6679

[2] Every reasonable effort has been made to identify operational district heating schemes in Scotland, however there may be some district heating schemes that are not included in the underlying database at this time. See section 3.6 for further details.

2 Summary of key findings

We estimate that:

- **1.710 GW of renewable heat capacity** was operational in Scotland by the end of 2016, **up 13%** (191 MW) from 2015, producing an estimated **3,752 GWh of actual heat** from renewable sources, which is a **decrease of 11%** (453 GWh) from 2015[3].

- This reduction in output was primarily due to changes at a small number of large sites. Large sites (greater than 1 MW) accounted for 0.717 GW of renewable heat capacity in 2016, and 2,070 GWh renewable heat output. This is a small increase in capacity compared to 2015 (an increase of 0.007 GW), but a large drop in output (of 888 GWh).

- For both 'micro' and 'small to medium' sized installations, capacity and output have increased between 2015 and 2016. However, in both size categories, this increase is lower than that seen in previous years – i.e. the rate of increase in capacity and output has declined. This may be the result of RHI tariff reductions and broader uncertainty around UK Government policy regarding the RHI during and after consultation affecting investor confidence.

- **In 2016 Scotland generated an estimated 4.8 – 5.0% of its non-electrical heat demand from renewable sources**, a reduction from 5.4% in 2015, which is the first reduction seen since 2008/09.

  Figures 1 and 2 show the change over time for both renewable heat capacity and output in Scotland. Data for 2008/9 is taken from the Renewable Heat in Scotland report, produced by the Sustainable Development Commission Scotland in June 2009[4]. EST has collected data for calendar years 2010 onwards[5].

  The majority of both capacity and output in 2016 came from biomass primary combustion and biomass combined heat and power. Combined, these technologies account for 84% of renewable heat capacity and 83% of output. Whilst biomass continues to dominate in renewable heat generation, there has nonetheless been a considerable growth in other technologies. The total heat pump output increased by 21% between 2015 and 2016 to 287 MWh, whilst the total energy from waste output increased by 78% to 342 MWh.

  The majority of renewable heat output and capacity is accounted for by installations in the 'large' size category (>1MW). Most biomass CHP and energy from waste

[3] The figures for renewable heat output and capacity stated here include data from the CHPQA database. This data was not available in previous years, but has been retrospectively applied to each year's data (for each year back to financial year 2008/9). As such, the figures in this report will differ from those in the previous annual Renewable Heat in Scotland reports. Further details on the CHPQA data and how it has been applied are available in the methodology and results sections of this report. Details of the discrepancies between the figures in this report and previous report are provided in Table 6.

[4] Renewable Heat in Scotland, the Sustainable Development Commission Scotland, June 2009: http://www.sd-commission.org.uk/data/files/publications/SDC%20Renewable%20Heat%20Report.pdf

[5] Figures for 2010 to 2013 were amended for the 2014 report (published in October 2015) to account for methodology changes to heat output calculation due to newly available information, so will differ from figures in pre-2014 reports. For methodology change, see the Renewable Heat in Scotland, 2014 report: http://www.energysavingtrust.org.uk/sites/default/files/reports/EST%20RH%20Report%202014_final%20OCT.pdf

facilities fall into this category. By contrast, most heat pumps and solar thermal installations fall into the 'micro' category.

Figures throughout this report will differ slightly from those in previous reports due to the inclusion of additional data this year from the Combined Heat and Power Quality Assurance (CHPQA) database. The additional capacity and output figures available from CHPQA data have been retrospectively applied to data from previous years (see table 6).

Figure 1. Estimated renewable heat capacity and output in Scotland, 2008/09 – 2016

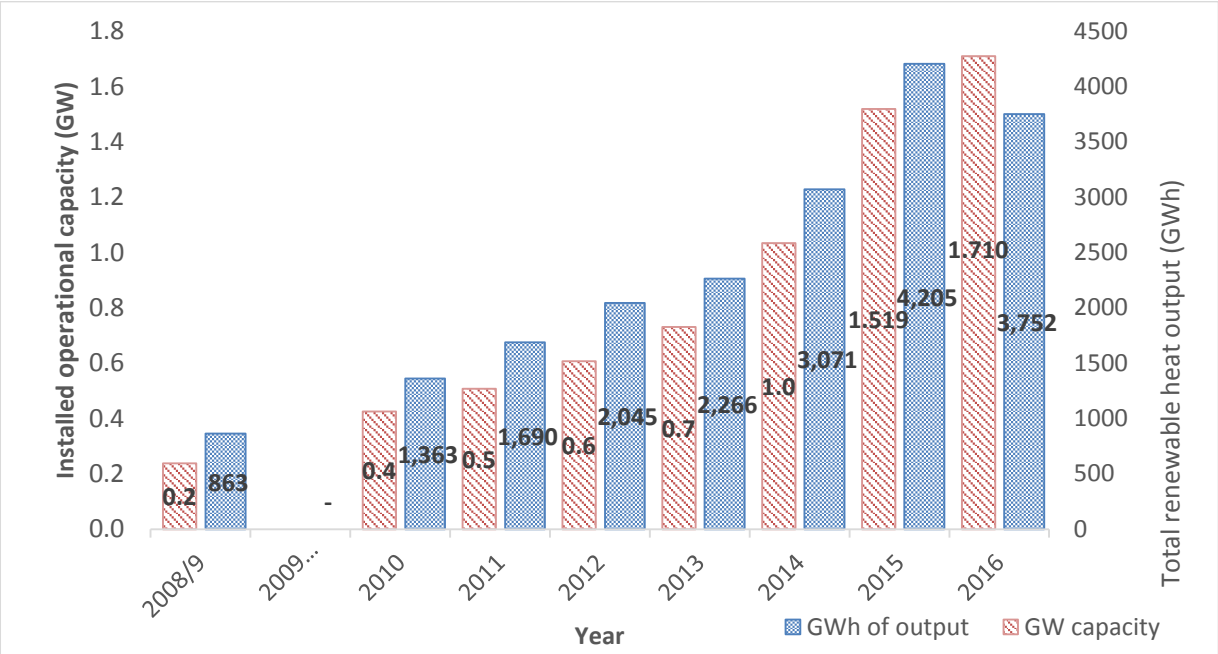
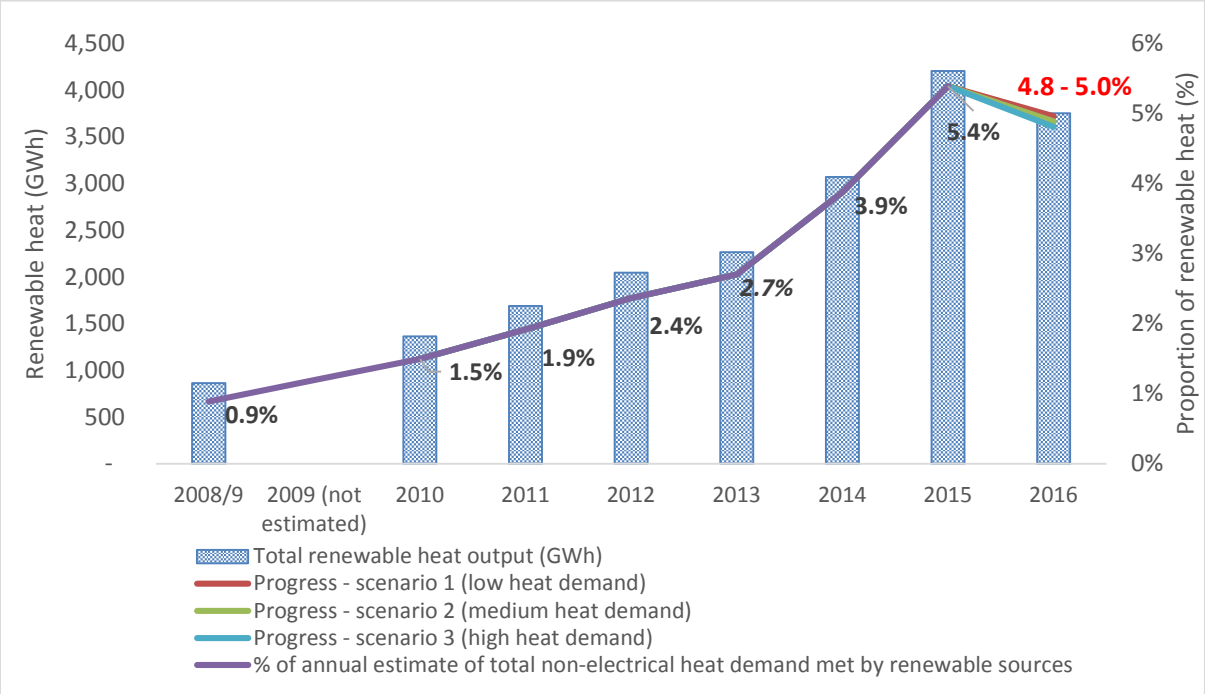


Figure 2. Estimated renewable heat output and % non-electrical heat demand met by renewables in Scotland, 2008/9 – 2016



Progress towards the 2020 target of 11% of non-electrical heat to come from renewable sources is monitored against an estimate of non-electrical heat demand, using the sub-national final energy consumption data published by the Department for Business, Energy and Industrial Strategy (BEIS) on an annual basis. Due to a time lag in the publication of sub-national energy consumption data, the most recent year we have non-electrical heat demand figures for is 2015. For 2016, progress is shown against estimated non-electrical heat demand based on three scenarios that have been inferred from historic trends[6].

Heat demand in Scotland has been steadily falling over the last ten years, due to improved energy efficiency and increases in average annual temperatures. This decrease in demand means that renewable heat meets a greater proportion of total heat demand than would otherwise have been the case. **Between 2008/9 and 2015, reductions in demand have contributed to around 85% of progress towards the renewable heat target** while the remaining progress has been due to increased renewable output.

Based on the three scenarios of heat demand from 2016 to 2020, renewable heat output would need to roughly double from its current level (an increase of between 96% and 129% depending on the heat demand scenario) in order to reach the Scottish Government's target.

[6] The three scenarios are that heat demand:

i. Average annual change (2008-2015) – i.e. low projected heat demand scenario
ii. Same change as most recent year (2014-15) – i.e. medium projected heat demand scenario
iii. Stays constant (from 2015) – i.e. high projected heat demand scenario

As large scale schemes can result in significant step changes in capacity and output any such increase is unlikely to be a smooth curve year on year. However, if this increase were spread evenly across the remaining 4 years this would be equivalent to an annual increase in output of between 18% and 23%. The average annual increase in output since 2010 is 20%.

Breakdown of 2016 data[7]

The majority of renewable heat output in Scotland continues to come from large (1 MW+) installations. **In 2016 56% of renewable heat came from large installations**, despite contributing only 42% of the total renewable capacity. This is because large installations often provide process heat year round, compared to smaller installations which generally have more seasonal demands such as providing space and water heating. The capacity of large installations remained stable between 2015 and 2016, with a marginal increase of 1%. However, the heat output from these installations reduced by 30%. This was due to a reduction in output from a small number of large sites.

By contrast, the total capacities of small to medium (>45 kW and <1 MW) and micro (<45 kW) installations have increased, by 30% and 11% respectively whilst the total outputs from these installations increased by 35% for small to medium (>45 kW and <1 MW) and by 21% for micro (<45 kW) installations.

The majority of Scotland's renewable heat output comes from biomass combustion (including biomass combined heat and power). **In 2016 biomass combustion supplied 83% of renewable heat in Scotland.** Heat pump and solar thermal installations, which are mostly used to provide water and space heating on small scales, accounted for around 8% with the remainder generated from waste sources.

By the end of December 2016 10,849 domestic Scottish installations had been accredited under the RHI scheme since it started in 2014, with 87% of these installed in off-gas areas. **Systems in Scotland accounted for approximately 20% of the total number of RHI-accredited systems under both the domestic and non-domestic RHI schemes as of December 2016** (20% domestic, 19% non-domestic)[8]. **This is considerably above the proportion of installations to be expected on a pro-rata basis**.

[7] CHPQA data has been excluded from the breakdown figures in this section. This is because CHPQA data could only be provided to EST at an aggregated level, without site-by-site details, therefore it is not possible to breakdown the data. The figures in this section are therefore directly comparable to those in the Renewable Heat in Scotland, 2015 report. Further details are provided in the methodology section.

[8] More up to date RHI data is published regularly by BEIS. A summary of the latest RHI data is included in this report (Section 5.2) as an indication of further capacity in development which has come on line in 2017. This data shows that as of the end of August 2017, 11,570 installations had been accredited under the domestic RHI and 3,620 full applications had been made under the non-domestic RHI (figures rounded to the nearest 10 installations).

3 Methodology

3.1 Approach taken

Outputs required

Two main outputs are required from the renewable heat database:

The first is an estimate of **operational renewable heat capacity**. Capacity refers to the maximum instantaneous power output of a renewable heating system such as a biomass boiler and is usually measured in kilowatt therms (kWth) or megawatt therms (MWth), depending on the size of the installation. Total heat capacity is presented in this report as gigawatts (GW)[9] or megawatts (MW), rather than as GWth or MWth, to avoid confusion with the units of heat output (GWh or MWh). Individual installations are classified in three capacity categories:

- Large (1 MW+)
- Small to Medium (45 kW – 1 MW)
- Micro (≤ 45 kW)

The second **output** required from the database is an estimate of **useful renewable heat energy** produced over the reported year (1 January 2016 to 31 December 2016). Useful heat is the heat delivered to the end user or process taking into account the technology efficiency and losses. This is referred to throughout the report as useful heat output and is recorded in megawatt hours (MWh) for each installation in the database, with the totals in this report given in gigawatt hours (GWh)[10].

Useful heat output - Heat delivered to an end user or process, taking into account losses and system efficiency.

Actual heat output - The total amount of heat produced by a site, accounting for losses and system efficiency. Actual heat output includes heat that is not delivered to an end user or process.

Potential heat output - The total amount of heat that could potentially be generated by the site if it operated at peak capacity for the total number of 'peak running hours' or at the installation's assumed capacity.

Please note that this brief summary is included here because the terms above are used repeatedly within the main body of the report. For a fuller explanation of terminology used please refer to Appendix 1: Technical terms used.

[9] 1 GW = 1,000 MW = 1,000,000 kW.
[10] 1 GWh = 1,000 MWh = 1,000,000 kWh.

Available data

Useful heat output is hard to measure without access to site-level metered data (provided metering is in place). Sites accredited under either the non-domestic Renewable Heat Incentive (RHI) or Combined Heat and Power Quality Assurance (CHPQA) will monitor the amount of heat they generate and the amount of heat consumed by an end user, either on site or connected via a heat network, as part of their obligations under these schemes.

As has been the case in previous years, current RHI legislation has prevented full access to the non-domestic RHI data for the database update. To work around the lack of availability of site level data for systems accredited under the non-domestic RHI scheme, BEIS provided, as it has done in previous years, aggregated data for the scheme to EST for inclusion in this report. Also as in previous years, BEIS carried out analysis on the RHI dataset and the EST dataset in order to provide a summary of the renewable heat capacity and useful heat output not already captured by the EST dataset. BEIS does not collect data on useful heat output directly in the RHI dataset; rather, they collect data on the 'heat paid for' per site under the scheme. For this report, we have used this 'heat paid for' figure as a proxy for useful heat output, as the RHI can only support heat that is used for an 'eligible purpose'. Aggregated data for the domestic RHI scheme was not provided, as the majority of these installations should have been captured within the Microgeneration Certification Scheme (MCS) Installation Database (MID) extract provided by Gemserv.

The data held by the CHPQA is confidential and is therefore not available at site level unless provided by the sites themselves. However, for this iteration of the report, Ricardo-AEA carried out analysis on the CHPQA dataset and the EST dataset in order to provide an aggregated summary of the renewable heat capacity and useful renewable heat output which is not already captured by the EST dataset. This analysis has ensured that the output and capacity of any CHP installations which are not captured within the EST database are nonetheless incorporated within the overall renewable heat output and capacity figures. This is the first iteration of the Renewable Heat in Scotland report to incorporate this additional CHPQA data. Further details of the process undertaken to carry out this analysis are available in Appendix 4.

Together the capacity and 'heat paid for' summaries provided by BEIS, the heat capacity and output summaries provided by Ricardo-AEA, and those calculated from the EST dataset provide the most accurate measure of renewable heat capacity and useful heat output in Scotland available to date. Further details of the process undertaken to carry out this analysis are available in section 6.1 and 6.2 and in Appendix 3 and Appendix 4.

In previous years the Forestry Commission Scotland (FCS) has conducted a woodfuel usage survey to determine the amount of woodfuel being used for heat generation purposes in Scotland. For the 2016 woodfuel usage survey, EST completed the data collection on behalf

of FCS. As in previous years the updated capacity and heat output data for large biomass sites (both combined heat and power and heat only) with a capacity greater than or equal to 1 MW collected through the woodfuel survey was used to update the 2016 iteration of the renewable heat database. Metered data was provided by most of the largest sites. For the sites that could not provide metered heat data, the amount of woodfuel consumed for heat generation purposes has been used to derive an estimate of actual (or 'total') heat output, based on the assumed energy content of the woodfuel and site efficiencies.

With some exceptions[11], the remaining data has been collated from sources where heat output (either 'actual' or 'useful') for the site is not necessarily known. In these situations, heat output needs to be estimated. Where possible, heat output estimates are based on the quantity, type and energy content of fuels used in the relevant year at the site along with assumed (or known) operating efficiencies. This information is used to estimate *actual* heat output during 2016 but will be greater than the *useful* heat output. This figure may also be different to estimates of *potential* heat output, which are usually based on the heat capacity of an installation and an assumed number of peak operating hours. *Potential* heat output may therefore be higher than *useful* or *actual* heat output.

The information available about each installation varies, depending upon the data sources used. Where supplied, 'useful heat output' is used for the figures in this report; alternatively, 'actual heat output' is used and finally 'potential heat output' where neither of the previous values are available.

Where information on capacity is not available, this is estimated based on known heat output variables which have been reported (either the actual heat output or useful heat output) and assumptions about typical running hours, based on installation size and the type of application the heat is used for (i.e. space heating or process heat). Where capacity is known, but not output, annual heat output is estimated based on assumptions about typical running hours per year. In the 2016 database, 90% of the total capacity is from known data, 7% is estimated, and 3% is unknown. 68% of the total renewable heat output is known, whilst 32% is estimated. Further information about the assumptions used is provided in section 3.4. In all cases only the renewable portion of the heat output has been included in the figures reported.

[11] For example, where we have a known contact at the site who can provide the correct information.

3.2 Technologies included

The following technologies produce heat from renewable sources and are included in our estimate of progress towards the target (more detailed descriptions of these technologies can be found in Appendix 1):

- Biomass (wood) primary combustion.
- Biomass (wood) combined heat and power (CHP).
- Solar thermal panels.
- Heat pumps: water source, air source and ground source.
- Energy from waste (EfW), including
  - Anaerobic digestion (AD)[12].
  - Landfill gas capture.
  - Biomass primary combustion of biodegradable material (other than wood).
  - Advanced thermal treatment (ATT), using pyrolysis and/or gasification.
  - Biomethane gas to grid injection after anaerobic digestion and processing.

Had examples been found, fuel cell biomass and deep geothermal[13] (as opposed to ground source heat pumps, which are shallow geothermal) could also have been included.

Technologies which are not included in our estimate of progress towards the target, as they produce heat which is not renewable, are:

- Non-biomass combined heat and power (CHP) running on mains gas or other fossil fuel.
- Exhaust air heat recovery (EAHR) where the initial heat is not provided from a renewable source.
- Energy from waste: installations where the only fuel is clinical (hospital) waste[14].

The following technologies can be considered sources of renewable heat, but are not currently captured in the renewable heat database:

- Passive renewable heating, for example solar gain. This is excluded due to the difficulty of assessing its contribution to heating demand.
- Wind or hydro-produced electricity which is used to provide heat. These technologies are excluded to avoid double counting of progress towards renewables targets, as the energy produced counts towards the Scottish Government's target for renewable electricity generation.

[12] Excluding the parasitic heat used to maintain the anaerobic digestion process.
[13] There are currently no known deep geothermal technologies in operation in Scotland; however, feasibility studies for 4 projects have been submitted to the Geothermal Energy Challenge Fund. These have been recorded as 'in scoping' in the database.
[14] In line with assumptions used in BEIS RESTATS methodology, clinical waste is considered non-biodegradable and therefore non-renewable. Renewable Energy Statistics: Data Sources and Methodologies, Department for Business, Energy & Industrial Strategy: https://www.gov.uk/government/collections/renewables-statistics

3.3 Data sources used

EST has maintained and updated the renewable heat database for the Scottish Government on an annual basis since 2011. The heat output estimate for 2016 contained in this report has been generated by a further update of the information held in the database. Efforts have focused on updating information from the installations with the largest capacities and including data from the non-domestic RHI database and the CHPQA dataset. Almost 98% of records were updated in 2017, representing 92% of the total renewable heat generated in 2016.

Multiple sources of data have been used to update the renewable heat database for 2016. The main sources used and the organisations which supplied them, are listed in Table 1. In addition, other organisations and individuals connected with specific installations were contacted and provided useful information.

Table 1. Main datasets used for 2016 figures and estimates of future output

Organisation	Dataset
Department for Business, Energy and Industrial Strategy (BEIS)	Aggregated non-domestic RHI data covering installations in Scotland – summaries of capacity and heat output for 2016, merged with EST data to generate a dataset of entries not already covered by the renewable heat database. Domestic RHI data is not included to avoid double counting with the data provided by Gemserv from the Microgeneration Certification Scheme (see below).
Ricardo-AEA, on behalf of BEIS	Aggregated CHP data covering renewable installations in Scotland – summaries of capacity and heat output from sites not currently covered by the renewable heat database.
Forestry Commission Scotland (based on survey carried out by EST)	Woodfuel demand and usage and estimated heat output in Scotland, 2016 (surveyed but with some assumed values). The data sets from the Forestry Commission Scotland's (FCS) woodfuel usage survey contain estimates of all wood fuel usage for the year 2016, for large sites only. FCS estimates wood fuel usage for smaller sites based on RHI data, but collects detailed site-level data for larger installations since they have such a large impact on overall wood usage figures.
Eunomia, on behalf of BEIS	The Renewable Energy Planning Database (REPD)[15].

[15] https://www.gov.uk/government/publications/renewable-energy-planning-database-monthly-extract

Resource Efficient Scotland, on behalf of the Scottish Government	Resource Efficient Scotland SME Loans Scheme.
Energy Saving Trust, on behalf of the Scottish Government	Applications to the District Heating Loan Fund, and the community and locally owned renewable energy database[16].
Local Energy Scotland, on behalf of the Scottish Government	Local Energy Challenge Fund (LECF), Geothermal Energy Challenge Fund
Scottish Environment Protection Agency (SEPA)	Information on installations covered by Pollution Prevention and Control licences in Scotland.
Gemserv	Microgeneration Certification Scheme (MCS) data.

In addition, further information on renewable installations known to be in development was sourced from local authority planning departments through their online planning databases.

3.4 Assumptions used

Converting biomass woodfuel use to heat output

For the majority of large installations burning biomass wood for primary combustion or CHP, the main source of information available was estimates of wood fuel usage from the Forestry Commission Scotland's annual survey. Where metered data was not available, woodfuel usage figures were converted into estimates of heat output, based on the assumptions about combustion efficiency given in Table 2. One oven-dried tonne (ODT) of wood is assumed to contain 4.92 MWh of energy[17]. The assumed boiler efficiencies used to convert oven-dried tonnes of wood burnt to heat output are given in Table 2. These efficiencies were updated during the 2014 database update (report published October 2015) following the publication of Steve Luker Associates' analysis of *in situ* performance of biomass boilers[18].

[16] http://www.energysavingtrust.org.uk/sites/default/files/reports/Community%20and%20locally%20owned%20report%202016_final.pdf
[17] Mitchell, Hudson, Gardner, Storry and Gray, 1990. Wood Fuel Supply Strategies Vol 1. The Report: ETSU B 1176-P1.
[18] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/376805/Review_of_biomass_performance_standards.pdf

Table 2. Boiler efficiencies assumed for converting oven-dried tonnes of wood burnt to heat output

Installation size	Assumed boiler efficiency	MWh heat output per ODT burnt
Large installations (>1 MW, or >10,000 ODT)	80%	3.94
Small to medium installations (45 kW – 1 MW, or <10,000 ODT) providing process heat	80%	3.94
Small to medium installations (45 kW – 1 MW, or <10,000 ODT) providing space heating	75%	3.69
Micro installations (≤45 kW) (not MCS)	70%	3.44

Combined heat and power (CHP)

Calculating useful heat output for combined heat and power (CHP) is difficult without detailed metered data for each specific site. Even with data on fuel input, energy content of the fuel, heat efficiency and running hours the realised useful heat output might vary considerably from the estimated heat output depending on whether or not the process (or customer) the useful heat goes to requires a regular amount of heat on a regular basis. Where known, useful heat output has been recorded for CHP sites, based on information from the sites themselves, either via the FCS and their woodfuel survey, or via direct contact with operations managers at the sites.
Where the actual useful heat output of the fuel is not known the following formula was used:

Estimated heat output (MWh) = Total fuel input (ODT) x Energy content of fuel (MWh/ODT) x Thermal efficiency of CHP plant (%)

Where the thermal efficiency of the CHP plant was unknown, a thermal efficiency of 48% was used. This is the average thermal efficiency in 2016, taken from chapter 7 of the Digest of UK Energy Statistics (DUKES) 2017[19].

Annual running hours

For installations where an estimate of annual heat output was provided (or derived from ODT of wood burnt) but information on capacity was not given, capacity has been estimated based on typical peak running hours per year by size of installation or sector (or actual running hours where known). These hours are given in Table 3. The same running hours

[19] https://www.gov.uk/government/statistics/combined-heat-and-power-chapter-7-digest-of-united-kingdom-energy-statistics-dukes

were used to derive an estimate of heat output for those installations where information on capacity was provided but an estimate of heat output per year was not.

Table 3. Peak running hours assumed by technology, size and heat use

Sector and size of installation	Peak running hours/year
Large (1 MW+) biomass providing process heat	8,000
Energy from waste installations providing process heat.	8,000
Commercial small to medium (45 kW-1 MW) biomass.	5,000
Combined heat and power, all sizes	3,603
Space heating biomass, all sizes (including district heating).	2,500
Heat pumps providing space heating.	2,500
Heat pumps or biomass providing space heating for community buildings.	250

Using known information to determine missing values

For installations where values for neither capacity nor output were provided, an estimate was made for likely installed capacity, based on technology type, ownership category and building type (where appropriate). This was derived from similar installations where capacity was known. The values assumed for capacity in those instances are given in Appendix 2.

For solar thermal panels, information was sometimes only provided in m^2 of panel area. The following assumptions were used to derive capacity and/or output, where this was not provided:

- Capacity per m^2: 0.7 kW, from the Solar Trade Association.
- Useful heat output per m^2: 0.441 MWh, derived from SAP 2012 calculations for all regions in Scotland[20].

Energy from waste

In line with assumptions used in BEIS's RESTATS methodology[21], approximately 50% of the feedstock of municipal solid waste (MSW) is considered to be biodegradable. Therefore, an

[20] This assumption was changed during the 2014 database update due to revisions to SAP. Previously 0.34 MWh per m^2 was used.
[21] Renewable Energy Statistics: Data Sources and Methodologies, BEIS: https://www.gov.uk/government/collections/renewables-statistics

installation producing heat from burning MSW will have 50% of its heat capacity and output recorded as renewable in the database. This assumption was updated from 63.5% during the 2015 update of the database to account for increased recycling rates.

For anaerobic digestion (AD) facilities, 30% of the heat output has been removed from the total figure for useful renewable heat production, as this is estimated to be the parasitic heat requirement of the AD process.

Operating status

In certain circumstances assumptions have been made about the operating status of projects. If no new information has been found for a project in the 2016 update, the following assumptions have been made:

Table 4. Status change map for 2015 to 2016

2015 status	New information available	2016 status
'In scoping'	None	'In scoping'
'In scoping' or 'In planning'	Planning permission granted	'Consented, not built'
'Under construction'	None	'Under construction'
'Unknown'	None	'Unknown'

3.5 Accounting for sites commissioned part-way through 2016

Most new additions to the renewable heat database were only operational for part of 2016. Where commissioning date is known, this has been used to determine the proportion of 2016 for which the site was operational. Where commissioning date is not known, an estimate has been used, based on when the data was collated and what information was given at the time. The estimated annual heat output for each site has been multiplied by the portion of 2016 for which it was operational.

3.6 Data collection for district and communal heating schemes

For district or 'communal' heating schemes, the number of non-domestic buildings or domestic dwellings connected to each scheme is recorded. Information on any extensions which are planned are also included in the database, where these are known. Information on whether or not an installation is providing district heating was not available from all sources used to update the database (e.g. from the RHI and REPD datasets). For this reason, it is not currently possible to use the dataset to estimate the extent of district heating in Scotland. The Scottish Government has recently gained access to BEIS's Heat Networks database.

We are currently exploring how to incorporate information from this database into future iterations of this report.

Data is collected on both renewable and non-renewable district heating schemes[22]; however only the proportion of renewable heat produced from these schemes is included in progress towards the renewable heat target.

[22] Every reasonable effort has been made to identify operational district heating schemes in Scotland, however there may be some district heating schemes that are not included in the underlying database at this time.

4 Renewable heat capacity and renewable heat output in 2016

4.1 Results for 2016

In 2016, 3,752 GWh of heat was produced from renewable sources, from an installed capacity of 1.710 GW[23].

In 2016 Scotland produced enough heat from renewable sources to meet **between an estimated 4.8% and 5.0% of non-electrical heat demand**. The final estimate will be reported in October 2018 when the 2016 heat demand data is available.

Progress towards the 2020 target of 11% of non-electrical heat to come from renewable sources is monitored against the non-electrical heat component of the final energy consumption data published by BEIS on an annual basis. This monitoring methodology was first used in the 2012 report (published June 2013). See Appendix 5 for more information on the methodology used prior to 2012, and how this differs from the current methodology.

In order to show progress towards the renewable heat target in this report, three non-electrical heat demand scenarios have been estimated for 2015 and 2016. These scenarios are based on published final sub-national energy consumption figures from BEIS[24] and have allowed us to present the progress towards the renewable heat target shown in Table 5. The three scenarios calculated were:

- Scenario 1 (low heat demand): Assuming heat demand between 2015 and 2016 reduces by the average annual reduction seen between 2008 and 2015.
- Scenario 2 (medium heat demand): Applying the 2014-15 percentage heat demand reduction for 2015-16.
- Scenario 3 (high heat demand): Assuming heat demand does not change from 2015.

[23] These figures include aggregated data from the CHPQA database provided by Ricardo-AEA. This CHP data was not used in previous iterations of this report.
[24] See 2005-2015 figures here: https://www.gov.uk/government/statistical-data-sets/total-final-energy-consumption-at-regional-and-local-authority-level

Table 5: Renewable heat target - renewable heat as a percentage of heat demand[25]

	2008/9	2009 (not estimated)	2010	2011	2012	2013	2014	2015	2016
Total renewable heat output (GWh)	863	Missing data	1,363	1,690	2,045	2,266	3,071	4,205	3,752
New measure: % of annual estimate of total non-electrical heat demand	**0.9%**	Missing data	**1.5%**	**1.9%**	**2.4%**	**2.7%**	**3.9%**	**5.4%**	**-**
Progress - scenario 1									5.0%
Progress - scenario 2									4.9%
Progress - scenario 3									4.8%
Heat demand (GWh)	97,053	89,155	91,156	88,269	86,447	83,805	79,207	77,976	
Heat demand scenario 1 (average annual reduction 2008-2015)									75,612
Heat demand scenario 2 (same reduction per year as 2014-15)									76,764
Heat demand scenario 3 (same as 2015)									77,976

[25] See Appendix 5 for more information on the methodology for calculating non-electrical heat demand in Scotland.

Methodological note

The figures for total renewable heat output presented in Table 5 (and in the analysis below) differ slightly to those reported in previous iterations of this report. This is because for this report additional data on CHP installations was provided to EST, at an aggregated level, by Ricardo-AEA from the CHPQA database. Aggregated data on the capacity and heat output of CHP systems not previously included in the EST database were provided this year for each year going back to financial year 2008/9 (but excluding calendar year 2009). This data has therefore been retrospectively added to the heat output figures for each year. Whilst this additional CHPQA data has been included in all figures relating to the total renewable heat output and capacity, it has been excluded from the breakdown analyses (section 4.2 onwards) as it was not possible to obtain breakdowns of the CHPQA data due to confidentiality requirements. However, in the local authority breakdown the 'unknown' category includes the CHPQA data so the total corroborates the headline figures.

Table 6 shows the difference between the figures reported in previous iterations of this report and the new figures, including CHPQA data, for each year.

Table 6. Differences in total heat output and capacity reported between this report and previous reports (due to inclusion of additional CHPQA data)

Reporting year	Previous reported capacity	New reported capacity	Percentage increase in reported capacity	Previous reported heat output	New reported heat output	Percentage increase in reported heat output
2008/9	0.234	0.238	2.10%	845	863	2.16%
2009	-	-	-	-	-	-
2010	0.421	0.425	1.07%	1345	1363	1.37%
2011	0.501	0.507	1.22%	1660	1690	1.78%
2012	0.602	0.607	0.85%	2003	2045	2.08%
2013	0.718	0.731	1.81%	2223	2266	1.95%
2014	1.022	1.035	1.19%	3031	3071	1.29%
2015	1.504	1.519	1.01%	4165	4205	0.95%

Between 2015 and 2016, there has been an **increase in capacity** of total renewable heat in Scotland of **0.191 GW** (191 MW), which is an **increase of 13%**. Data from small to medium installations and RHI data accounted for the majority of this increase.

Despite this increase in capacity, the overall **renewable heat output** from operational sites in Scotland **decreased by 453 GWh** from 4,205 GWh in 2015 to 3,752 GWh in 2016, **which**

is a decrease of 11%). The majority of this decrease in output is related to changes at a small number of large non-domestic sites in 2016.

For further breakdowns and discussion on both capacity and output by size and technology, see sections 4.2 to 4.4.

Annual figures for renewable heat capacity and useful renewable heat output since 2008/09 can be seen in Figure 3.

Figure 3. Estimated renewable heat capacity and output in Scotland, 2008/09 - 2016

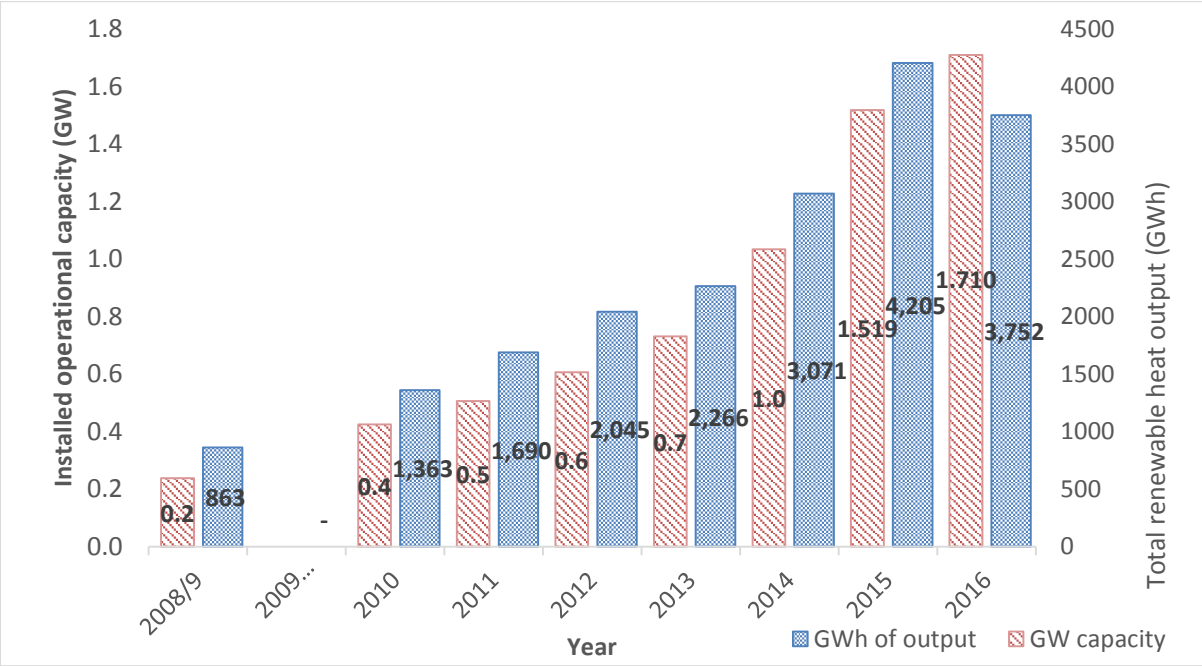
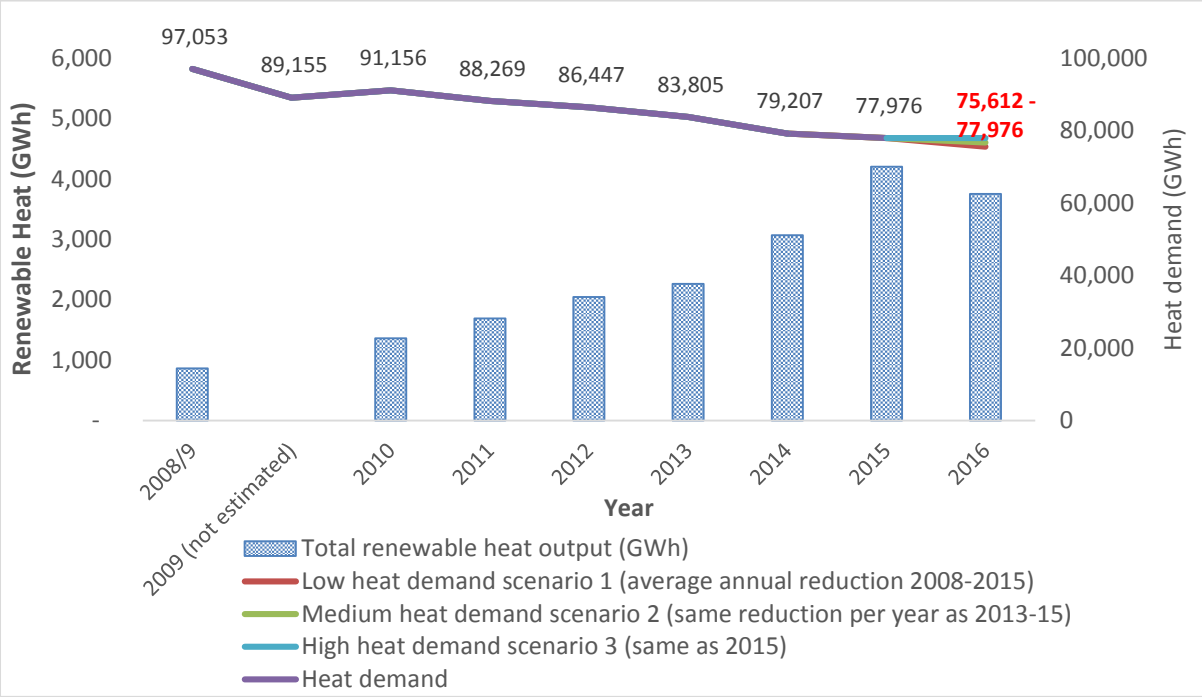


Figure 4. Estimated renewable heat output and non-electrical heat demand in Scotland, 2008/9 - 2016



While renewable heat output has gradually increased since 2008/9, heat demand has fallen over this period due to a combination of factors including improved energy efficiency and increases in average annual temperatures. This means that renewably generated heat now meets a greater proportion of overall heat demand than would have otherwise been the case. It is estimated that the reductions in demand contributed the vast majority (approximately 85%) of progress towards the renewable heat target between 2008/9 and 2015[26]. In 2016 however, even under scenarios which project ongoing reductions in heat demand (scenarios 1 and 2), the figure for renewable heat as a proportion of demand has nonetheless fallen compared to 2015. This is due to a reduction in output as a result of changes at a small number of large biomass-CHP installations.

In the following sections (sections 4.2 to 4.4), we investigate the data broken down by installation size and technology type. For this analysis, **we have removed the data provided from the CHPQA database**. This data could only be provided on an aggregated basis due to confidentiality requirements, therefore it is not possible to include this within the breakdowns. As such, the figures for total heat output and capacity throughout this section are slightly lower than the headline figures presented above, and may underrepresent biomass installations.

[26] Percentage of progress coming from a decrease in heat demand calculated as the proportion of change in heat demand to the total progress towards the target, between 2008/9 and 2015

4.2 Results by installation size

The **majority of renewable heat output in 2016 continues to come from large (1 MW+) installations** (see Table 7). In total, large installations (all sites with capacity of 1 MW or more) contributed 42% of the renewable heat capacity and 56% of the annual output. Within this category there are **6 sites** that generate **more than 100 GWh heat per year**; together these sites provided 39% (1,473 GWh), of the total renewable heat output in Scotland in 2016 and 17% (0.296 GW) of the operational renewable heat capacity.

This large contribution from a small number of sites is inherent both from the scale of these sites and because the large installation category includes installations which are primarily using renewable heat to provide process heat, as a product of combined heat and power, or combustion of waste, which are year-round activities. Small to medium and micro installations are more likely to be used to provide space heating and/or hot water for buildings, whose demands are more seasonal and so their contribution to total renewable heat output is proportionately less.

The large contribution that the greater than 1 MW installations make to the overall output emphasises the importance of improving the quality of data collected from these sites, as small changes in the information collected from these sites could result in potentially significant changes to the heat output total.

Table 7. Renewable heat capacity and output in Scotland, 2016, by size of installation

Size category	Renewable heat capacity (GW)	% Renewable heat capacity	Annual output (GWh)	% Annual output	Number of installations (rounded to the nearest 10)	% Number of installations
Large (1MWth+)	0.717	42%	2,070	56%	70	<1%
Small to medium (>45kWth and <1MWth)	0.663	39%	972	26%	3,610	15%
Micro (≤45kWth)	0.314	19%	562	15%	20,510	85%
Biomethane (no stated capacity)	N/A	N/A	100	3%	10	<0.1%
Unknown	<0.001	<0.1%	<1	<0.1%	Missing data	Missing data
Total	1.695	100%	3,705	100%	24,200	100%

Notes: 1) Missing data - this comes from a bundle of installations where we have total capacity and total estimated output but no information on the size breakdown or the type of technology.

2) Biomethane gas to grid injection does not have a stated capacity, output from this technology is not included in any size category but has been added to the total heat output figure.

3) Data has been rounded for ease of reading, hence some subtotals may not precisely equal summed figures.

Table 8. Renewable heat capacity and output in Scotland, 2015, by size of installation

Size category	Renewable heat capacity (GW)	% Renewable heat capacity	Annual output (GWh)	% Annual output	Number of installations (rounded to the nearest 10)	% Number of installations
Large (1MWth+)	0.710	47%	2,958	71%	60	0.3%
Small to medium (>45kWth and <1MWth)	0.510	34%	722	17%	3,130	15%
Micro (≤45kWth)	0.283	19%	464	11%	17,670	85%
Biomethane (no stated capacity)	N/A	N/A	21	1%	1	0.005%
Unknown	0.000	0%	1	0%	Missing data	Missing data
Total	1.504	100%	4,165	100%	20,870	100%

Notes: 1) Missing data – this comes from a bundle of installations where we have total capacity and total estimated output but no information on the size breakdown or the type of technology.

2) Biomethane gas to grid injection does not have a stated capacity, therefore output from this technology is not included in any size category but has been added to the total heat output figure.

3) Data has been rounded for ease of reading, hence some subtotals may not precisely equal summed figures.

Key points from Tables 7 and 8 are:

In 2016, **small to medium** (>45 kW and <1 MW) systems made up 15% of the renewable heat installations in Scotland (by number). The small to medium size category is mostly made up of biomass systems (97%) with other technologies (energy from waste, heat pumps and solar thermal) making up the remainder. **Capacity from these systems has increased by 30% between 2015 and 2016, by 0.153 GW, while output has increased by over a third (35%)**. In the absence of RHI data at the site specific level it is difficult to provide much analysis or draw conclusions from this change. It is notable that, whilst capacity within this size bracket has increased in 2016, the increase between 2015 and 2016 (30%) is lower than the increase between 2014 and 2015 (51%). This implies that the rate of installs is falling. It is possible that this reduction in rate of increase is due to changes in the RHI tariffs[27].

[27] As a result of regulatory amendments to the RHI made in September 2017, originally consulted on in March 2016, a number of RHI tariffs have changed (the majority increasing). Additionally for the domestic RHI annual heat demand limits were introduced. For more details see: https://www.ofgem.gov.uk/environmental-programmes/domestic-rhi/about-domestic-rhi/changes-scheme for the domestic scheme and : https://www.ofgem.gov.uk/system/files/docs/2017/09/factsheet_september_gb_rhi_reforms.pdf for the non-domestic scheme.
.

- **Micro heat capacity increased by 11% between 2015 and 2016 while output increased by 21%.** Whilst this shows an ongoing increase in capacity and output year on year, the rate of this increase has declined. Between 2015 and 2016, capacity and output increased at a considerably lower rate than between 2014 and 2015 (44% increase in capacity and 42% increase in output between 2014 and 2015). This may be because the domestic RHI tariff dropped quite considerably throughout 2015 and the lower rates available by 2016 offer a less financially attractive offer for micro-installations.

  Since 2008/9 capacity has increased by almost 600% (from 0.0454 GW) and output has increased by more than 300% (from 139 GWh). This shows the impact of the domestic RHI (and Renewable Heat Premium Payment (RHPP) scheme) and other supporting SG programmes on this sector within Scotland. The increase in output between 2008/9 and 2016 seems small compared to the increase in capacity over the same time period. This is to be expected for micro heat installations as they have lower running hours than systems that are used for commercial or industrial purposes.

- The **total capacity of large installations increased marginally (1%) between 2015 and 2016 while output decreased by 30%.** This reduction in output is primarily due to a significant reduction in operation from one large site which continues to supply heat but at much lower output than in previous years. Since the site is still operational, it continues to contribute to the heat capacity figure despite its lower output. A further reason for the reported reduction in output is that improved data has been received from a different large site which provides a more accurate heat output figure and overrides a previous estimated output. Since 2008/9, the total capacity of large installations more than quadrupled and total output has more than tripled (from 0.164 GW to 0.717 GW capacity and from 637 GWh to 2,270 GWh output).

4.3 Results by technology

The **majority of both output and capacity in 2016 came from biomass primary combustion and biomass combined heat and power** (see Table 9, and Figures 5 and 6). 84% of renewable heat capacity, and 83% of renewable heat output came from installations which used biomass primary combustion or biomass combined heat and power. This is a continuation of the trends seen in both the publically available domestic and non-domestic RHI reports[28], as well as from previous years' renewable heat in Scotland reports[29].

Tables 9 and 10 and Figures 5 and 6 show the breakdown of operational renewable heat capacity and renewable heat output in Scotland in 2016 by technology categories.

[28] See BEIS's website: https://www.gov.uk/government/collections/renewable-heat-incentive-statistics for monthly updates on both schemes.
[29] http://www.energysavingtrust.org.uk/reports

Table 9. Renewable heat output and capacity in Scotland, 2016, by technology

Technology	Renewable heat capacity (GW)	% Renewable heat capacity	Annual output (GWh)	% Annual output
Biomass	1.030	61%	2,504	68%
Biomass CHP	0.401	24%	555	15%
Energy from waste	0.079	5%	342	9%
Heat pump	0.147	9%	287	8%
Solar thermal	0.036	2%	19	<1%
Total	1.695	100%	3,705	100%

Note: data has been rounded for ease of reading, hence some subtotals may not precisely equal summed figures.

As energy from waste includes a number of technologies such as incineration, advanced conversion technologies and landfill gas, a breakdown of this category is provided in Table 10.

Table 10. Renewable heat output and capacity in Scotland, 2016, energy from waste technologies

Energy from Waste Technology	Renewable heat capacity (MW)	% Renewable heat capacity	Annual output (GWh)	% Annual output
Energy from waste - advanced conversion technologies	65	4%	272	7%
Energy from waste – incineration	13	<1%	67	2%
Energy from waste - landfill gas	1	<0.1%	2	<0.1%
Total	79	5%	342	9%

Note: 'Energy from waste – advanced conversion technologies' incorporates biomethane to grid, anaerobic digestion CHP and anaerobic digestion heat production

Whilst biomass remains the largest contributor to both renewable heat output and capacity by some margin, other technologies have seen considerable growth between 2015 and 2016. In particular, energy from waste has seen an increase in capacity of 52% and increase in output of 78%. Within this category the number of biomethane to grid sites has doubled from 5 in 2015 to 10 in 2016. Heat pumps have also seen considerable growth, with a 17% increase in capacity and 21% increase in output.

Within the energy from waste category, the largest increase in output is from advanced conversion technologies. These technologies have seen an increase in output of 123GWh,

representing an 82% increase. The majority of this (67%) is due to increases in the output of anaerobic digestion CHP technologies.

Figure 5. Renewable heat capacity in Scotland, 2016, by technology

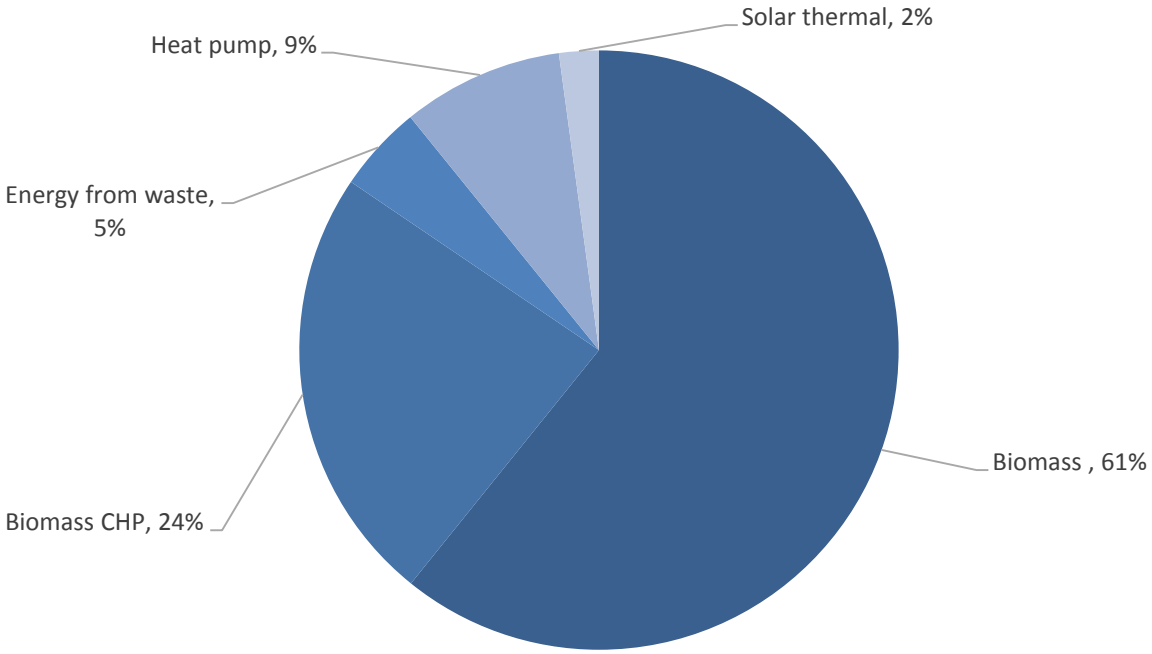
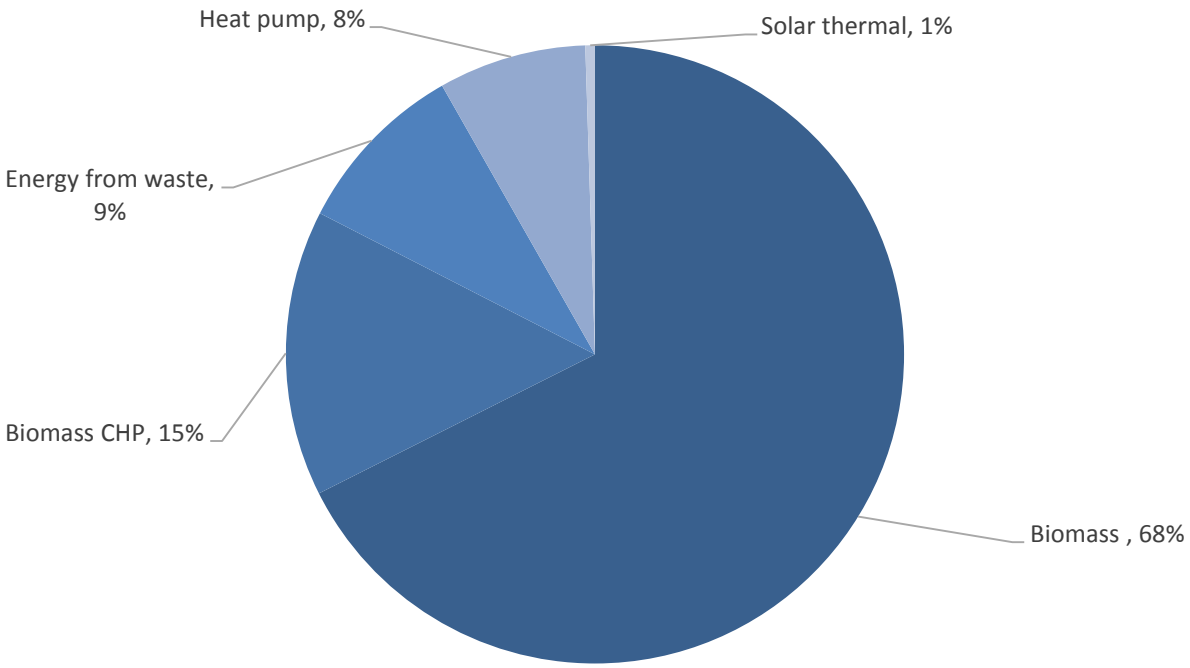


Figure 6. Renewable heat output in Scotland in 2016, by technology



4.4 Results by size and technology

Almost all biomass CHP and energy from waste sites in 2015 were within the 'large' size bracket, whereas solar thermal and heat pumps in 2015 were almost entirely within the 'micro' size bracket. This is likely due to solar thermal systems and heat pumps being generally more suitable for space and/or water heating which currently in Scotland is usually generated on a smaller scale.

In 2016, the biomass CHP and energy from waste sites follow the same pattern, with the majority of them within the 'large' size bracket. Again solar thermal systems and heat pumps are almost entirely in the micro size bracket. Large biomass sites account for around 25% of total biomass (heat) capacity, however their renewable heat output accounts for 52% of the total biomass renewable heat output in 2016. This is likely because larger sites often provide heat year round (e.g. for industrial use), whereas smaller sites generally have more seasonal demands such as providing space and water heating.

A breakdown of technology and size (as percent of the overall total for each technology) is shown in Figures 7 and 8.

Figure 7. Capacity by size and technology (% of total technology operational capacity), 2016

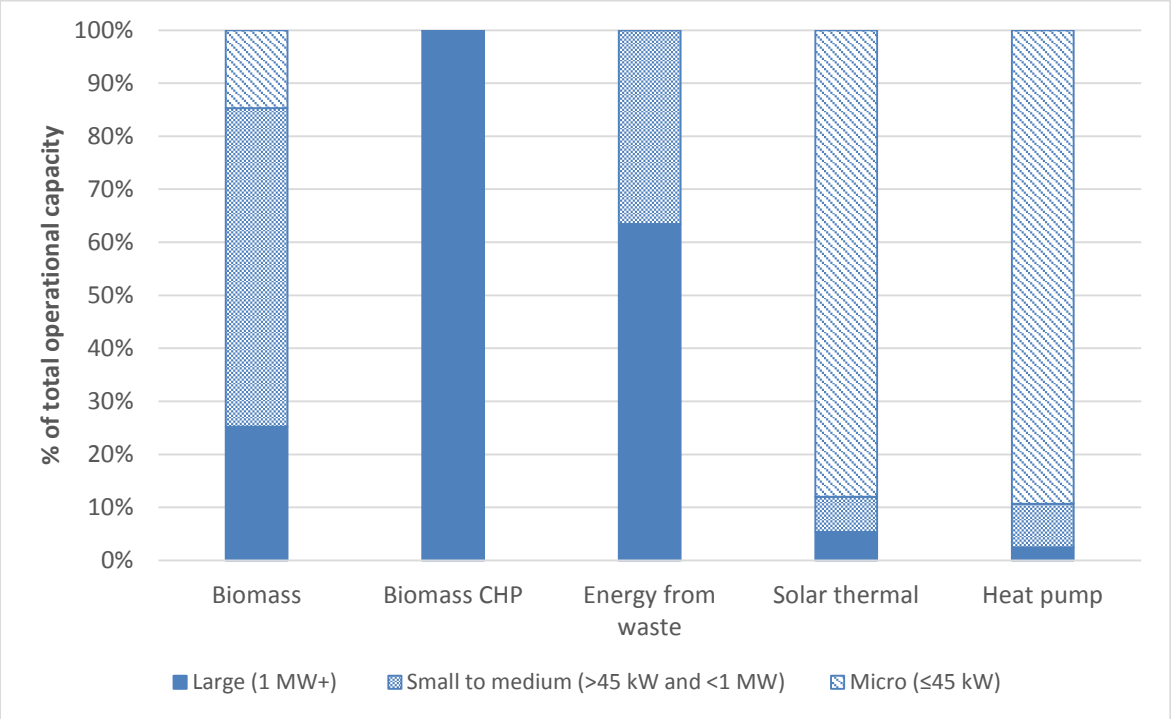
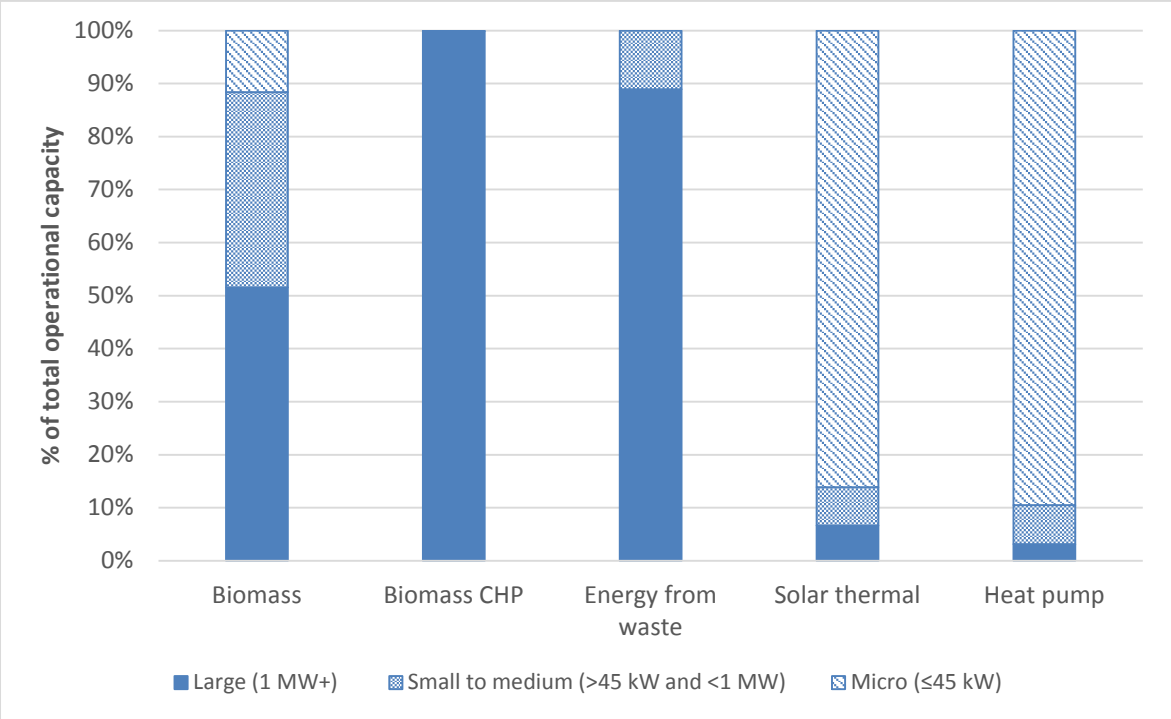


Figure 8. Output by size and technology (percent of total technology heat output), 2016



4.5 Change in output and capacity by technology since 2015

The overall proportions of renewable heat capacity provided by different technology types have remained relatively stable between 2015 and 2016. Biomass primary combustion continues to be the largest contributor to renewable heat capacity in Scotland, followed by biomass CHP. Combined, these technologies accounted for 84% of renewable heat capacity in 2016, compared to 86% in 2015. Both technologies have seen an increase in capacity in 2016; the increase in biomass combustion and biomass CHP capacity account for 73% of the total increase in renewable heat capacity in 2016. Biomass therefore remains the dominant renewable heat technology in Scotland, and changes in this sector have the greatest impact on absolute capacity figures.

Biomass also continues to make up the vast majority of total renewable heat output (83%, compared to 89% in 2015). However, the proportion of this which is provided by biomass CHP, as opposed to combustion, has dropped considerably. Biomass CHP saw a drop in output of 963 GWh in 2016 (a 63% drop). In part this is due to a reduction in operations from one site and in part due to improved data availability for a separate large site. For this latter site, previously the heat output was estimated within the renewable heat database however additional information on heat output was provided by the site this year which has led to a reduction in the heat output recorded for this site.

Whilst biomass remains the dominant renewable heat technology in Scotland, there has also been considerable growth in the energy from waste and heat pump sectors. Energy from waste currently accounts for only 5% of renewable heat capacity and 9% of output, however, this was the fastest growing renewable heat technology in Scotland in 2016 in terms of proportional increase in both capacity and output. Energy from waste capacity has increased by 52% (0.027GW) between 2015 and 2016, and output has increased by 78% (150GWh). This follows an ongoing trend of increasing energy from waste year-on-year, with the capacity of energy from waste sites being almost five times bigger (390% increase) since 2013, and the output almost tripling (180% increase) over the same time period.

Heat pumps, similarly, only contribute a relatively small proportion of total renewable heat capacity and output, but have seen reasonably large proportional increases in capacity and output between 2015 and 2016, with capacity increasing by 17% (0.022 GW, of additional capacity) and output by 21% (50 GWh).

Table 11. Changes in renewable heat output and capacity in Scotland from 2015 to 2016, by technology

Technology category	2016 Total capacity (GW)	Change since 2015 (GW)	Percentage change	2016 Total annual output (GWh)	Change since 2015 (GWh)	Percentage change
Biomass	1.030	+ 0.13	14%	2,504	+ 300	14%
Biomass CHP	0.401	+ 0.01	3%	555	-963	-63%
Energy from waste	0.079	+ 0.027	52%	342	+ 150	78%
Heat pump	0.147	+ 0.022	17%	287	+ 50	21%
Solar thermal	0.036	+ 0.003	9%	19	+ 2	11%
Total	1.695	+ 0.191	13%	3,705	-460	-11%

Notes: a) data has been rounded for ease of reading, hence some subtotals may not precisely equal summed figures.
b) 'Energy from waste – advanced conversion technologies' incorporates biomethane to grid, anaerobic digestion CHP and anaerobic digestion heat production.

4.6 Capacity and output by local authority area

The database captures information on the local authority area for most operational sites that are in the large (1 MW+) or small and medium (>45 kW and <1 MW) size categories. Information for each local authority is not available for micro (≤45 kW) installations as location information for these records has not been disclosed to EST from MCS (used from 2012 onwards) and is not available for aggregated data from previous schemes (used for 2008/9-2011).

As in previous years a local authority breakdown of the aggregated RHI data was not available for this report; aggregated RHI scheme data provided by BEIS to EST does not show local authority area as doing so would risk disclosing information about individual sites (combined with the other data provided). Similarly, a local authority breakdown of the aggregated CHPQA data was also not available for this report. As such, **the data in the bullet points below does not include 38% of the overall heat output and 53% of the overall capacity reported for 2016**, as this is not assigned to a local authority. In Table 12, this missing data is labelled as 'local authority unknown'.

The key findings from analysis of the non-micro and non-RHI aggregated installations by local authority area, for those sites with available locational information, are[30]:

[30] The percentages given here are based on a total heat output of 2.321 GWh and a total capacity of 0.810 GW – this is the heat output and capacity **excluding** those sites for which local authority data is not available (i.e. excluding aggregated RHI data, aggregated CHPQA data and micro-installation data from MCS)

- Highlands accounted for at least 27% of Scotland's total renewable heat output for which the location is known in 2016 and had 17% of the overall operational capacity

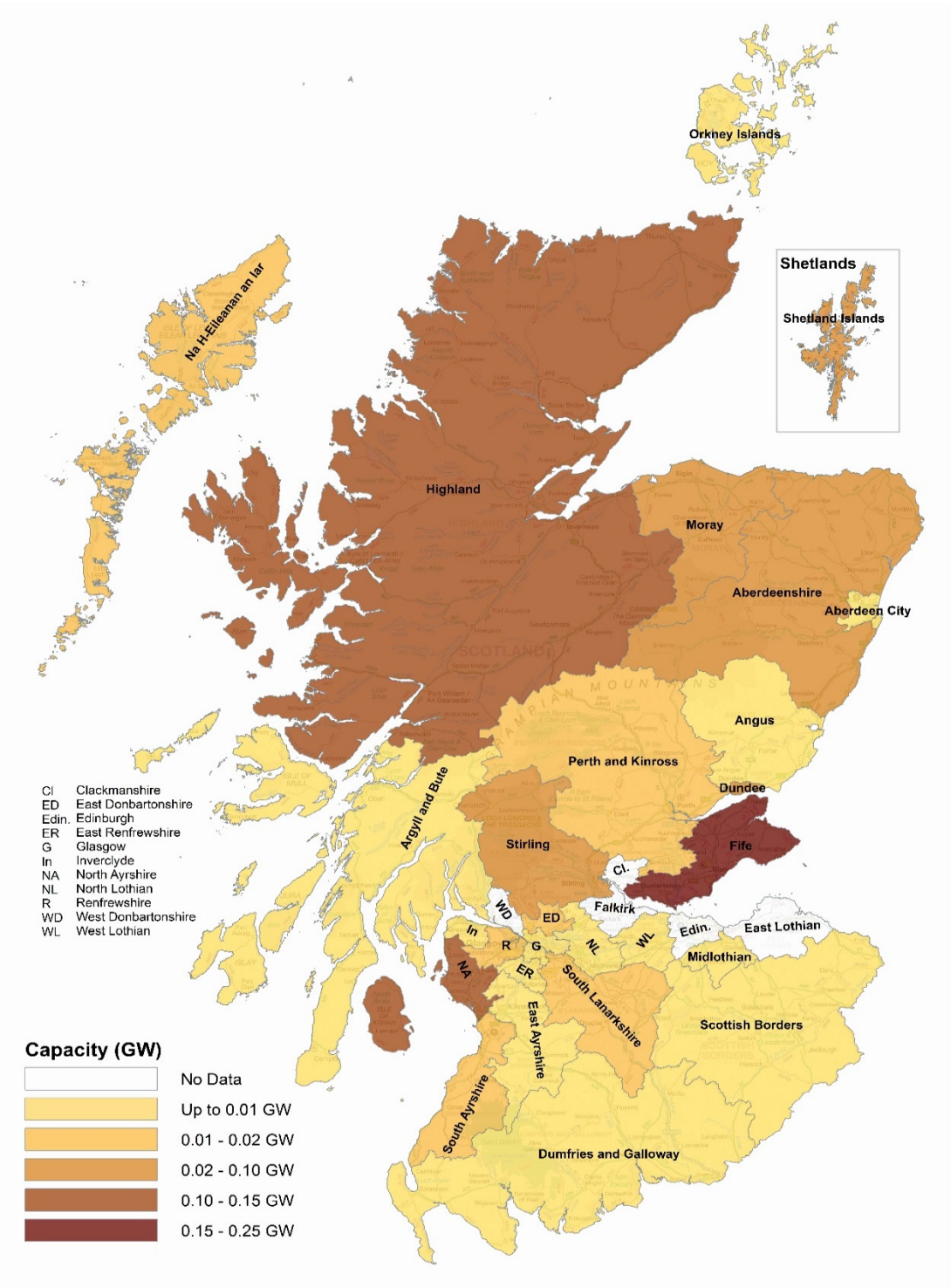
- 70% of the 2016 heat output came from just 4 areas (Highlands, Stirling, North Ayrshire and Moray), which collectively contributed over 1,633 GWh of renewable heat in 2016. These 4 areas had a combined capacity of 0.376 GW (46% of the renewable capacity in Scotland for which the location is known).

Table 12. Heat output and capacity by local authority area, Scotland, 2016[31]

Local authority area	Renewable heat output, 2016 (GWh)	Renewable heat output, 2016 (%)	Operational renewable heat capacity, 2016 (GW)	Operational renewable heat capacity, 2016 (%)
Aberdeen City	8	0.2%	0.004	0.2%
Aberdeenshire	59	2%	0.023	1%
Angus	21	1%	0.008	0.5%
Argyll and Bute	26	1%	0.009	1%
Clackmannanshire	c	c	c	c
Comhairle nan Eilean Siar	5	0.1%	0.002	0.1%
Dumfries and Galloway	35	1%	0.024	#N/A
Dundee City	2	0.0%	0.001	0.1%
East Ayrshire	109	3%	0.018	1%
East Dunbartonshire	c	c	c	c
East Lothian	32	1%	0.008	0.5%
East Renfrewshire	c	c	c	c
Edinburgh, City of	33	1%	0.012	1%
Falkirk	c	c	c	c
Fife	126	3%	0.239	14%
Glasgow City	7	0.2%	0.002	0%
Highland	616	16%	0.139	8%
Inverclyde	3	0%	0.001	0.1%
Midlothian	19	1%	0.003	0.2%
Moray	163	4%	0.057	3%
North Ayrshire	327	9%	0.103	6%
North Lanarkshire	11	0.3%	0.004	0.2%
Orkney Islands	4	0.1%	0.001	0.1%
Perth and Kinross	66	2%	0.013	1%
Renfrewshire	19	0%	0.013	1%
Scottish Borders	19	1%	0.007	0.4%
Shetland Islands	11	0.3%	0.008	0.4%
South Ayrshire	24	1%	0.013	1%
South Lanarkshire	30	1%	0.011	1%
Stirling	527	14%	0.078	5%
West Dunbartonshire	c	c	c	c
West Lothian	3	0.1%	0.001	0.1%
Local authority unknown	1431	38%	0.900	53%
TOTAL	3752	100%	1.710	100%

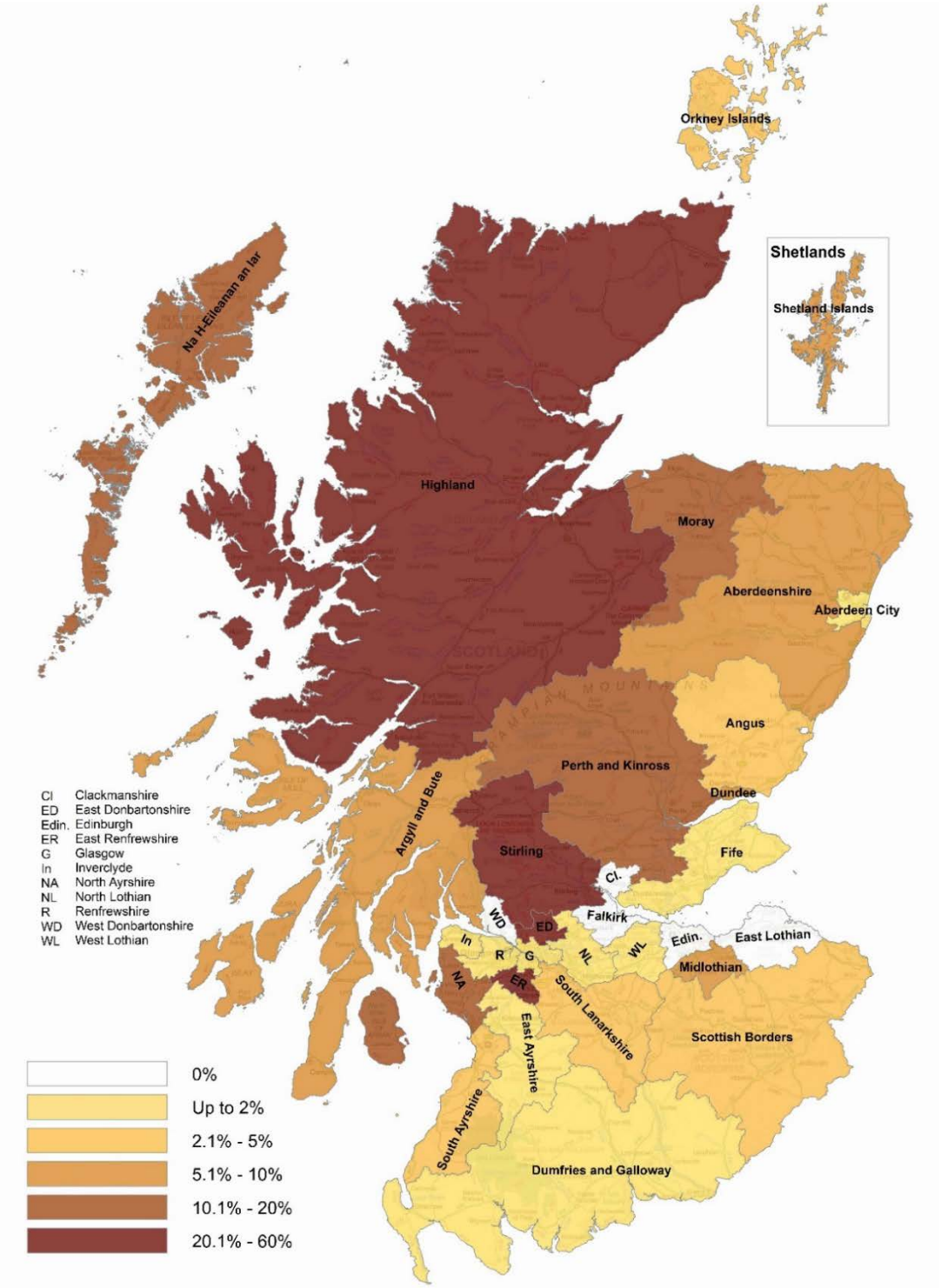
[31] 'c' marks where fewer than 5 installations are recorded in an area. This information has been withheld to avoid disclosing information about individual sites.

Figure 9. Map showing operational renewable heat capacity by local authority area, 2016[32]



[32] Local authority areas shown here to have a high proportion of renewable heat capacity do not mirror exactly those with the highest proportions of renewable heat capacity under RHI. To see which local authorities have the highest proportions of renewable heat capacity under RHI please refer to: https://www.gov.uk/government/collections/renewable-heat-incentive-statistics.

Figure 10. Map showing the proportion of non-domestic heat demand met by renewable heat output, 2016[33].



[33] Heat demand figures assume that heat demand does not change from 2015 (scenario 3). Heat output figures exclude micro installations and aggregated RHI data. To see which local authorities have the highest proportions of renewable heat capacity under RHI please refer to: https://www.gov.uk/government/collections/renewable-heat-incentive-statistics.

Whilst the aggregated RHI data provided by BEIS to EST does not show local authority area, the data is available separately from BEIS on the breakdown of the number and capacity of accreditations under the non-domestic RHI by local authority area[34]. We have chosen not to present these breakdowns in this report, as it contains only RHI data and therefore would provide similar but differing information to that in Table 12.

As mentioned above, the renewable heat database does not record local authority area for microgeneration technologies. However, BEIS do publish tables of domestic RHI accreditation numbers by local authority area. The data for Scotland from the December 2016 data is given in Table 13.

[34] Please refer to: https://www.gov.uk/government/collections/renewable-heat-incentive-statistics.

Table 13. Number of installations by local authority area accredited in Scotland under the domestic RHI scheme as of December 2016[35]

Local authority area	Number of installations	% installations
Aberdeen City	36	<1%
Aberdeenshire	889	8%
Angus	254	2%
Argyll and Bute	483	4%
Clackmannanshire	27	<1%
Comhairle nan Eilean Siar	646	6%
Dumfries and Galloway	1,466	14%
Dundee City	28	<1%
East Ayrshire	163	2%
East Dunbartonshire	29	<1%
East Lothian	177	2%
East Renfrewshire	28	<1%
Edinburgh, City of	75	<1%
Falkirk	61	<1%
Fife	366	3%
Glasgow City	27	<1%
Highland	1,842	17%
Inverclyde	24	<1%
Midlothian	81	<1%
Moray	300	3%
North Ayrshire	100	<1%
North Lanarkshire	59	<1%
Orkney Islands	245	2%
Perth and Kinross	592	5%
Renfrewshire	49	<1%
Scottish Borders	487	4%
Shetland Islands	149	1%
South Ayrshire	179	2%
South Lanarkshire	1,579	15%
Stirling	284	3%
West Dunbartonshire	18	<1%
West Lothian	106	<1%
TOTAL	**10,849**	**100%**

[35] Source: BEIS Non-Domestic RHI and domestic RHI monthly deployment data: December 2016. https://www.gov.uk/government/collections/renewable-heat-incentive-statistics#monthly-deployment-data

This breakdown shows that the Highland local authority area is leading in the deployment of domestic microgeneration systems with 17% of the domestic RHI installations in Scotland located in this area. Other areas with large numbers of microgeneration systems are South Lanarkshire and Dumfries and Galloway. Both areas had over 1,000 domestic RHI accredited systems as of December 2016, and held 15% and 14% of the total accredited domestic installations in Scotland respectively. As of December 2016, Scotland as a whole had 20% of the 52,971 accredited domestic RHI systems in Great Britain which is above the proportion of installations to be expected on a pro-rata basis.

The figures above do not provide a full picture of renewable heat being supplied to homes in each local authority area. For example, domestic RHI figures do not include homes supplied by renewable heat through district or communal heating or homes with microgeneration renewable technologies installed before 15 July 2009.

A number of factors influence uptake of RHI in each local authority area including the number of homes in the area and the proportion of homes that do not have access to mains gas. The domestic RHI was designed to be targeted at, but not limited to, households which are off the gas grid. The vast majority of microgeneration systems accredited under the domestic RHI are located off the gas grid, with 90% of heat pumps and 89% of biomass systems installed in off-grid areas[36]. A smaller proportion of solar thermal systems (62%) are located in off-grid areas. This is to be expected, as domestic solar thermal systems are most often used alongside a main heating system and work well with gas central heating systems.

Table 14. Number of installations on and off the gas grid accredited in Scotland under the domestic RHI scheme as of December 2016, by technology[37]

Technology	Number of installations on grid	% installations on grid	Number of installations off grid	% installations off grid
Biomass	410	11%	3,205	89%
Heat pump	634	10%	5,553	90%
Solar thermal	394	38%	653	62%
TOTAL	**1,438**	**13%**	**9,411**	**87%**

Uptake of the domestic RHI has continued to increase across all eligible technologies since December 2016. Please refer to section 5.2 for further commentary on the trends seen in both the domestic and non-domestic RHI between December 2016 and August 2017.

[36] Based on RHI data from April 2014 to December 2016

[37] Source: BEIS Non-Domestic RHI and domestic RHI monthly deployment data: December 2016. https://www.gov.uk/government/collections/renewable-heat-incentive-statistics#monthly-deployment-data
Off grid is defined as isolated communities which could not feasibly connect to the national grid (such as some Scottish isles and particularly remote mainland locations)

5 Further renewable heat capacity in development

5.1 Pipeline projects in the renewable heat database

In previous iterations of the renewable heat in Scotland report, an overview of projects currently in development has been presented alongside projections of both expected capacity and heat output over the coming years. There was an inherently large degree of uncertainty around these projections because the projects may not have come to fruition and the stated capacity and heat output for projects still in development are often subject to change. It is also likely that a large proportion of developing projects are not captured by the methodology used to update the database, particularly for smaller installations and installations that are not required to go through formal planning permission.

Because of the uncertainty associated with projected figures, commentary on the renewable heat capacity in development and potential output recorded in the renewable heat database has not been included in this report.

5.2 Trends seen in the RHI monthly statistics

While there is a large degree of uncertainty around the projects recorded as 'in development' in the renewable heat database, the RHI statistics published by BEIS on a monthly basis can give an indication of renewable heat capacity in the pipeline during 2017. During the first eight months of 2017, there was an increase in both the number of full applications[38] under the non-domestic RHI scheme and in accreditations under the domestic scheme.

Trends in the domestic RHI scheme[39]:

- There was a **7% increase in accreditations** for systems in Scotland under the domestic RHI between December 2016 and August 2017. (An increase of 720, from 10,850 as of 31 December 2016 to 11,570 as of 31 August 2017).

- The rate of growth in accreditations for systems in Scotland under the domestic RHI is slowing down. The average monthly increase of the number of accreditations was 7.1% for 2015 and 1.4% for 2016 respectively. For 2017, the average monthly growth of accreditations equates to 1.3%.

- The technology with the largest increase in the number of accreditations under the domestic RHI was **air source heat pumps,** with an **increase of 470,** from 5,210 as of 31 December 2016 to 5,670 as of August 2017 (an increase of **9%**).

[38] Under the non-domestic RHI 'Full application' refers to applications that are not preliminary. This means that the site will have been commissioned, but can be either accredited or currently going through the accreditation process.
[39] Numbers of installations have been rounded to the nearest 10 for ease of reading

- The number of domestic **ground source heat pumps** accredited under the domestic RHI from December 2016 to August 2017 has **grown by 11%**, from 980 in December 2016 to 1,090 systems in August 2017.

- **Solar thermal** and **biomass installations** have seen lower rates of uptake, with solar thermal accreditations increasing by **4%** (from 1,050 to 1,090) and biomass accreditations increasing by **3%** (from 3,620 to 3,710) between December 2016 and August 2017.

- As of August 2017, systems in **Scotland accounted for 20% of the total number of accredited systems under the domestic RHI scheme**.

Trends in the non-domestic RHI scheme[40]:

- There was an 11% increase in the number of non-domestic RHI 'full applications' in Scotland between December 2016 and August 2017, with a 33% increase in capacity (an increase from 3,270 full applications in December 2016 to 3,620 in August 2017, and a capacity increase of 223 MW, from 684 MW to 908 MW).

- The rate of increase of full applications in Scotland under the non-domestic RHI has reduced since 2015 when it averaged 2.6% per month. This rate halved during 2016 to a monthly average of 1.3%. This has further dropped in 2017 to an average monthly growth in full applications of 1.1%.

- The general trend across all countries (England, Wales and Scotland) was that the largest proportional growth in number and capacity of full applications between December 2016 and August 2017 was in CHP systems. GB wide, the number of CHP full applications increased from 21 in December 2016 to 59 in August 2017 (an increase of 181%).

- Medium solid biomass installations made up the largest number of new installations in Great Britain in the first 8 months of 2017 with 1,200 new installations from December 2016 to August 2017. This is an increase of 53% between December 2016 and August 2017.

- As of August 2017 systems in **Scotland accounted for 19% of the total number of full applications and 21% of the total installed capacity under the non-domestic RHI** scheme.

[40] For the non-domestic scheme, a breakdown of the capacity and heat paid for under different technology categories is not available by region, so determining the trend in Scotland is less clear than with the domestic scheme.

These figures demonstrate the continued impact both the non-domestic and domestic RHI schemes, alongside supporting Scottish Government schemes, have on renewable heat in Scotland.

5.3 Emerging technologies and innovative projects in the pipeline

Sites converting from anaerobic digestion (AD) to biomethane to gas grid injection (BtG) are likely to become an increasingly prominent technology. These sites will not add to Scotland's overall heat capacity; as these sites start to inject gas, the contribution will only be noticeable in the figures for heat output. This is because there is no associated capacity with this kind of technology as you do not have a dedicated facility built to output a fixed capacity of biomethane; instead you have a varying volume of biomethane (generated from various amounts of agricultural or waste material) you inject into the gas grid to increase its overall heat output. Although there will be some low conversion losses, gas to grid injection should avoid higher heat losses from combusting gas on site (or flaring the excess gas and wasting the energy), and should make a contribution to decarbonisation of the gas grid.

There are a wide range of innovative projects being funded through various challenge funds. Together, these projects aim to show how different renewable technologies can be used and to reduce heat demand through the installation of energy efficiency measures and behavioural change. Many of the projects are not yet at a stage where heat capacity and estimated output can be included in the figures presented in this report. A summary of some of the relevant funding programmes is given below.

5.3.1 District Heating Loan Fund

The Scottish Government's District Heating Loan Fund has funded/co-funded a significant number of district heating schemes in Scotland to date, and continues to provide a vital funding stream helping to facilitate both low carbon and renewable district heating projects. Information on projects awarded funding can be found at:
http://www.energysavingtrust.org.uk/scotland/grants-loans/district-heating-loan

5.3.2 Local Energy Challenge Fund

One project which has received support through the Scottish Government's Local Energy Challenge Fund is the Large Scale ASHP District Heating Exemplar project, let by Glasgow Housing Association. The project, which plans to deploy the UK's largest air source heat pump (700kW) to heat 350 dwellings in multi-storey buildings built in the 1970s is currently under construction, with completion of the energy centre expected in November 2017 and completion of the district heating connections expected in May 2018.

5.3.3 Low Carbon Infrastructure Transition Programme

Launched in March 2015, the Low Carbon Infrastructure Transition Programme (LCITP) is a collaborative partnership led by the Scottish Government, working with Scottish Enterprise, Highlands and Islands Enterprise, Scottish Futures Trust and Resource Efficient Scotland. With a budget of £76 million, this programme focuses on supporting the acceleration of low carbon infrastructure projects (including district heating) across the public, private and community sectors to develop investment grade business cases to help projects secure public and private capital finance.

LCITP has provided around £26 million support to 10 renewable heat demonstration projects in Scotland which are expected to be operational by October 2018. Details of LCITP funding calls and supported projects are available on the LCITP website: www.gov.scot/Topics/Business-Industry/Energy/Action/lowcarbon/LCITP

5.3.4 Scotland's Energy Efficiency Programme Pilot

The Scottish Government's Infrastructure Investment Plan 2015 reaffirmed the designation of energy efficiency as a National Infrastructure Priority. The cornerstone of this will be Scotland's Energy Efficiency Programme (SEEP) which will commence in 2018. As well as making homes and businesses warmer, the programme will support the Scottish Government's fuel poverty targets and bring clear economic benefits. It will be a co-ordinated programme to improve the energy efficiency of homes and buildings in the commercial, public and industrial sectors with an estimated overall investment of up to £10 billion required.

The Programme for Government 2016-17 committed over half a billion pounds to SEEP over the next four years. Work on the programme is already underway. During the first phase of the programme the focus is on delivering existing programmes more effectively and developing new pilot schemes to test integrated delivery mechanisms for the domestic and non-domestic sectors. The Scottish Government is piloting approaches with local authorities between 2016-19. Phase 1 pilots helped local authorities to pilot new and innovative approaches to energy efficiency with community groups and businesses, helping reduce costs and improving warmth in homes, schools, hospitals and businesses. Phase 2 pilots continued this integrated approach and also include support to 12 local authorities to pilot different approaches in developing a Local Heat & Energy Efficiency Strategy (or elements of).

5.4 Other developments from 2016 onwards

From the summary of findings, it is clear that operational renewable heat capacity in Scotland is growing faster than the annual heat renewable output from the operational sites. This implies that, although some systems will not be needed all year round, there is some

underuse of the potential heat available which could potentially be exported to other heat users. Further strategic development of heat networks (where feasible) will allow authorities to identify and utilise excess heat, improve operational efficiencies, strengthen heat security and accelerate Scotland towards its renewable heat targets.

In January 2017 the Scottish Government worked with the Scottish Environment Protection Agency (SEPA) to repeat the surplus industrial heat data collection exercise. Data was requested on a voluntary basis via the Scottish Pollution Release Inventory (SPRI) from industries regulated by SEPA under the Pollution Prevention and Control (Scotland) Regulations 2012 (as amended). Responses were received from a small number of organisations and will be combined with information obtained in 2016 to inform future policy development.

The Heat Policy Statement published in 2015 stated that the Scottish Government recognise the need for regulation of district heating, commensurate with the scale of the market, and the 2016 Programme for Government committed the Scottish Government to consult on such regulations, as part of the development of Scotland's Energy Efficiency Programme (SEEP). In January 2017 the Scottish Government issued a consultation paper alongside the publication of the Energy Strategy on regulation of district heating and on Local Heat & Energy Efficiency Strategies (LHEES). This consultation closed on 18 April and was a high-level policy scoping consultation that sought views and further evidence on a broad scenario for district heating regulation and Local Heat & Energy Efficiency Strategies which would support the development of SEEP.

The consultation also considered how to deliver the recommendations of the Special Working Group of the Expert Commission on District Heating which submitted its report on potential regulatory frameworks for district heating in Scotland to Scottish Ministers in February 2016.

The Scottish Government are now proposing to consult further with another consultation in Autumn 2017 setting out the preferred approach to district heating regulation and on LHEESs, for further comment and testing with stakeholders.

Evidence from all rounds of consultation will be used to inform the Scottish Government's final decisions on whether any legislation (primary and / or secondary) would be needed for district heating regulation and LHEES.

6 Uncertainty levels associated with the methodology used, and recommendations for future updates

In any analysis of this kind where incomplete data are gathered from a variety of sources, certain assumptions have to be made to fill in gaps in the data. Assumptions made for particular technologies or sectors are discussed in this section as well as the following general advice on the robustness of these figures:

- As in previous years there is a chance that installations could have been either missed or double counted.
- Realised heat output from installations may not match the predictions of output based on installed capacity and peak running hours.
- It is worth noting that some heat projects, particularly CHP installations, propose to export heat to nearby heat users; however, the heat networks necessary to transport this heat have yet to be constructed and in some cases there is not yet a heat user located nearby. Use of the renewable heat will therefore depend firstly upon a suitable heat user being identified or established nearby and secondly how much heat that user requires, either for process heat or space heating.

In the figures reported, 90% of renewable heat capacity is known, 7% was estimated and 3% had unknown status. 68% of renewable heat output is known and 32% is estimated.

6.1 Estimating heat capacity and renewable heat output for non-domestic RHI accredited installations

The non-domestic Renewable Heat Incentive (RHI) launched in 2011, making its first payments for heat generated in 2012. The scheme is administered by Ofgem on behalf of BEIS. Previous reports have recommended that access to the RHI database be given to EST or the Scottish Government to ensure that all installations are captured in the renewable heat in Scotland database and that the respective output is included in the target monitoring figures. While some progress has been made on this action, legislative changes would be required to enable the non-domestic RHI database to be made available to the Scottish Government or EST for this purpose.

The RHI continues to incentivise the uptake of renewable heat technologies, a large number of which are small to medium biomass boilers. The renewable heat database is likely to capture most large-scale installations through the use of the Renewable Energy Planning Database (REPD) and a large proportion of micro installations through the receipt of anonymised data from the Microgeneration Installations Database (MID) (see section 6.2). The RHI data is likely to be the largest single source of site-level information on medium installations and this information is hard to find efficiently through other sources without a

high risk of double counting. Current site-level information in the renewable heat database on medium sized installations is therefore more likely to be uncertain (in terms of useful renewable heat output) and likely to be underreported. It has therefore become increasingly important to be able to cross-reference the renewable heat database with the RHI database as the RHI continues to see an increase in interest in this size range of biomass boilers[41]. An extract of the non-domestic RHI database was not available at the time of compiling the data for this report. In order to ensure that this work could make use of the RHI dataset, BEIS instead carried out analysis on the EST and RHI databases. By doing so they were able to provide EST with aggregated figures for the capacity, heat output and number of RHI accredited installations that are not already accounted for in the renewable heat database. Full details of the work carried out and the steps taken to avoid double counting are available in Appendix 3.

The additional capacity, eligible heat output and numbers of installations identified by BEIS have been added to the total figures shown in this report.

6.2 Estimating heat capacity and renewable heat output for CHPQA installations

The CHPQA programme is a government initiative which began in 2001. It aims to provide a practical, determinate method for assessing all types and sizes of combined heat and power schemes throughout the UK. The voluntary scheme, which is implemented by Ricardo-AEA, requires the submission of annual or monthly energy figures for electricity generated, fuel consumed and heat utilised. The scheme is voluntary, therefore may not capture every CHP installation in Scotland. However, various government tax breaks and incentives schemes require the installation to be a member of the CHPQA scheme in order to receive government support; this therefore incentivises membership of the scheme. Previous iterations of this report have recommended working with the administrators of the CHPQA scheme where commercial confidentiality permits; this is the first iteration of the report in which we have received data from the CHPQA scheme.

The inclusion of aggregated CHPQA data has allowed a more accurate estimate of total renewable heat capacity and output to be estimated and presented in this report. However, given the small number of sites included in the aggregated CHPQA total, it was not possible to receive a breakdown of the figures by size or technology type, as this could allow individual sites to be identified and would therefore breach confidentiality. Without this, the aggregated CHPQA data could not be included in the further analysis of the breakdown figures.

[41] https://www.gov.uk/government/collections/renewable-heat-incentive-statistics

6.3 Estimating micro installations: capacity and output

As in previous years, Germserv have supplied an updated data extract from the MCS Installation Database (MID). Gemserv are the administrators of the Microgeneration Certification Scheme (MCS) which is a quality assurance scheme for microgeneration technologies and installers. Under this scheme MCS installers must register each installation on the MID otherwise it will not be recognised as an MCS installation. The MID therefore provides exact numbers of solar thermal, ground source heat pumps, air source heat pumps and biomass systems that are installed by MCS certified installers.

The current data in the renewable heat database for micro installations now includes MCS accreditation data from 2012-2016 (inclusive). For the 2011 report the number of micro installations was estimated because MCS data from the MID was not available to EST until 2012. The data used in the 2011 report came from a range of sources such as: EPC data, Building Services Research and Information Association (BSRIA), Energy Saving Trust grant and loan schemes, Heating and Hotwater Industry Council (HHIC) estimates and Stove Industry Alliance sales estimates for Scotland. Pre-2012 MCS data has not been included in the renewable heat database to avoid double counting.

Micro-renewable heat installations must be MCS certified (or equivalent) to be eligible for support under the RHI schemes (both domestic and non-domestic). It is therefore assumed that data for Scotland from the MID covers all micro heat systems accredited under the RHI. However, there are likely to be micro-renewable heat generating systems operational in Scotland that are not MCS accredited (either because they do not require scheme funding or would not be eligible for scheme funding). This means that the number, capacity and heat output for micro systems (smaller than 45 kW) are all likely to be underestimated. At the time of writing there was no data available that would provide the missing information without risking double counting.

6.4 Potential useful heat output that is not currently utilised

In previous reports the potential for unused heat from industrial sites currently using less heat than they produce has not been quantified. It is still beyond the current scope of this report to cover this subject as the detailed data required and the agreed methodology are not yet available. Data required would include: energy consumed onsite; detailed heat and electrical output; unused ‘useful heat’ including the form of heat available, for example warm or hot water, steam, hot air. There is also a methodology required for quantifying the size and value of nearby potential heat loads in relation to the type and scale of heat available.

6.5 Recommendations for future updates

6.4.1 Recommendation 1 – RHI data

This is the third year in which RHI data has been merged with the renewable heat database to provide a more comprehensive picture of the deployment of renewable heat technologies in Scotland. It will not realistically be possible to publish an accurate report on progress towards the Scottish Government's 2020 targets in future years without the UK Government continuing to provide analytical support. An alternative could be for the Scottish Government to receive RHI data which may be used for this purpose. This alternative would result in a potentially more efficient process and more accurate report since it would reduce the risk of double counting within the database and would provide the detail required by the Scottish Government to inform and direct policy action on the ground.

6.4.2 Recommendation 2 – energy from waste data

Given the estimated current and potential contribution of energy from waste to renewable heat output, the database would benefit from greater information sharing between organisations involved in the development of energy from waste projects, as far as is possible within the limits of commercial confidentiality. On site data from operational projects regarding biodegradable content and quantity of the waste used for heat generation (or as feedstock for conversion to biofuels via AD, BtG, gasification or pyrolysis processes) as well as metered heat output data would help to ensure greater certainty in the calculations used to estimate the useful heat output figures included in this report. In addition, improved data about changes to the fraction of biodegradable material within the municipal waste stream over time would improve the evidence base of the contribution made by installations producing heat from burning municipal solid waste. Access to such data would also provide the information needed to more accurately estimate the potential contribution of projects in the pipeline to the Scottish Government's heat targets.

6.4.3 Recommendation 3 – CHP data

Considerable effort has been made to ensure accuracy of 'useful heat output' data from complex sites, both heat only and combined heat and power. The inclusion of aggregated CHPQA data has allowed a more accurate estimate of total renewable heat capacity and output to be presented in this report. However, it is recommended that future revisions of the database and report continue to improve the information that heat output figures are based on by using information on heat output directly from the operator where possible. This will allow the CHP installations to be included in the more in-depth analysis of the database and give a more accurate representation of renewable heat in Scotland.

6.4.4 Recommendation 4 – unused 'useful heat'

It is recommended that the Scottish Government continues to carry out work, with partners including SEPA, to quantify the amount of waste heat from industrial sites (see section 5.4). This could help inform future estimates of available unused but useful heat which, as mentioned in section 6.3 above, is currently beyond the scope of the database.

Appendix 1. Technical terms used

7.1 References to 'heat output'

The following terms have been used in the report when talking about heat output from heat generating installations:

- **Heat output**

Where used in this report 'heat output' refers to the heat output from a site. This may be potential, actual or useful heat output.

- **Useful heat output**

Heat delivered to an end user or process, taking into account losses.

- **Actual heat output**

The total amount of heat produced by a site, accounting for losses and efficiency. Actual heat output includes heat that is *not* delivered to an end user or process.

- **Potential heat output**

The total amount of heat could potentially be generated by the site if it operated at peak capacity for the total number of 'peak running hours' stated in Table 3. Alternatively, the total heat output potentially generated by a site if it operated at the assumed capacity stated in Table 15.

- **Renewable heat output**

Refers to the renewable heat output from a site. This term is used for clarity where it may not be clear if the heat output being discussed is renewable, for example with energy from waste sites.

7.2 Renewable energy technologies

The following technologies are considered to produce heat from renewable sources, and are included in the database:

- **Biomass (wood) primary combustion**

Wood is burnt to directly produce heat for space or water heating, or to provide heat for an industrial process. The wood fuel may be chips, pellets or logs, or waste wood, sawdust or offcuts. In some installations the wood fuel may be supplemented by, or be a supplement to, other non-renewable fuels such as coal. These cases are referred to as 'co-firing', and the renewable heat capacity and renewable heat output of installations when co-firing occurs are estimated to be a proportion of the total capacity and heat, based on the mix of different renewable and non-renewable fuels used.

- **Biomass (wood) combined heat and power (CHP)**

Biomass is burnt in order to generate electricity. Heat is produced as a by-product, which can then be used for process heat, or supplying space or water heating.

- **Solar thermal panels**

Panels which produce hot water using the sun's heat. The systems can be designed so that the hot water produced also contributes to space heating demand ('solar space heating') but it is more commonly used to provide only hot water.

- **Heat pumps: water source, air source and ground source**

Technologies to extract low-grade heat from the external environment (the ground, air or a water body) and through a compression system produce heat for space or water heating or both. Although heat pumps rely on electricity to operate, their high co-efficient of performance (COP) means they extract more heat energy from the environment than they use in electricity. 'Exhaust air heat pumps' (which, in addition to extracting heat from the external air, also draw warmth from warm stale air leaving a building) have been included within the category air source heat pumps. However, units which are purely exhaust air heat recovery, without also extracting heat from the air outside, have not. Cooling provided by heat pumps has not been included in the database.

- **Energy from waste (EfW)**

Heat energy produced from the treatment of organic biodegradable waste other than wood. This category includes the following technologies:

  - **Anaerobic digestion (AD):**

Organic matter is broken down in the absence of oxygen to produce methane gas. The methane is then burnt to produce heat, or burnt in a combined heat and power unit to generate both heat and electricity. In some cases, it can be upgraded to biomethane gas and injected into a gas grid. In some applications the heat produced is used solely to maintain the anaerobic digestion process which requires some heat input. Useful renewable heat has been classed as heat produced (and used) beyond that fed back into the anaerobic digestion process to maintain it and is sometimes called the parasitic heat load.

  - **Landfill gas capture:**

Landfill gas (methane from rotting organic matter in landfill) is captured and burnt to produce heat or used in a combined heat and power unit.

  - **Biomass primary combustion:**

This category covers installations where materials other than wood, such as municipal solid waste and animal carcasses, are burnt directly to produce heat. For installations burning

municipal solid waste, a proportion of the heat capacity and output is estimated to be renewable and is based on the biodegradable proportion of the waste burnt.

- **Advanced thermal treatment (ATT), using pyrolysis or gasification or both**

Treatment of waste at high temperatures either in the complete absence of oxygen (pyrolysis) or a limited amount of oxygen (gasification) to produce gases which can be burnt to generate heat or heat and electricity.

- **Biomethane injection to the gas grid (BtG)**

This is the same technology as anaerobic digestion up to the point of having a biomethane (biogas) product. The resultant biomethane is not combusted on site but is 'upgraded'[42] to allow it to be injected into the gas grid, whilst ensuring it has similar properties to fossil natural gas. This technology will therefore allow the biomethane to displace fossil natural gas in the grid.

- **Deep geothermal**

Heat from deep underground is extracted by pumping water into a deep well, allowing it to heat up using the heat of the rocks, then abstracting the water via another well.

Had examples been found, fuel cell biomass could also have been included:

- **Fuel cell biomass**

Fuel cells running on biomass could be used to produce useful heat.

Technologies which are not included in the database, as they do not produce renewable heat, are:

- **Non-biomass combined heat and power (CHP)**

Combined heat and power units running on gas (or other fossil fuels) to produce electricity and heat. The heat from such units comes from fossil fuel sources and so it has not been counted towards 'renewable heat' targets in this report.

- **Exhaust air heat recovery (EAHR)**

Systems for recovering the heat from warm stale air leaving a building which is used to warm incoming air. This can help to reduce space heating requirements. However, because the heat being recovered for the building will normally have come from fossil fuels in the first instance, rather than being drawn from a renewable source, these systems have not been included as providing renewable heat.

[42] 'Upgrading' consists of: removing carbon dioxide and other impurities and adding propane to ensure similar energy content to natural gas already in the gas network. The gas is then odorised and compressed before being injected into the gas grid.

- **Energy from waste: installations where the only fuel is hospital waste**

DUKES[43] considers hospital waste as non-biodegradable, so installations burning only hospital waste are not counted as producing renewable heat. However, installations which burn other wastes that are considered biodegradable such as municipal waste, in addition to hospital waste, have been included in the database**.**

The following renewable heat technologies are not included in the renewable heat database:

- **Passive renewable heating**

This is where building design is used to ensure buildings benefit from features such as solar gain through large areas of south-facing glazing. Such design features can help a building meet its heat demand; however, they have not been included in this report or database because the heat resource provided is very hard to assess.

- **Wind or hydro to heat (electricity)**

Wind to heat installations (where wind turbines produce electricity which is used to directly charge electric storage heaters for space heating) can be an important source of low-carbon heating in remote rural locations in Scotland. However, the electricity produced by these systems is already counted towards renewable electricity targets for Scotland and so estimates of heat from these systems have not been included in the renewable heat figures reported here.

[43] Renewable Energy Statistics: Data Sources and Methodologies, Department for Business, Energy and Industrial Strategy: https://www.gov.uk/government/collections/renewables-statistics

Appendix 2. Capacities assumed for individual installations where information was not available

8.1 Capacity assumptions

Table 15 shows the assumed capacities that were used in the renewable heat database where information on capacity was not available.

Table 15. Assumptions used for capacity where not known, 2016

Ownership category[44]	Building type	Technology	Estimate of likely installed capacity	Derived from
Community	Community buildings	Solar thermal	6 kWth	Average of other community solar thermal installations recorded in the database.
	Community buildings	Heat pumps (ASHP and GSHP)	16 kWth	Average of other heat pumps in public sector, LA non-domestic and community buildings, recorded in the database.
	All	Biomass	60 kWth	Average of other community biomass installations recorded in the database.
	All	Biomass district heating	175 kWth	Average of other community biomass district heating installations recorded in the database.
Other public sector and charity	All	Solar thermal	13 kWth	Average of other public sector and charity solar thermal installations recorded in the database.
	All	Heat pumps (ASHP and GSHP)	16 kWth	Average of other heat pumps in public sector, LA non-domestic and community buildings recorded in the database.

[44] Ownership categories are those used in the community and locally owned renewable energy database, maintained by the Energy Saving Trust for the Scottish Government

	All except hospitals	Biomass	130 kWth	Average of other public sector and charity biomass installations, excluding hospital installations, recorded in the database.
	Hospitals	Biomass	1.5 MWth (1,500 kWth)	Average of other hospital biomass installations recorded in the database.
Farms and Estates	All	Biomass	150 kWth	Average of other farm and estate biomass installations recorded in the database.
	All	Biomass district heating	150 kWth	Average of other farm and estate biomass district heating installations recorded in the database.
Local businesses	All	ASHP	12 kWth	Average of other local business ASHPs recorded in the database.
	All	GSHP	30 kWth	Average of other local business GSHPs recorded in the database.
	All	Biomass	140 kWth	Average of other local business biomass recorded in the database.
	All	Biomass district heating	140 kWth	Average of other local business biomass district heating recorded in the database.
Local authority	Domestic properties	Solar thermal – installed in 2011, 2012 or 2013	3.4 m^2	Analysis of Energy Saving Scotland home renewables loans.[45]
	Domestic properties	Solar thermal – installed in 2014, 2015 or 2016	4 m^2	Analysis of Energy Saving Scotland home renewables loans.[45]
	Domestic properties	Heat pumps (ASHP and GSHP)	7 kWth	Average of other LA- and HA-owned heat pumps in domestic properties recorded in the database.

[45] Energy Saving Scotland home renewables loans are loans for domestic renewables, administered by the Energy Saving Trust on behalf of the Scottish Government.

	Schools	Solar thermal	7 kWth	Average of other school solar thermal installations recorded in the database.
	Schools	ASHP	10 kWth	Average of school ASHP installations recorded in the database.
	Schools	Biomass	200 kWth	Average of other school biomass boiler installations recorded in the database.
	Other buildings	Heat pumps (ASHP and GSHP)	16 kWth	Average of other heat pumps in public sector, LA and community buildings, recorded in the database.
Housing Association	Domestic properties	Solar thermal – installed in 2011, 2012 or 2013	3.4 m^2	Analysis of Energy Saving Scotland home renewables loans.[45]
	Domestic properties	Solar thermal – installed in 2014, 2015 or 2016	4 m^2	Analysis of Energy Saving Scotland home renewables loans.[49]
	Domestic properties	Heat pumps (ASHP and GSHP)	7 kWth	Average of other LA- and HA-owned heat pumps in domestic properties, recorded in the database.
	Domestic properties	ASHP - EAHR[46]	7 kWth	Average of other LA- and HA-owned ASHP-EAHRs in domestic properties, recorded in the database.

[46] ASHP - EAHR = air source heat pump with exhaust air heat recovery. Such heat pumps draw heat from both air outside a building, and heat from stale air leaving the building or extracted from rooms such as kitchens and bathrooms within the building, to provide space and water heating.

Appendix 3. Merging the renewable heat database with the non-domestic RHI database

9.1 Background

The non-domestic Renewable Heat Incentive (RHI) opened to applicants in November 2011 (with scope for legacy applicants to apply for accreditation). The non-domestic scheme is designed to incentivise uptake of renewable heat technologies in mainly non-domestic applications but does include district heating for residential schemes[47]. The RHI is administered by Ofgem on behalf of BEIS.

No site-level detail on the installations accredited (or awaiting accreditation) under the scheme has been shared with the Scottish Government or the Energy Saving Trust to date. Some of the systems accredited under the RHI will already be known about by the Energy Saving Trust from other data sources such as the FCS woodfuel surveys. However, it is likely that these data sources only capture a proportion of the uptake of renewable heat technologies, particularly in the small to medium technology size bracket (>45 kW and <1 MW). A substantial proportion of the micro (45 kW or less) installs in Scotland will be captured by the Microgeneration Installations Database (MID) data extract provided by Gemserv, and the larger installs are relatively easy to track through the REPD, publications of funding allocation to renewable heating projects, press releases and relevant organisation contacts. Small and medium sized projects are harder to track especially now as the REPD no longer monitors projects with a capacity of less than 1 MW. It has therefore become increasingly important to reconcile the renewable heat database and the non-domestic RHI database, to ensure the accuracy of the Scottish Government's target monitoring.

At the time of collating data for this report, BEIS was unable to share full site-level information on non-domestic RHI installations (due to legal reasons) but did undertake some analysis on the two datasets in order to estimate:

- The **number of full applications** under the RHI where no match exists in the renewable heat database.
- The **capacity** of renewable systems accredited under the RHI where no match exists in the renewable heat database.
- The **eligible heat** output of systems accredited under the RHI where no match exists in the renewable heat database.

[47] Communal and district heating include systems that link more than one property to the heat network. These may still be domestic applications but they are not eligible for support under the Domestic RHI scheme.

9.2 Methodology

The analysis undertaken by BEIS was done using an extract of the renewable heat database as of 21 June 2017[48]. For all sites with a capacity of 0.5 MW (500 kW) or higher, the data was manually cross-referenced to ensure accurate matching of sites with the largest capacity. The remaining data was then matched, with a positive result (match between both datasets) requiring an exact match between site names, or two of any of the other variables (postcode, address or organisation name).

For all systems on the RHI database where no match was found in the renewable heat database, the capacity and 'heat paid for' were aggregated and provided by for the calendar year 2016.

The variables provided by BEIS were:

- Number of full applications by technology and tariff band.
- Operational capacity by technology and tariff band.
- 'Heat paid for' under the RHI scheme, by technology and tariff band. It should be noted that this will not be an exact match for 'heat produced' but is the closest proxy available. As the RHI only pays for heat that is used for an eligible purpose[49], it can be directly translated into 'useful renewable heat output' for the purposes of this report.

Where the aggregated figures were based on 5 or fewer sites the respective information has been withheld to ensure information about particular sites was not disclosed.

9.3 Uncertainties and duplication

In order to ensure no duplication with the MID data provided by Gemserv, any micro (≤45 kW) systems in the RHI dataset were removed before the capacity and heat totals were aggregated.

As not all data were manually matched, the aggregates provided by BEIS may still include output and capacity for sites that are already listed in the renewable heat database. This will be because either a match wasn't found or because the record was not sent to BEIS (due to being confidential or personal data). To avoid double counting, the records were assessed against the risk of double-counting by using the descriptors given in Table 16.

[48] Any personal data was removed from the EST extract in compliance with the Data Protection Act 2008; any data provided to EST as otherwise confidential was also removed from the database before sharing with BEIS.
[49] Please see the RHI guidance for further details: https://www.ofgem.gov.uk/environmental-programmes/non-domestic-renewable-heat-incentive-rhi/eligibility-non-domestic-rhi

Table 16. Risk indicators assigned to renewable heat database records

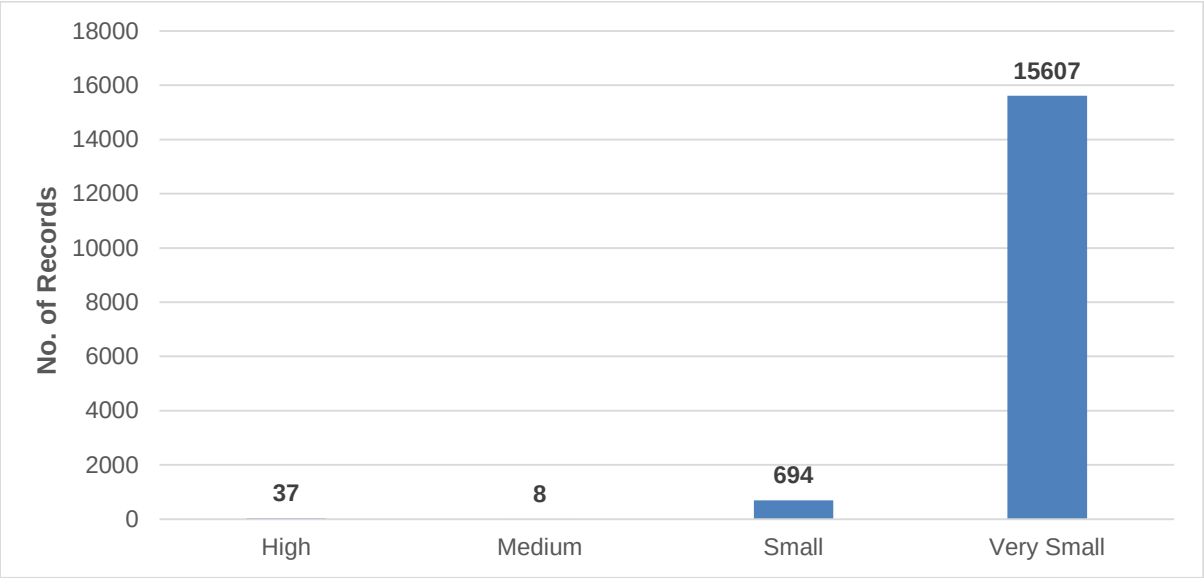
Risk	Descriptor
Very low	• The record is for a microgeneration system (capacity ≤45 kW). All microgeneration systems were removed from the RHI data after merging to avoid double counting. Or • The record has a capacity of 0.5 MW or more. These records were all checked manually for a match. Or • The site is accredited under the Renewables Obligation (RO) scheme and claims the Combined Heat and Power uplift under that scheme[50]. These sites cannot claim support under the RHI as well.
Low	• The record was sent to BEIS for merging with the renewable heat database and has good location information in the renewable heat database. Or • The renewable heat database records that the system was commissioned before November 2009, which would mean that the site is too old to claim RHI support. • The technology is unlikely to be supported by the RHI, as there are very few technologies in the RHI database (i.e. for CHP systems). • The system is not yet operational
Medium	• The record was sent to BEIS but has no, or poor, location information in the renewable heat database. Or • The record was not sent to BEIS, is not a micro technology and was commissioned between 2009 late 2011. These systems may be double counted as they will not have been included in the analysis carried out by BEIS. They are not, however 'High' risk as they may not have taken advantage of applying to the RHI as a legacy applicant.
High	• The record was not sent to BEIS, is not a micro technology and commissioned late 2011 and is an RHI-eligible technology. These systems will not have been included in BEIS analysis but are more likely to have applied for RHI support following the launch of the scheme.

The risk of each record being double-counted was labelled as 'High', 'Medium', 'Low' or' Very low'. Figure 11 shows the total number of records within the database in each risk

[50] For details please see https://www.ofgem.gov.uk/sites/default/files/docs/2015/02/guidance_volume_one_-_july_2015_-.pdf

category. The 'High' and 'Medium' records have been excluded from the overall figures used within this report[51]. The aggregated RHI figures were then added to the relevant renewable heat database summary figures to provide total capacity and heat figures for Scotland.

Figure 11. Proportion of records by double counting risk



[51] These sites are still recorded in the renewable heat database for reference.

Appendix 4. Combining renewable heat database with CHP dataset

10.1 Background

The CHPQA programme is a government initiative which aims to provide a practical, determinate method for assessing all types and sizes of combined heat and power schemes throughout the UK. The voluntary scheme, which is implemented by Ricardo-AEA, requires the submission of annual or monthly energy figures for electricity generated, fuel consumed and heat utilised.

As with the RHI data, no site-level detail on the installations which are CHP certified under the CHPQA scheme has been shared with the Scottish Government or the Energy Saving Trust to date. It is, however, likely that the majority of CHP systems certified under the scheme are already known to EST from other data sources, including the FCS woodfuel survey, and the REPD.

At the time of collating data for this report, Ricardo-AEA were unable to share full site-level information on CHPQA certified installations but did undertake some analysis on the two datasets in order to estimate:

- Operational renewable heat capacity
- Useful renewable heat output

10.2 Methodology

An extract of the CHP installations held in the renewable heat database as of 2nd June 2017 was sent to Ricardo-AEA[52]. Sites were matched with the CHP database using key variables, including site names, organisation names and address data.

For all renewable energy generating systems in the CHP dataset where no match was found in the renewable heat database, the annual renewable capacity and useful heat output were aggregated and provided for calendar years 2010 to 2016. As no CHP systems contributed to the estimated renewable heat output for 2008/9, the total aggregated renewable heat capacity and output from the CHP dataset was provided for these years.

10.3 Uncertainties and duplication

As there are only a small number of CHP installations recorded in the renewable heat database and all installations have good address level data, the risk of double counting or missing sites during the matching process has been deemed to be relatively low. However, if

[52] Any personal data was removed from the EST extract in compliance with the Data Protection Act 2008; any data provided to EST as otherwise confidential was also removed from the database before sharing with BEIS.

the matching process is repeated in future years, the risk of double counting would need to be reassessed.

There was no risk of double counting between the CHPQA aggregated figure and the RHI aggregated figure. This is because no additional capacity for CHP sites was provided by RHI (suggesting that all CHP sites currently receiving RHI funding are already included in the EST dataset). It is recommended that, if both matching exercises are repeated in future years and CHP RHI aggregated figures are returned by BEIS, these figures should be discounted as they should already be included in the CHP aggregated figure[53].

As the CHPQA programme is a volunteer scheme, it is possible that there are operational CHP systems operational in Scotland that have not been captured by the renewable heat database, or by the CHP dataset.

[53] To be eligible for the RHI CHP systems must also be CHPQA certified, so installations not included by the renewable heat database should be included in both the RHI aggregated figure and the CHPQA aggregated figures

Appendix 5. Measurement of heat demand in Scotland

This Appendix sets out:

- How the Scottish Government derived the original 11% renewable heat target.
- How until the 2012 report (monitoring progress to 2011) the Scottish Government monitored progress on renewable heat as a percentage of projected 2020 heat demand.
- An explanation of how improved data and an updated methodology is being used to monitor renewable heat as a percentage of annual non-electrical heat demand in Scotland.

11.1 Background

Heat has been estimated to account for more than half of Scotland's total energy use54. Switching from fossil fuel to renewable heat sources has the potential to reduce greenhouse gas emissions, and make a significant contribution to Scotland's overall renewable energy target. The 2009 Renewable Heat Action Plan55 set a target of delivering 11% of Scotland's projected 2020 (non-electrical)56 heat demand from renewable sources.

In 2006, the Scottish Energy Study57 described Scotland's current energy supply, energy consumption and energy-related CO2 emissions during 2002. This was the first major study of energy supply and demand to be conducted in Scotland for more than a decade. At that time, the discrete study provided the most robust data source available for estimates of energy consumption in Scotland. This study produced estimates for 2002 and subsequently a figure for 2020 heat demand was derived from these estimates. This heat demand figure was subsequently used to derive the 11% heat target (detailed in section 11.2). Due to improved availability of heat demand data for Scotland (detailed in section 11.3), the heat demand figure derived in 2006 Is no longer used to monitor progress towards the 2020 target.

11.2 Derivation of the 11% heat target

The target figure of 11% for renewable heat by 2020 was derived using the estimated contributions that renewable electricity and renewable transport would make to the overall 2020 renewable energy target. Based on the requirements of the other sectors it was estimated that renewable heat must contribute 6,420 GWh of output in order for Scotland to meet its 2020 Renewable Energy Target. Total heat energy demand in Scotland in 2020 was

[54] Energy in Scotland 2017, the Scottish Government, http://www.gov.scot/Topics/Statistics/Browse/Business/Energy/EIS/EIS2017
[55] Renewable Heat Action Plan (2009). http://www.scotland.gov.uk/Publications/2009/11/04154534/0
[56] To avoid double counting we measure the non-electrical heat component against the heat target, acknowledging that the demand for heating delivered by electricity will be included as part of the renewable electricity target. The Scottish Household Condition Survey (2013) estimates that around 12% of households in Scotland use electricity as their primary heating fuel.
[57] Scottish Energy Study, Vol 1 (2006). http://www.scotland.gov.uk/Publications/2006/01/19092748/0

estimated to be 60,089 GWh using data from the 2006 Scottish Energy Study. Therefore, the target was set at 11% (See Table 17).

Table 17: Description of the derivation of the renewable heat target (estimated 2020 figures)

Step	Step description	Output (GWh)
1	Total energy demand	160,307
2	Renewable energy target (20%)	32,061
3	Estimated renewable electricity contribution (50% target[58])	22,244
4	Estimated renewable transport contribution (10% target)	3,397
5	**Renewable heat output required (remainder)**	**6,420**
6	Total energy consumed within D/I/S sectors	95,276
7	Less: electricity consumption in these sectors	35,187
8	**Derived heat energy demand**	**60,089**
9	**Therefore renewable heat required**	**c. 11%**

11.3 Improving data on heat demand in Scotland

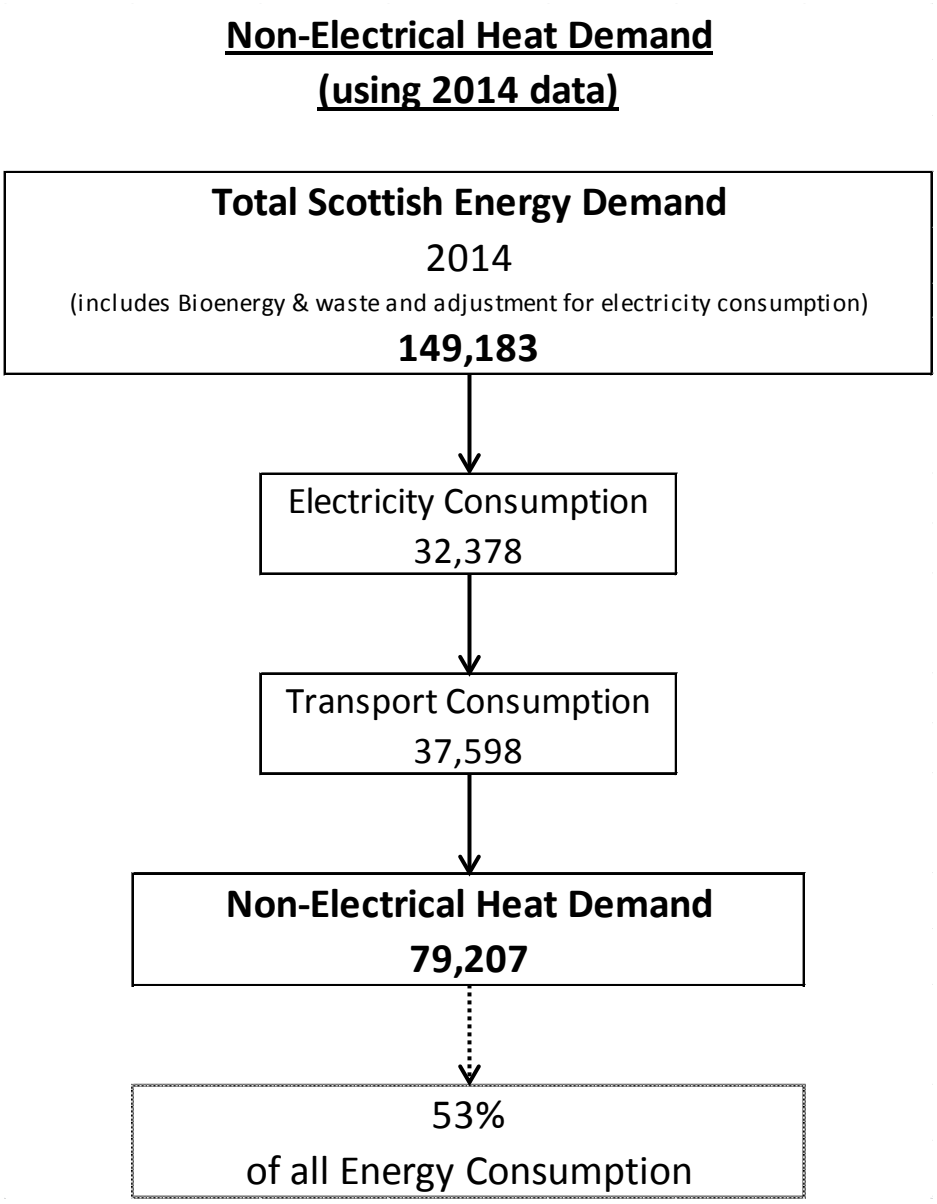
In the years following the publication of the Scottish Energy Study, BEIS began publishing more detailed sub-UK estimates of energy consumption[59] which has enabled the development of a systematic and robust method of monitoring (non-electrical) heat demand in Scotland on an annual basis. The Scottish Government has worked with colleagues in BEIS to derive a heat demand methodology for Scotland which will allow more accurate annual measurement of progress towards the renewable heat target.

BEIS data shows a breakdown of final energy consumption by end use for Scotland down to local authority level. By subtracting electricity and transport consumption from the final energy consumption figure, this results in an estimate for non-electrical heat demand in Scotland (see the flow chart in Figure 12 for more detail).

[58] The heat target was derived at a time when the renewable electricity target in Scotland was set at 50%. http://www.scotland.gov.uk/News/Releases/2007/11/27095600

[59] Total final energy consumption at sub-national level, BEIS. https://www.gov.uk/government/collections/total-final-energy-consumption-at-sub-national-level

Figure 12: Heat demand methodology



The methodological differences between the 2006 Scottish Energy Study and BEIS's annual estimates of final energy consumption have implications for the monitoring of the renewable heat target. Table 18 presents a time series using both sources, demonstrating the impact this annual heat demand estimate has made on measuring progress towards the 11% renewable heat target.

It is important to note that BEIS's estimates of final energy consumption (from 2005 onwards) are subject to annual revision. This can impact on the Scottish Government's time series of non-electrical heat demand, and hence the renewable heat target progress figures.

Table 18: Renewable heat target - renewable heat as a % of heat demand 2008/09 to 2016

	2008/9	2009 (not estimated)	2010	2011	2012	2013	2014	2015	2016
Total renewable heat output (GWh)	863	Missing data	1,363	1,690	2,045	2,266	3,071	4,205	3,752
New measure: % of annual estimate of total non-electrical heat demand	**0.9%**	Missing data	**1.5%**	**1.9%**	**2.4%**	**2.7%**	**3.9%**	**5.4%**	**-**
Progress - scenario 1									5.0%
Progress - scenario 2									4.9%
Progress - scenario 3									4.8%
Heat demand (GWh)	97,053	89,155	91,156	88,269	86,447	83,805	79,207	77,976	
Heat demand scenario 1 (average annual reduction 2008-2015)									75,612
Heat demand scenario 2 (same reduction per year as 2014-15)									76,764
Heat demand scenario 3 (same as 2015)									77,976
Previous measure: % of forecast 2020 non-electrical heat demand	1.4%	Missing data	2.3%	2.8%	3.4%	3.8%	5.1%	7.0%	6.2%
Previous heat demand measure (GWh)	*60,089*	*60,089*	*60,089*	*60,089*	*60,089*	*60,089*	*60,089*	*60,089*	*60,089*

11.4 Summary of the changes as a result of the new methodology

Advantages

- The target can now be measured annually against the heat demand in a particular year, allowing more accurate monitoring of target progress.
- Improves the comparability and consistency with other energy target measures.

Issues

- There is a lag in the availability of BEIS sub-UK consumption data – 2016 data will not be available until September 2018.
- All bioenergy & waste consumption is assumed to be non-electrical heat demand – which is likely to be an overestimate.
- An adjustment is made to the electricity consumption data to account for discrepancies within BEIS datasets.

To ensure transparency the Scottish Government has published both measures in parallel, for a transitional period, as the evidence base regarding heat use in Scotland is continuously being improved.

For any queries or feedback on the new measure, or on the measurement of heat demand in Scotland in general, please contact energystatistics@scotland.gsi.gov.uk.