Renewable heat in Scotland, 2015

A report by the Energy Saving Trust for the Scottish Government

October 2016

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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 Fiona Flynn.

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, the Forestry Commission Scotland and Rural Development Initiatives.

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 2015 calendar year and new installations which are in development.

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 2015 and August 2016.

[1] Renewable Heat Action Plan for Scotland, 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.

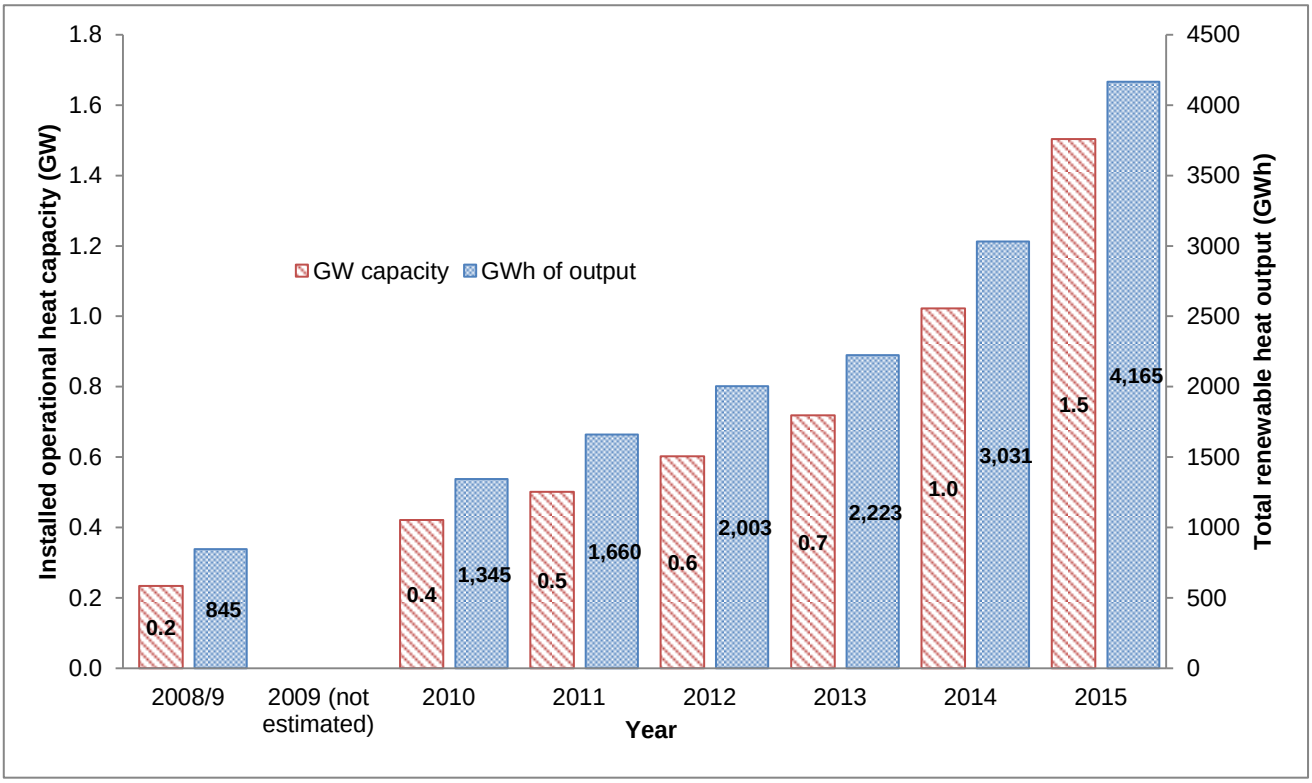
2 Summary of key findings

We estimate that:

- **In 2015 Scotland generated an estimated 5.3 - 5.6% of its non-electrical heat demand from renewable sources**, up from 3.8% in 2014, continuing the year on year increases seen since 2008/09.
- **1.504 GW of renewable heat capacity** was operational in Scotland by the end of 2015, **up 47%** (481 MW) from 2014, producing an estimated **4,165 GWh of heat** from renewable sources, an **increase of 37%** (1,134 GWh) from 2014.
- The majority of the increase came from large commercial sites and installations supported by the RHI.

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[3]. EST has collected data for calendar years 2010 onwards[4].

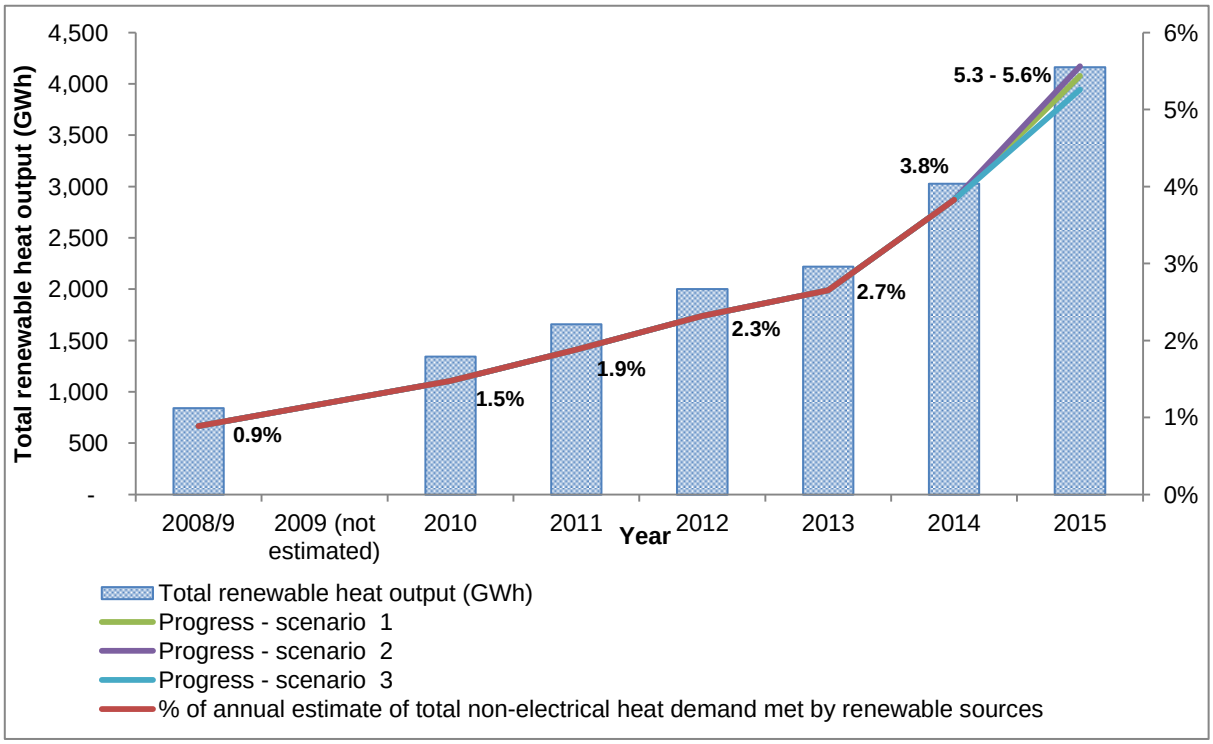
Figure 1. Estimated renewable heat capacity and output in Scotland, 2008/09 - 2015



[3] Renewable Heat in Scotland, the Sustainable Development Commission Scotland, June 2009: http://www.sdcommission.org.uk/publications/downloads/SDC%20Renewable%20Heat%20Report.pdf

[4] 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

Figure 2. Estimated renewable heat output and % non-electrical heat demand met by renewables in Scotland, 2008/9 - 2015



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 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 2014. For 2015, progress is shown against estimated non-electrical heat demand based on three scenarios that have been inferred from historic trends[5].

Heat demand in Scotland has been steadily falling over the last ten years, due to rising gas prices, 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 2014, reductions in demand have contributed to around 89% 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 increase by between 149% and 209% in order to reach the Scottish

[5] The three scenarios are that heat demand:
i. Average annual change (2008-2014)
ii. Same change as most recent year (2013-14)
iii. Stays constant (from 2014)

Government's target. 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 5 years this would be equivalent to an annual increase in output of between 8% and 16%. This is less than the average annual increase in output of 26% seen since 2010.

Breakdown of 2015 data

The majority of renewable heat output in Scotland continues to come from large (1 MW+) installations. **In 2015 over two thirds of renewable heat came from large installations**, despite contributing less than half of the total renewable capacity. This is because large installations often provide process heat year round, compared to the smaller installations which generally have more seasonal demands such as providing space and water heating. The capacity from large installations increased by 45% over 2015, while the total capacities of small to medium (>45 kW and <1 MW) and micro (<45 kW) installations also increased, by 51% and 44% respectively.

Most of Scotland's renewable heat output comes from biomass combustion (including biomass combined heat and power). **In 2015 biomass combustion supplied almost 90% 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 6%, with the remainder generated from waste sources.

By the end of December 2015 9,030 domestic RHI installations were accredited in Scotland, with 87% of these installed in off grid areas. Systems in Scotland accounted for approximately 20% of the total number of accredited systems under both the domestic and non-domestic RHI schemes as of December 2015[6]. This is significantly above the proportion of installations to be expected on a pro rata basis when compared to the size of the population in Scotland as a portion of Great Britain as a whole.

[6] More up to date RHI data is published regularly by the department of Business, Energy and Industrial Strategy. 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 2016. This data shows that as of the end of August 2016, 10,510 installations had been accredited under the domestic RHI and 3,120 full applications had been made under the non-domestic RHI.

3 Methodology

3.1 Approach taken

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)[7] 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 2015 to 31 December 2015). 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).[8]

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, as the terms above are used repeatedly within the main body of the report, a brief summary has been included. For a fuller explanation of terminology used please refer to Appendix 1. Technical terms used.

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

[7] 1 GW = 1,000 MW = 1,000,000 kW.
[8] 1 GWh = 1,000 MWh = 1,000,000 kWh.

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. The data held by the CHPQA is confidential and is therefore not available at site level unless provided by the sites themselves. As has also been the case in previous years, due to current RHI legislation, full access to the non-domestic RHI data was not available for the database update.

As site level data for systems accredited under the non-domestic RHI scheme was not available for the 2015 database update, the Department for Business, Energy and Industrial Strategy (BEIS)[9] provided aggregated data for the scheme to the EST for inclusion in this report. Analysis was carried out by BEIS 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. Together the capacity and 'heat paid for'[10] summaries provided by BEIS 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 in Appendix 3. Aggregated data for the domestic RHI scheme was not provided, as the majority of these installations should have been captured within the MCS Installation Database (MID) extract provided by Gemserv.

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. As with the 2014 database update, we asked the FCS to share 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. 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 2015 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.

[9] As of July 2016, the Department for Business, Energy and Industrial Strategy (BEIS) has taken over responsibility of legislation previously overseen by the Department of Energy and Climate Change (DECC).
[10] The RHI data does not allow for annual heat output figures to be reported, but can show the amount of heat paid for per site under the scheme. This has been used as a proxy for 'useful heat output' as defined above as the RHI can only support heat that is used for an 'eligible purpose'.
[11] For example, where we have a known contact at the site who can provide the correct information.

The information available on each installation varies, depending upon the data sources used. Where they are 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 variables (often reported actual 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. 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.

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.
- Deep geothermal[13].

Had examples been found, fuel cell biomass 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].

[12] Excluding the parasitic heat used to maintain the anaerobic digestion process.
[13] There are currently no known deep geothermal technologies in operation; 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.

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.

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 2015 contained in this report has been generated by a further update of the information held in the database. Efforts have been focused on updating information from the installations with the largest capacities and including data from the non-domestic RHI database.

Multiple sources of data have been used to update the renewable heat database for 2015. 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 also contacted and provided useful information.

The data sets from the Forestry Commission Scotland (via Rural Development Initiatives) contain estimates of all wood fuel usage for the year 2015, for large sites only.

[14] In line with assumptions used in the Department for Business, Energy and Industrial Strategy (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

Table 1. Main datasets used for 2015 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 2015, merged with EST data to generate a dataset of entries not already covered by the renewable heat database.
Forestry Commission Scotland (based on survey by Rural Development Initiatives)	Woodfuel demand and usage and estimated heat output in Scotland, 2015 (surveyed but with some assumed values).
Eunomia, on behalf of the Department for Business, Energy and Industrial Strategy (BEIS)	The Renewable Energy Planning Database (REPD)[15].
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 use from Rural Development Initiatives' annual survey of wood fuel use in Scotland for the Forestry Commission Scotland. Where metered data was not available, woodfuel usage figures were

[15] https://www.gov.uk/government/publications/renewable-energy-planning-database-monthly-extract
[16] http://www.energysavingtrust.org.uk/sites/default/files/reports/Community%20and%20locally%20owned%202015%20report_final%20version%20171115.pdf

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 below. These efficiencies were updated during the 2014 database update (report published October 2015) following the publication of Steve Luker Associates' report on their analysis on *in situ* performance of biomass boilers[18].

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[19].

[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
[19] For information on 'good quality' CHP please see BEIS's website: https://www.gov.uk/combined-heat-power-quality-assurance-programme

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 2015, taken from chapter 7 of the Digest of UK Energy Statistics (DUKES) 2016[20].

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 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	3,496
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.

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

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[21].

Energy from waste

For the 2015 update of the database, the biodegradable content of municipal solid waste (MSW) was revised down from 63.5% to 50% to account for increased recycling rates. This is in line with changes to the assumptions used in BEIS's RESTATS methodology[22]. Therefore an installation producing heat from burning MSW will have 50% of its heat capacity and output recorded as renewable in the database.

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 2015 update, the following assumptions have been made:

Table 4. Status change map for 2014 to 2015

2014 status	New information available	2015 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 2015

Most new additions to the renewable heat database were only operational for part of 2015. Where commissioning date is known, this has been used to determine the proportion of 2015 for which the site was operational. Where commissioning date is not known, an

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

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 2015 for which it was operational.

3.6 Data collection for district 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.

Data is collected on both renewable and non-renewable district heating schemes[23]; however only the proportion of renewable heat produced from these schemes is included in progress towards the renewable heat target.

[23] 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 2015

4.1 Results for 2015

In 2015, 4,165 GWh of heat was produced from renewable sources, from an installed capacity of 1.504 GW.

In 2015 Scotland produced enough heat from renewable sources to meet **between an estimated 5.3% and 5.6% of non-electrical heat demand**. The final estimate will be reported in October 2017 when the 2015 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 4 for more information on the difference between the current and previous methodologies and how non-electrical heat demand in Scotland is calculated.

In order to show progress towards the renewable heat target in this report, three non-electrical heat demand scenarios have been estimated for 2015. 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: Assuming heat demand between 2014 and 2015 reduces by the average annual reduction seen between 2008 and 2014.
- Scenario 2: Applying the 2013-14 percentage heat demand reduction for 2014-15
- Scenario 3: Assuming heat demand does not change from 2014.

Table 5 also shows progress against the previous measure for reference.

[24] See 2005-2014 figures here: https://www.gov.uk/government/statistical-data-sets/total-final-energy-consumption-at-regional-and-local-authority-level-2005-to-2010

Table 5: Renewable heat target - renewable heat as a percentage of heat demand[25,26]

	2008/9	2009 (not estimated)	2010	2011	2012	2013	2014	2015
Total renewable heat output (GWh)	845	:[27]	1,345	1,660	2,003	2,223	3,031	4,165
New measure: % of annual estimate of total non-electrical heat demand	**0.9%**	**:**	**1.5%**	**1.9%**	**2.3%**	**2.7%**	**3.8%**	**-**
Progress - scenario 1								5.4%
Progress - scenario 2								5.6%
Progress - scenario 3								5.3%
Heat demand	97,053	89,155	91,156	88,269	86,447	83,805	79,207	-
Heat demand scenario 1 (average % annual reduction 2008-2014)								76,611
Heat demand scenario 2 (same % reduction per year as 2013-14)								74,862
Heat demand scenario 3 (same as 2014)								79,207
Previous measure: % of forecast 2020 non-electrical heat demand	1.4%	:	2.2%	2.8%	3.3%	3.7%	5.0%	6.9%
Previous heat demand measure	*60,089*	*60,089*	*60,089*	*60,089*	*60,089*	*60,089*	*60,089*	*60,089*

Between 2014 and 2015, the overall **renewable heat output** from operational sites in Scotland **increased by 1,134 GWh, which is an increase of 37% on the previous year** (3,031 GWh). The majority of this increase comes from output related to the non-domestic RHI in 2015 and increased generation from a small number of large commercial sites.

The **increase in capacity** between 2014 and 2015 was **0.481 GW** (481 MW), which is an **increase of 47%**. Data from large commercial sites and RHI data accounted for the majority of this increase. 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. Please note that during the 2014 database update, figures from 2010 – 2013 were revised to take account of an updated methodology, so will differ from figures quoted in earlier published reports.

[25] See Appendix 4 for more information on the methodology for calculating non-electrical heat demand in Scotland.
[26] The milestones previously set in the Renewable Heat Action Plan are no longer applicable as these were set against the previous measure of progress (% of forecast 2020 non-electrical heat demand).
[27] ':' marks where data was unavailable.

Figure 3. Estimated renewable heat capacity and output in Scotland, 2008/09 - 2015

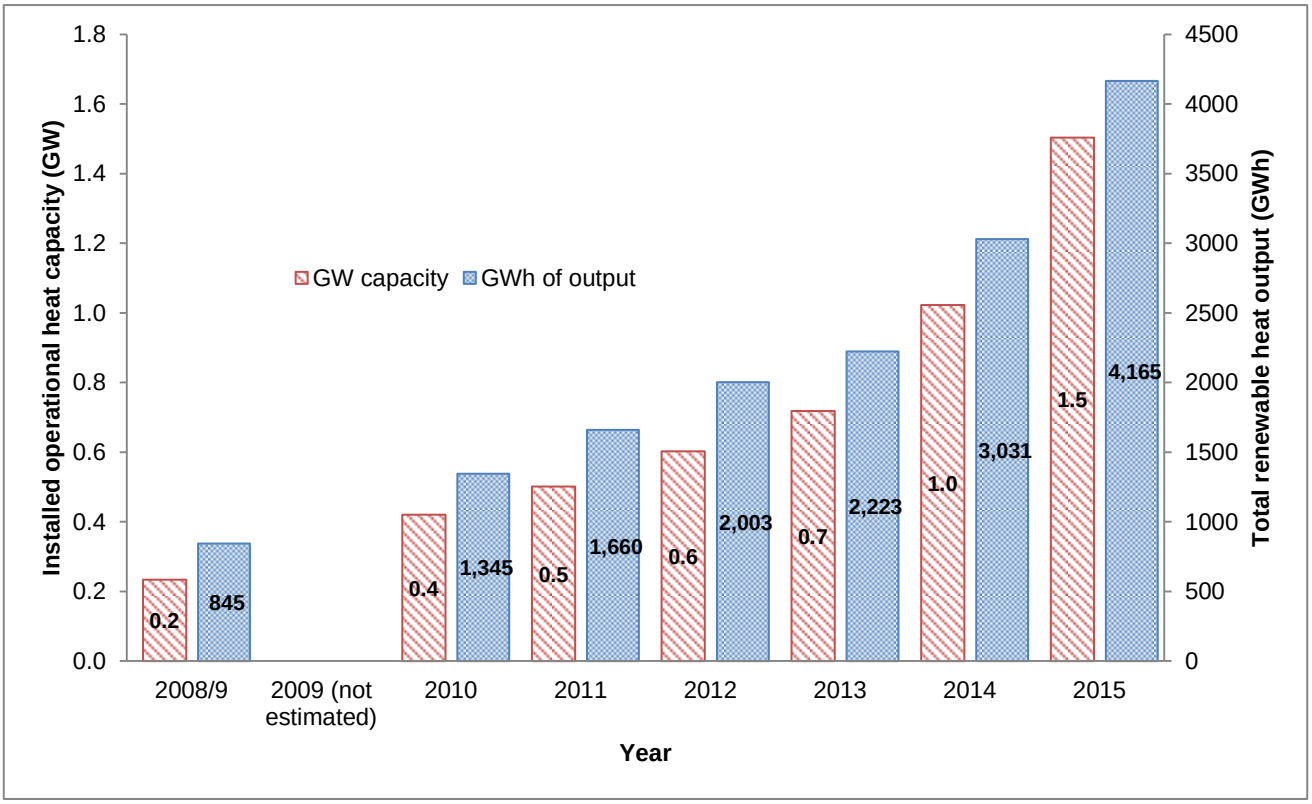
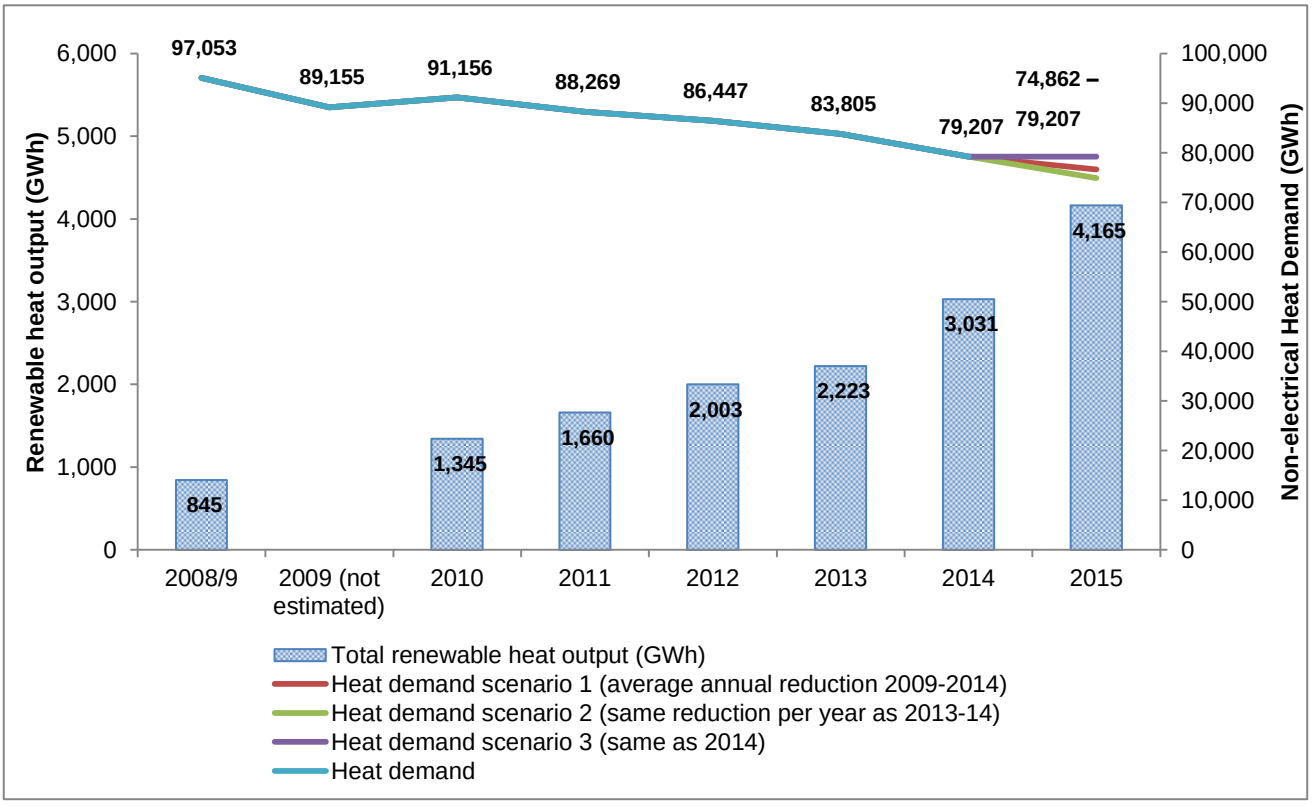


Figure 4. Estimated renewable heat output and non-electrical heat demand in Scotland, 2008/9 - 2015



While renewable heat output has continued to increase since 2008/9, heat demand has also fallen over this period due to combination of factors including rising gas prices, 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 89%) of progress to towards the renewable heat target between 2008/9 and 2014[28].

4.2 Results by installation size

The **majority of renewable heat output in 2015 continues to come from large (1 MW+) installations** (see Table 6). In total, large installations (all sites with capacity of 1 MW or more) contributed 47% of the renewable heat capacity and 71% of the annual output. Within this category there are **7 sites** that generate **more than 100 GWh heat per year**; together these sites provided 57% (2,373 GWh), of the total renewable heat output in Scotland in 2015 and 34% (0.550 GW) of the operational renewable heat capacity.

This large contribution from a small number of sites is inherent with the scale of these sites but also the fact that 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 over 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.

[28] 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 2014

Table 6. 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 (1 MW+)	0.710	47%	2,958	71%	60	<1%
Small to medium (>45 kW and <1 MW)	0.510	34%	722	17%	3,130	15%
Micro (≤45 kW)	0.283	19%	464	11%	17,670	85%
Unknown or N/A	<0.001	<0.1%	<1	<0.1%	<10	<0.01%
Total	1.504	100%	4,165	100%	20,870	100%

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

Table 7. Renewable heat capacity and output in Scotland, 2014, by size of installation [29]

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 (1 MW+)	0.488	48%	2,329	77%	50	<1%
Small to medium (>45 kW and <1 MW)	0.337	33%	376	12%	2,070	17%
Micro (≤45 kW)	0.197	19%	326	11%	10,240	83%
Unknown or N/A	<0.001	<0.1%	<1	<0.1%	<10	<0.01%
Total	1.022	100%	3,031	100%	12,360	100%

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

[29] These figures have been revised from those reported in the 2014 database due to errors found in the size categorisation in the underlying database. Total capacity and output figures are the same as those stated in the 2014 report.

Key points from Tables 6 and 7 are:

- In 2015, **small to medium** (>45 kW and <1 MW) systems made up 15% of the renewable heat installations in Scotland (by number). **Capacity from these systems has increased by 51% between 2014 and 2015 to 0.510 GW, while output has almost doubled**. There is clearly a larger increase in heat output compared to the increase in generating capacity over the same period; discernible from the RHI data available to us. However, in the absence of RHI data at the site specific level it is difficult to provide much analysis or draw conclusions. Possible explanations for the difference could be the high heat demand of some sites, a delay between the dates when systems are installed and when systems start being paid for the heat they generate, and the positive stimulus provided to heat production through the availability of the RHI as an incentive mechanism.

- **Micro heat capacity increased by 44% between 2014 and 2015, while output increased by 42%.** Since 2008/9 capacity has increased by more than 500% (from 0.045 GW) and output has more than tripled (from 139 GWh). This shows the impact of the domestic RHI (and RHPP scheme) on this sector within Scotland. The increase in output between 2008/9 and 2015 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. In addition, it may reflect the fact that that a large number of micro installations have only been operational for part of 2015.

- The **total capacity of large installations increased by 45% between 2014 and 2015, while output increased by 27%.** The smaller increase in output compared to capacity is likely to be partly due to the increased use of back up fossil fuel heating systems driven by lower fossil fuel prices. Some large installations were also not operational for all of 2015. Since 2008/9, both capacity and output have more than quadrupled (from 0.164 GW capacity and 637 GWh output).

4.3 Results by technology

The **majority of both output and capacity in 2015 came from biomass primary combustion and biomass combined heat and power** (see Table 8, and Figures 5 and 6). 86% of renewable heat capacity, and 89% 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[30], as well as from previous years' renewable heat in Scotland reports[31].

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

Tables 8 and 9 and Figures 5 and 6 show the breakdown of operational renewable heat capacity and renewable heat output in Scotland in 2015 by technology categories.

Table 8. Renewable heat output and capacity in Scotland, 2015, by technology

Technology	Renewable heat capacity (GW)	% Renewable heat capacity	Annual output (GWh)	% Annual output
Biomass	0.901	60%	2,203	53%
Biomass CHP	0. 391	26%	1,517	36%
Energy from waste	0.052	3%	192	5%
Heat pump	0.126	8%	236	6%
Solar thermal	0.033	2%	17	<1%
Total	1.504	100%	4,165	100%

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

As energy from waste includes incineration as well as advanced conversion technologies and landfill gas, a breakdown of this category is provided in Table 9 below.

Table 9. Renewable heat output and capacity in Scotland, 2015, energy from waste technologies

Energy from Waste Technology	Renewable heat capacity (MW)	% Renewable heat capacity	Annual output (GWh)	% Annual output
Advanced conversion technologies	38	3%	149	4%
Incineration	12	1%	42	1%
Landfill gas	2	<1%	1	<0.1%
Total	52	3%	192	5%

Figure 5. Renewable heat capacity in Scotland, 2015, by technology

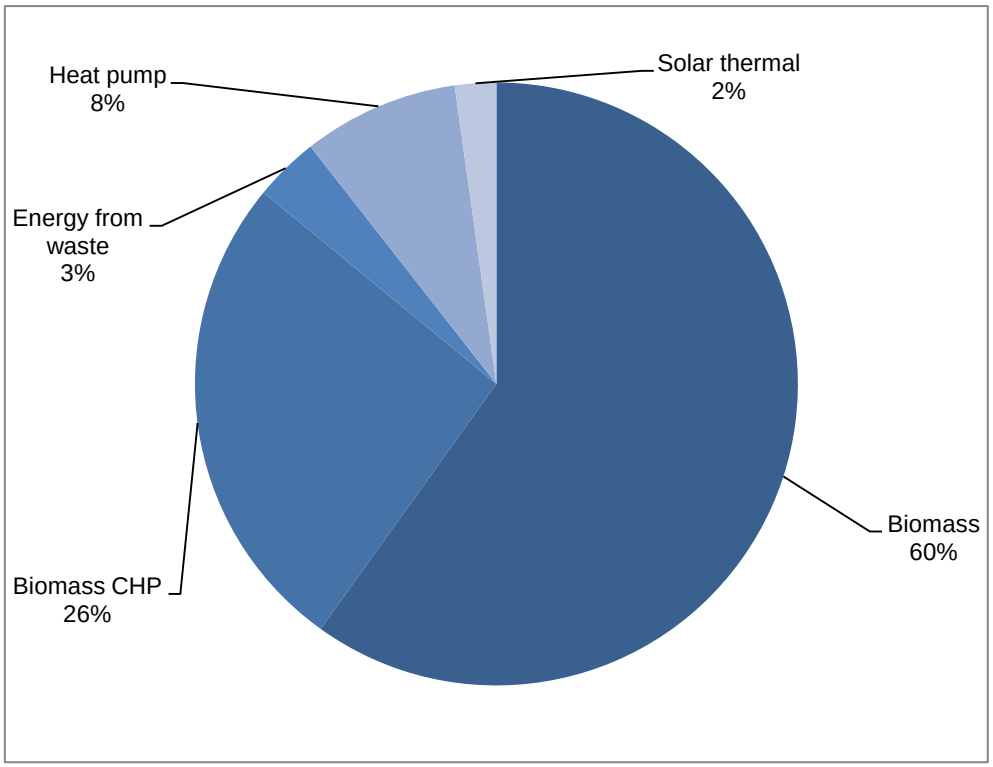
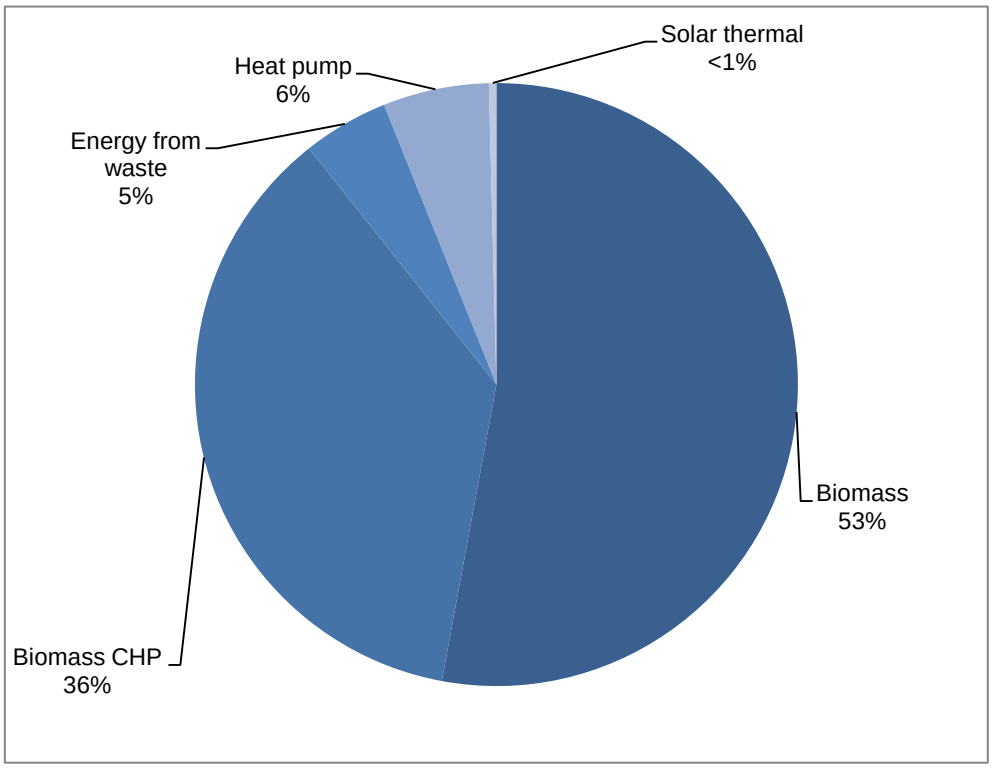


Figure 6. Renewable heat output in Scotland in 2015, by technology



While **energy from waste** has only seen a slight increase in capacity and output between 2014 and 2015 (with capacity increasing by 9 MW and output increasing by 21 GWh), it still has an important role in Scotland's renewable heat production. Some progress worth noting is that of the Keithick Biogas 'biomethane to gas grid injection' (BtG). Keithick BtG was commissioned in December 2014, and operations increased during 2015. Once running at full capacity, the site is expected to produce 3 million cubic metres of biomethane each year[32] and could contribute up to 32 GWh[33] of renewable heat in Scotland[34].

4.4 Results by size and technology

As in 2014, biomass primary combustion is still the renewable heat technology within the database with the most noticeable spread over the different size categories (large, small to medium, and micro). Almost all biomass CHP and energy from waste sites in 2015 are within the 'large' size bracket, whereas solar thermal and heat pumps in 2015 are 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.

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

[32] http://www.ionacapital.co.uk/page/113/Keithick-Biogas-Limited.htm
[33] Equates to 0.8% of current renewable heat output.
[34] Assuming an average gross calorific value (GCV) of biomethane to be 38 megajoules per cubic metre (38MJ/m3). Formula used to calculate MWh is: (3,000,000 cubic metres x 38 MJ/m3) ÷ (3,600 MWh/MJ) = 31,666 MWh, which is equivalent to approximately 32 GWh.

Figure 7. Capacity by size and technology (% of total technology operational capacity), 2015

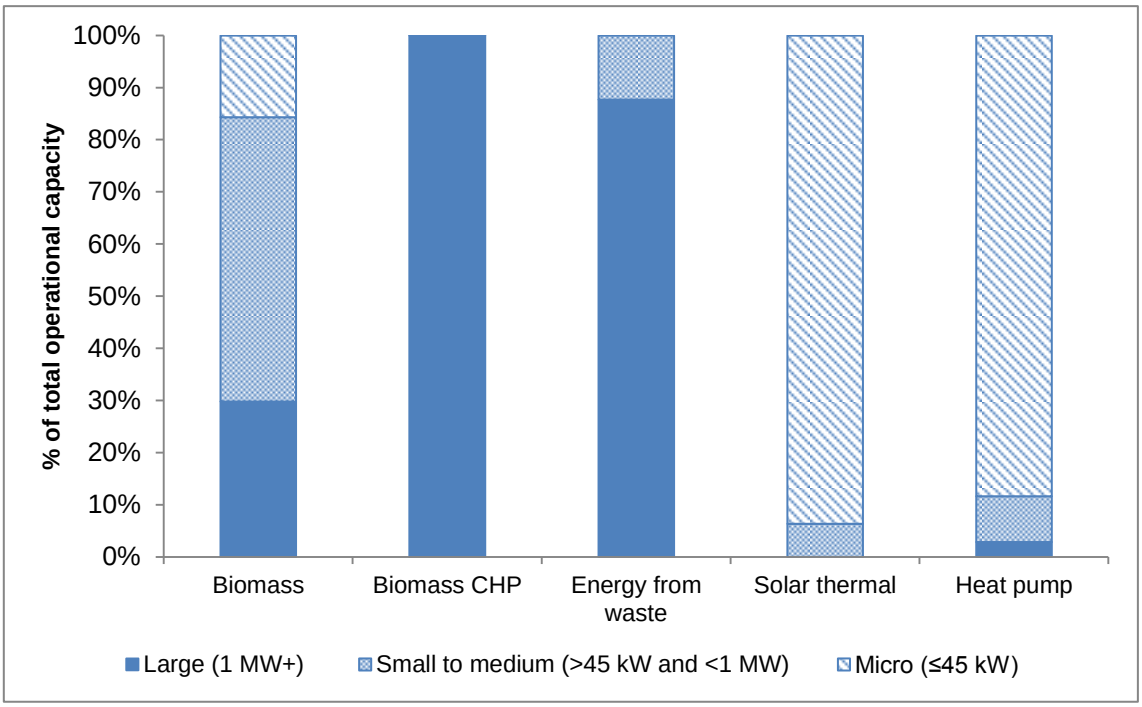
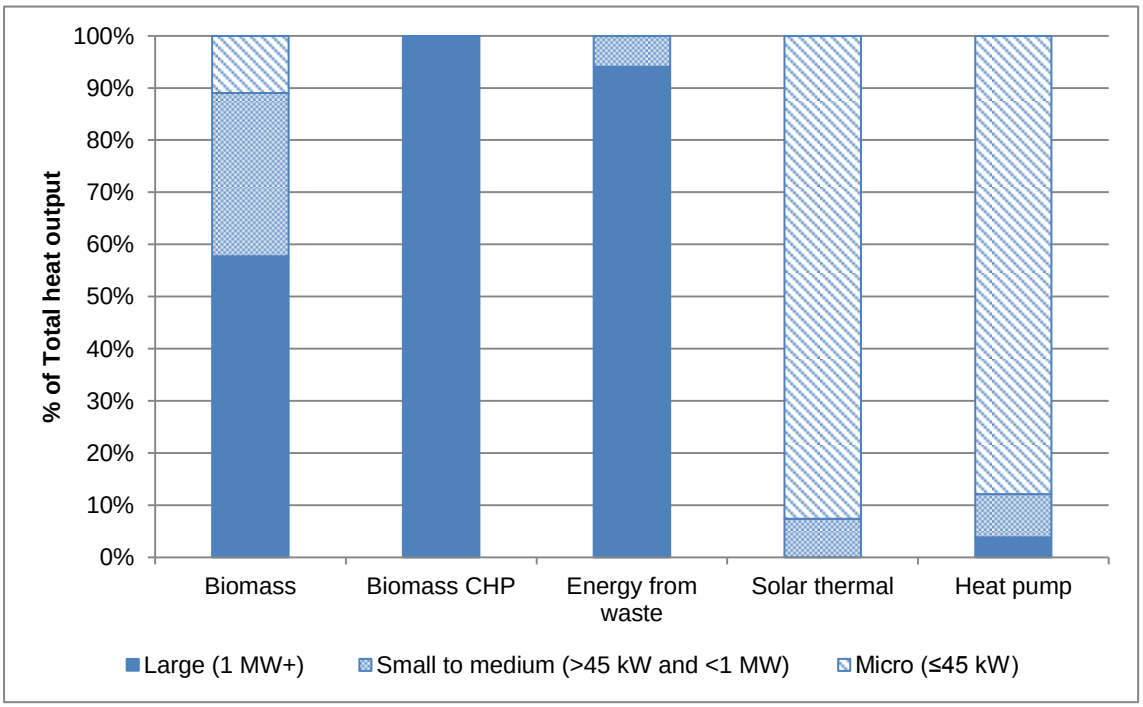


Figure 8. Output by size and technology (percent of total technology heat output), 2015



4.5 Change in output and capacity by technology since 2014

Three notable developments since 2014 account for significant differences in renewable heat output and operational capacity between 2014 and 2015. **Biomass CHP, heat pumps and biomass primary combustion saw the greatest proportional increases in output (at 57%, 44% and 28% respectively) and capacity (80%, 48% and 39%)** These developments are discussed in more detail below:

4.5.1 Biomass combined heat and power:

Biomass CHP saw the biggest proportional increase of all the technology categories, with capacity increasing by 80% and output by 57% (increases of 0.174 GW and 552 GWh respectively). This increase was largely due to significant increases in the renewable heat capacity and output from a small number of large commercial CHP plants.

4.5.2 Biomass primary combustion:

Between 2014 and 2015 the estimated capacity of biomass (non CHP) has increased by 39% and output by 28% (increases of 0.254 GW and 487 GWh respectively). A large proportion of the increase seen is accounted for by the additional capacity and output from the aggregated RHI data provided by BEIS. Small and medium sized biomass systems have also continued to be popular technologies for use on farms and estates, as well as in the public sector and by local authorities. For example, local authorities continued to install biomass systems into schools across Scotland during 2015.

4.5.3 Heat pumps:

Although they make up a relatively small proportion of the total renewable heat capacity and output, heat pumps also saw a significant proportional increase between 2014 and 2015, with capacity increasing by 48% (41 MW, or 0.041GW, of additional capacity). Small to medium sized heat pumps had a capacity increase of 11 MW (an increase of 73% from 2014), while the capacity of micro installations increased by 44% (from 144 MW to 207 MW since 2014). There was no change in the capacity of large heat pumps from 2014 to 2015.

Table 10. Changes in renewable heat output and capacity in Scotland from 2014 to 2015, by technology

Technology category	2015 Total capacity (GW)	Change since 2014 (GW)	Percentage change (%)	2014 Total annual output (GWh)	Change since 2014 (GWh)	Percentage change (%)
Biomass	0.901	+ 0.254	39%	2,203	+ 487	28%
Biomass CHP	0.391	+ 0.174	80%	1,517	+552	57%
Energy from waste	0.052	+ 0.009	21%	192	+ 21	12%
Heat pump	0.126	+ 0.041	48%	236	+ 72	44%
Solar thermal	0.033	+ 0.004	12%	17	+ 2	14%
Total	**1.504**	**+ 0.481**	**47%**	**4,165**	**+ 1,134**	**37%**

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

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). A local authority breakdown of the aggregated RHI data was not available for this report.

The key findings from analysis of the non-micro and non-RHI aggregated installations by local authority area are:

- Fife accounted for at least 24% of Scotland's total renewable heat output in 2015 (988 GWh) and had 15% of the overall operational capacity (0.232 GW)

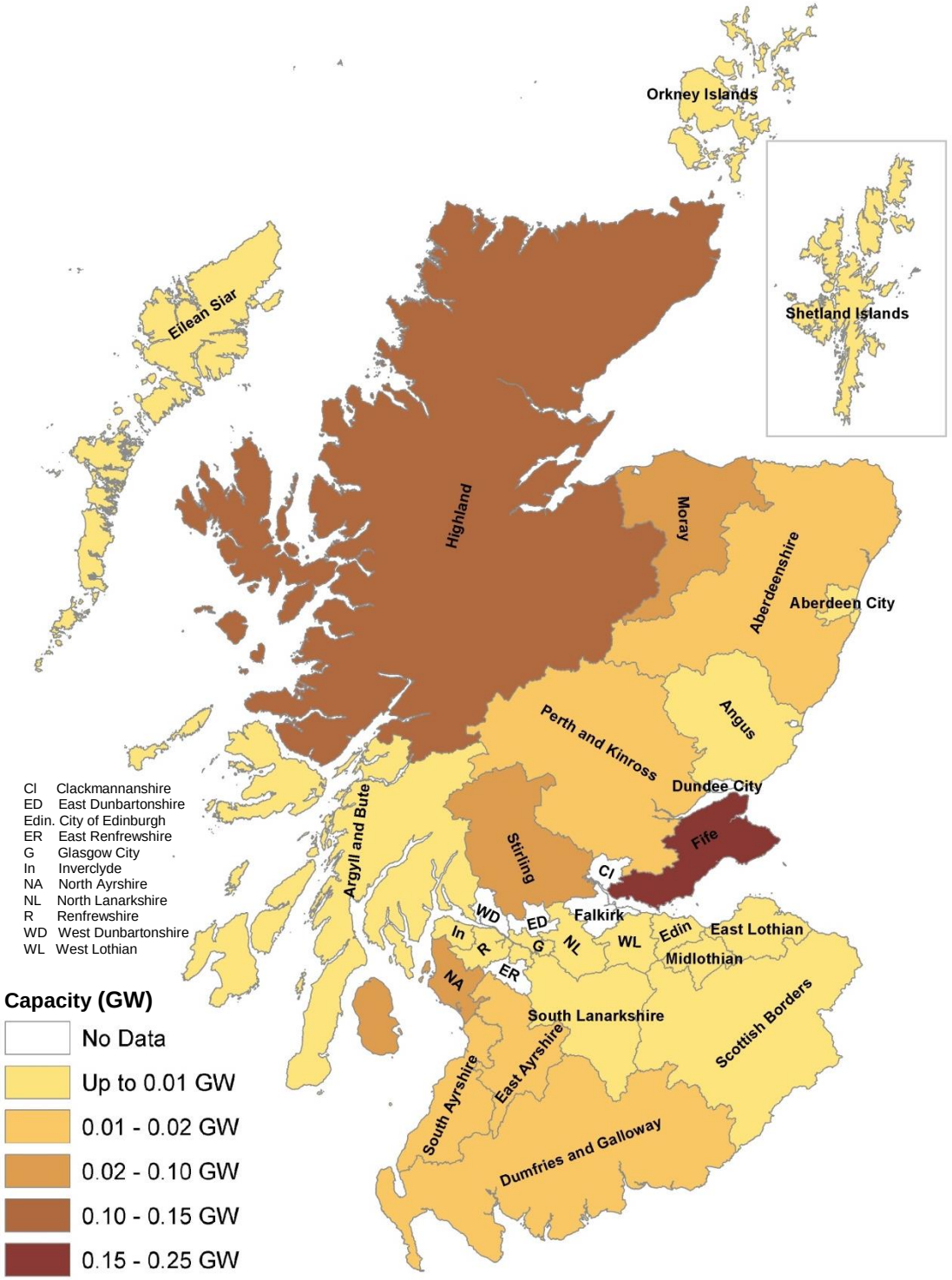
- 56% of the 2015 heat output came from just 4 areas (Fife, Highland, Stirling and North Ayrshire), each of which contributed over 300 GWh of renewable heat in 2015. These 4 areas had a combined capacity of 0.542 GW (36% of the total renewable capacity in Scotland).

Table 11. Heat output and capacity by local authority area, Scotland, 2015[35]

Local authority area	Renewable heat output, 2015 (GWh)	Operational renewable heat capacity, 2015 (GW)
Aberdeen City	13	0.004
Aberdeenshire	47	0.019
Angus	15	0.007
Argyll and Bute	23	0.008
Clackmannanshire	c	c
Comhairle nan Eilean Siar	4	0.002
Dumfries and Galloway	53	0.019
Dundee City	c	c
East Ayrshire	186	0.020
East Dunbartonshire	c	c
East Lothian	12	0.003
East Renfrewshire	c	c
Edinburgh, City of	31	0.006
Falkirk	c	c
Fife	988	0.232
Glasgow City	8	0.003
Highland	524	0.133
Inverclyde	3	0.001
Midlothian	5	0.003
Moray	157	0.050
North Ayrshire	307	0.100
North Lanarkshire	12	0.005
Orkney Islands	4	0.001
Perth and Kinross	58	0.013
Renfrewshire	11	0.009
Scottish Borders	19	0.007
Shetland Islands	14	0.006
South Ayrshire	96	0.016
South Lanarkshire	23	0.010
Stirling	521	0.077
West Dunbartonshire	c	c
West Lothian	3	0.001
Local authority unknown[36]	1,013	0.741
TOTAL	**4,165**	**1.504**

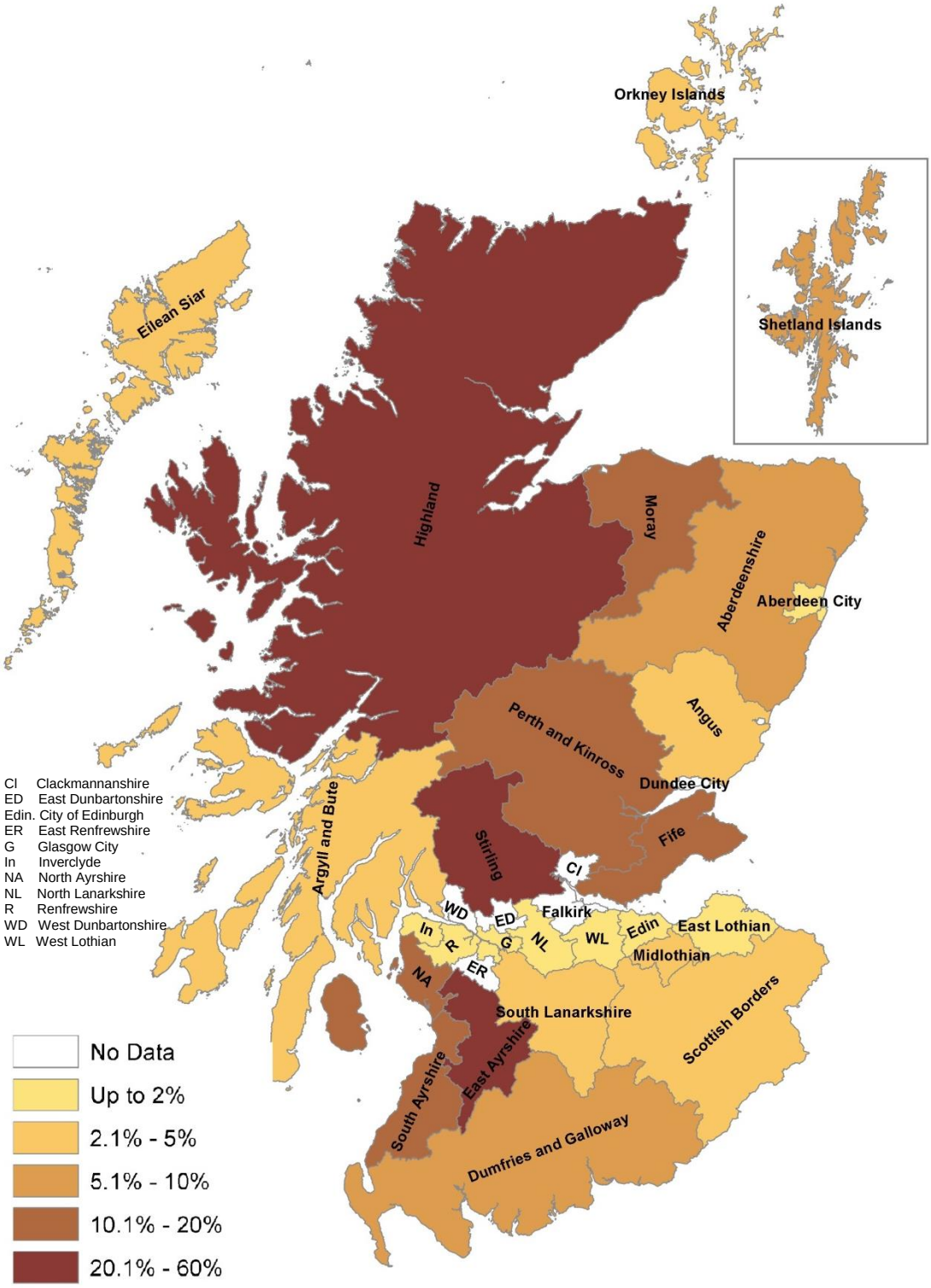
[35] 'c' Marks where fewer than 5 installations are recorded in an area this information has been withheld to avoid disclosing information about individual sites.
[36] 'Local authority unknown' includes all micro-generation installations and aggregated RHI figures

Figure 9. Map showing operational renewable heat capacity by local authority area, 2015[37]



[37] 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, 2015[38].



[38] Heat demand figures assume that heat demand does not change from 2014 (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.

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). Therefore, Table 11 above does not include 24% of the overall heat output and 49% of the overall capacity reported for 2015 as this is not assigned to a local authority. Rather than include two tables with similar but apparently differing information, the decision has been taken not to include the breakdown of the number and capacity of accreditations under the non-domestic RHI by local authority in this report. This data is however available separately from BEIS[39].

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 2015 data is given below in Table 12.

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

Table 12. Number of installations by local authority area accredited in Scotland under the domestic RHI scheme as of December 2015[40]

Local authority area	Number of installations	% installations
Aberdeen City	43	<1%
Aberdeenshire	685	8%
Angus	142	2%
Argyll and Bute	396	4%
Clackmannanshire	30	<1%
Comhairle nan Eilean Siar	544	6%
Dumfries and Galloway	1,377	15%
Dundee City	91	1%
East Ayrshire	126	1%
East Dunbartonshire	30	<1%
East Lothian	167	2%
East Renfrewshire	23	<1%
Edinburgh, City of	59	1%
Falkirk	46	1%
Fife	326	4%
Glasgow City	23	<1%
Highland	1,509	17%
Inverclyde	19	<1%
Midlothian	65	1%
Moray	248	3%
North Ayrshire	77	1%
North Lanarkshire	39	<1%
Orkney Islands	200	2%
Perth and Kinross	482	5%
Renfrewshire	41	<1%
Scottish Borders	382	4%
Shetland Islands	128	1%
South Ayrshire	144	2%
South Lanarkshire	1,191	13%
Stirling	264	3%
West Dunbartonshire	33	<1%
West Lothian	100	1%
TOTAL	**9,030**	**100%**

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

[40] Source: BEIS Non-Domestic RHI and domestic RHI monthly deployment data: December 2015. https://www.gov.uk/government/collections/renewable-heat-incentive-statistics#monthly-deployment-data

located in this area. Other areas with large numbers of microgeneration systems are Dumfries and Galloway and South Lanarkshire. Both areas had over 1000 domestic RHI accredited systems as of December 2015, and held 15% and 13% of the total accredited domestic installations in Scotland respectively. As of December 2015, Scotland as a whole had 20% of the 45,111 accredited domestic RHI systems in Great Britain.

Figures do not provide a full picture of renewable heat being supplied to homes by each local authority area. For example; domestic RHI figures do not include homes supplied by renewable heat through district 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, off gas grid households. The vast majority of microgeneration systems accredited under the domestic RHI are located off the gas grid, with 91% of heat pumps and 89% of biomass systems installed in off grid areas. A smaller proportion of solar thermal systems (61%) were 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 13. Number of installations on and off the gas grid accredited in Scotland under the domestic RHI scheme as of December 2015, by technology[41]

Technology	Number of installations on grid	% installations on grid	Number of installations on off grid	% installations off grid
Biomass	353	11%	2,784	89%
Heat pump	462	9%	4,497	91%
Solar thermal	367	39%	567	61%
TOTAL	**1,182**	**13%**	**7,848**	**87%**

Uptake of the domestic RHI has continued to increase across all eligible technologies since December 2015. Please refer to section 5.2 for further commentary on the trends seen in both the domestic and non-domestic RHI between December 2015 and August 2016.

[41] Source: BEIS Non-Domestic RHI and domestic RHI monthly deployment data: December 2015. https://www.gov.uk/government/collections/renewable-heat-incentive-statistics#monthly-deployment-data

5 Further renewable heat capacity in development

5.1 Overview of pipeline projects in the renewable heat database

This report also tracks projections of both expected capacity and heat output over the coming years. The database has been structured to record the current status of each project, namely:

- Under construction - where the project is in the build phase.
- Consented, not built - where a planning application and other required permissions have been granted but construction is not yet underway.
- In planning – where a planning application or otherwise has been submitted, but with no formal approval yet received.
- In scoping - where the project is in its initial phase.

It is estimated that as of December 2015:

- 0.340 GW of renewable heat capacity was in one of the development stages, potentially contributing a further 1,468 GWh of renewable heat output in the future.

- If all the projects in development were completed the total renewable heat capacity in Scotland would be 1.843 GW and output could increase to 5,633 GWh per year - a 23% increase in capacity and 35% increase in output.

Although these figures can be used to provide an estimate of the future renewable heat output in Scotland, there is inherently a large degree of uncertainty around such figures as projects may be altered or cancelled during the development phases. Furthermore it is likely that a large proportion of developing projects are not captured within the scope of this database, particularly for smaller installations and installations that are not required to go through formal planning permission. These two uncertainties should be taken into account when the data presented here are interpreted.

Figure 11: Capacity of the technologies in development in Scotland in 2015[42]

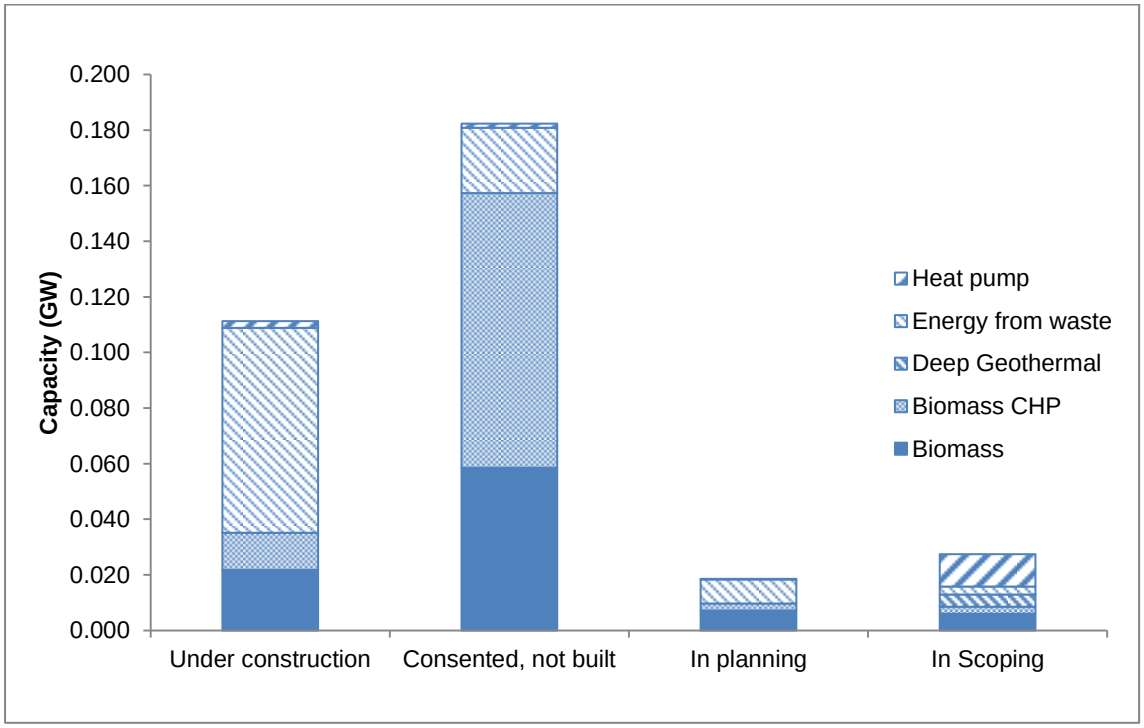
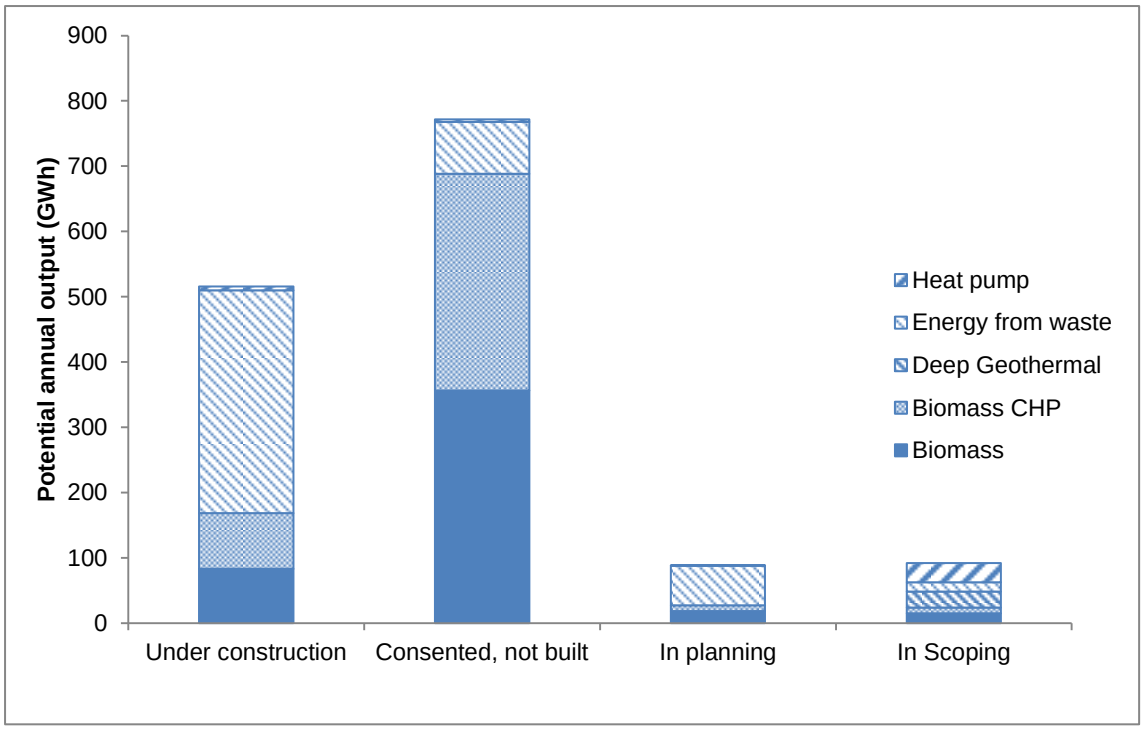


Figure 12: Potential output from technologies in development in Scotland in 2015



[42] Only installations in development that are >45kW in size are recorded in the database. No solar thermals systems >45kW in size were known it be in development in 2015. Data from previous years suggests that in development estimates do not fully represent the potential increase in capacity and output.

Projects 'under construction' have a total capacity of 0.111 GW and an estimated heat output of 516 GWh. The majority of this comes from 7 energy from waste sites. This includes Polmadie energy from waste site near Glasgow, which has been under construction since 2013 and Dunbar energy from waste plant, which is due to become operational in 2017.

The 'consented, not built' projects have a total capacity of 0.182 GW with an estimated heat output of 772 GWh. While energy from waste projects still makes up a significant proportion of capacity and output, the highest contributing technologies in this category are biomass CHP with 0.099 GW capacity and biomass heat only with 0.059 GW capacity.

0.019 GW of heat capacity was in the 'planning' phase as of December 2015, which could generate 89 GWh of heat output. The highest contributors in planning are biomass projects, with many small to medium installations planned for schools and small district heating networks.

The projects currently in scoping could provide another 0.028 GW of heat capacity, leading to approximately 92 GWh of heat output. Included in these figures are 4 deep geothermal projects that were awarded grants through the Geothermal Energy Challenge Fund in 2015 to 'explore the technical feasibility, economic viability and environmental sustainability of the emerging technology'[43]. Feasibility studies for the projects were submitted to the Low Carbon Infrastructure Transition Programme in spring 2016 and can be viewed on the Scottish Government website[44].

Also in scoping are two district heating projects that were awarded development funding through the Local Energy Challenge Fund in 2016[45]. The River Tay Heat Pump District Heating project intends to use a 2 MW water source heat pump to heat dwellings, business plots and council buildings, while the Large Scale ASHP District Heating Exemplar project, led by Glasgow Housing Association, plans to use a 700 kW air source heat pump to heat 350 dwellings in multi-storey buildings built in the 1970s.

It is important to note that figures from the 'in scoping' category should be treated with extreme caution as:

- It is not known how many of these projects will ultimately become operational and key details may change as different options are explored.

- Numbers are likely to be a huge underestimate as not all projects in scoping will have been captured in the renewable heat database. In particular the Renewable Energy Planning database (REPD) no longer monitors projects with a capacity less than 1 MW. This has had a detrimental impact on our ability to monitor the small and medium scale projects (>45 kW and <1 MW) that, as seen in section 4 above make up a significant portion of the renewable heat capacity and output in Scotland.

[43] http://news.scotland.gov.uk/News/Geothermal-energy-projects-awarded-quarter-million-19ed.aspx
[44] http://www.gov.scot/Topics/Business-Industry/Energy/Action/lowcarbon/LCITP/geothermal
[45] http://www.localenergyscotland.org/funding-resources/funding/local-energy-challenge-fund/development-projects-2015/

5.2 Trends seen in the RHI monthly statistics

During the first eight months of 2016, there was an increase in both the number of full accreditations[46] under the non-domestic RHI scheme and in accreditations under the domestic scheme.

Trends in the domestic RHI scheme[47]:

- There was a **16% increase in accreditations** for systems in Scotland under the domestic RHI between December 2015 and August 2016. (An increase of 1,480, from 9,030 as of 31 December 2015 to 10,510 as of 31 August 2016)

- The technology with the biggest increase in accreditations under the domestic RHI was **air source heat pumps, with a 21% increase** (from 4,140 as of December 2015 to 5,030 as of August 2016).

- The number of domestic **ground source heat pumps** accredited under the domestic RHI from December 2015 to August 2016 has **grown 15%**, from 820 in December 2015 to 940 systems in August 2016.

- **Biomass systems** and **solar thermal installations** have seen lower rates of uptake, with biomass accreditations increasing by **12%** (from 3,140 to 3,510) and solar thermal accreditations increasing by **10%** (from 930 to 1,030) between December 2015 and August 2016.

- As of August 2016, systems in **Scotland accounted for 21% of the total number of accredited systems under the domestic RHI scheme**.

Trends in the non-domestic RHI scheme[48]:

- There was an 11% increase in the number of non-domestic RHI 'full applications' in Scotland between December 2015 and August 2016, with a 24% increase in capacity. (An increase from 2,820 full applications in December 2015 to 3,120 in August 2016, and a capacity increase of 122 MW, from 507 MW to 629 MW)

- The general trend across all countries (England, Wales and Scotland) was that the biggest growth between December 2015 and August 2016 was in CHP systems and biogas systems. GB wide the number of CHP full applications increased from only 2 in December 2015 to 18 in August 2016, while the number of full applications for biogas increased from 150 to 580 over the same period (an increase of 295%).

[46] 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.
[47] Numbers of installations have been rounded to the nearest 10 for ease of reading
[48] 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.

- Between December 2015 and August 2016, the number of full applications for medium solid biomass installations increased by 59% across all of GB, while full applications for biomethane installations increased by 47%.

- As of August 2016 systems in **Scotland accounted for 19% of the total number of full applications and 20% of the total the installed capacity under the non-domestic RHI** scheme.

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

5.3 Emerging technologies and innovative projects in the pipeline

Following on from the commissioning of the 'biomethane to gas grid injection' (BtG) at Keithick Biogas in late 2014, it is likely that other AD plants around Scotland may be converting, or may begin to convert, some or all of their capacity to BtG. As with Keithick Biogas, sites converting from AD to BtG will not add to the overall heat capacity, so as these sites start to inject gas the contribution will only be noticeable in the figures for 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 also a wide range of innovative projects being funded through various challenge funds. Together, these projects not only aim to show how different renewable technologies can be used but also aim 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 projects is given below to show the range of projects currently being supported:

5.3.1 District Heating Loan Fund

The Scottish Government's District Heating Loan Fund has part-funded a significant number of district heating schemes in Scotland to date and continues to provide a vital funding stream for both low carbon and renewable projects that may be seen as high risk by other lenders. 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

The Scottish Government together with Local Energy Scotland has launched the Local Energy Challenge Fund. This fund provides grant and loan funding for major demonstration

projects providing transformative and innovative local energy solutions. These projects aim to have high impact not only in terms of helping to achieve Scottish Government renewable targets but also in showcasing new ways of using renewables.

As mentioned in section 5.1, two district heating projects currently funded through the Local Energy Challenge Fund are already in scoping and are recorded in the database. Another innovative project receiving development funding is the Montrose Local Energy Project. This will process and dry used animal bedding to produce a new fuel source in the form of pellets. While this will not directly generate renewable heat, it is possible that the availability of this new fuel source may encourage the uptake of compatible renewable heating systems in the local area.

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 £76m, 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. To date, LCITP has provided financial supported to 46 low carbon projects covering a wide range of technologies.

A number of the feasibility studies, supported through the programme, 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 Infrastructure Investment Plan reaffirmed the designation of energy efficiency as a National Infrastructure Priority. The cornerstone of this will be Scotland's Energy Efficiency Programme which will commence in 2018 with substantial annual public funding. 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 £10bn.

The Programme for Government 2016-17 (PfG) committed over half a billion pounds to SEEP over the next four years, setting out a clear commitment to develop this very significant energy efficiency and low carbon heating generation programme with substantial annual public funding. Scottish Government are working with councils to pilot integrated action on domestic and non-domestic energy efficiency with investment of over £9 million of funding in 11 local authorities to support pilots in 2016-17 with further funding being made available next year. A summary list of the pilots to date can be viewed at: http://news.scotland.gov.uk/News/Action-on-fuel-poverty-2c06.aspx

5.4 Other developments from 2015 onwards

From the summary of findings it is clear that operational heat capacity in Scotland is growing faster than the annual heat 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 2016 the Scottish Government worked with the Scottish Environment Protection Agency (SEPA) to collect data on excess waste heat from industrial sites to inform policy development. Data on waste heat was requested on a voluntary basis via the Scottish Pollution Release Inventory (SPRI) questionnaire, issued to industries regulated by SEPA under the Pollution Prevention and Control (Scotland) Regulations 2012 (as amended). Responses were received from several organisations, and to supplement this data the exercise will be repeated in January 2017 with more guidance and engagement with industry.

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. Estimates of future output and capacity from installations still in development should also be treated with caution, as these projects may not come to fruition for a variety of reasons, and the stated capacity and heat output for projects still in development may be subject to change.

- Realised heat output from future installations may also not match predictions of future output based on installed capacity and peak running hours.

- It is worth noting that many heat installations currently in development 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.

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 the Department for Business, Energy and Industrial Strategy (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 5.2 below). 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[49]. 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 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 2012-2015 (inclusive). For the 2011 report the number of micro installations was estimated as 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). Therefore it is 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

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

output for micro systems (smaller than 45 kW) are all likely to be underestimated. At the time of writing there were no data available that would provide the missing information without risking double counting.

6.3 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.)

6.4 Recommendations for future updates

6.4.1 Recommendation 1 – RHI data

This is the second 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 andwould 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. Given the site-by-site complexities in large scale generation (including what the heat is used for) 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.

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.

6.4.5 Recommendation 5 – calorific value of woodfuel

For the 2015 update of the database one oven-dried tonne (ODT) of wood was assumed to contain 4.92 MWh of energy[50]. It is recommended that that further research into the calorific value of woodfuel is carried out before the 2016 database update to ensure this assumption is in line with current research, or to update the assumption if required.

6.4.6 Recommendation 6 – assessment of pipeline projects

As discussed in section 5.1 there is currently a large amount of uncertainty surrounding the capacity and potential output from projects which are in the pipeline and are yet to be commissioned. It is recommended for future reports that potential alternative ways of predicting the impact of future developments are investigated. The way in which in development data is presented could also be considered further, to ensure that projections of future capacity and output are as meaningful as possible.

[50] Mitchell, Hudson, Gardner, Storry and Gray, 1990. Wood Fuel Supply Strategies Vol 1. The Report: ETSU B 1176-P1.

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 14.

- **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, which 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, 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'[51] 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. Because the heat from such units comes from fossil fuel sources, 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.

[51] '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[52] 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, as 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, so estimates of heat from these systems have not been included in the renewable heat figures reported here.

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

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

8.1 Capacity assumptions

Table 14 below shows the assumed capacities that were used in the renewable heat database where information on capacity was not available.

Table 14. Assumptions used for capacity where not known, 2015

Ownership category[53]	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	170 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.
	All except hospitals	Biomass	130 kWth	Average of other public sector and charity biomass installations, excluding hospital installations, recorded in the database.

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

	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 ASHP's recorded in the database.
	All	GSHP	30 kWth	Average of other local business GSHP's recorded in the database.
	All	Biomass	140 kWth	Average of other local business biomass recorded in the database.
	All	Biomass district heating	150 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.[54]
	Domestic properties	Solar thermal – installed in 2014 or 2015	4 m^2	Analysis of Energy Saving Scotland home renewables loans.[54]
	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.
	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.

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

	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.[54]
	Domestic properties	Solar thermal – installed in 2014 or 2015	4 m^2	Analysis of Energy Saving Scotland home renewables loans.[54]
	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[55]	7 kWth	Average of other LA- and HA-owned ASHP-EAHRs in domestic properties, recorded in the database.

[55] 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) is a renewable heat incentive scheme that 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[56]. 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 were 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 **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.

9.2 Methodology

The analysis undertaken by BEIS was done using an extract of the renewable heat database as of 27 May 2016.[57] For all sites with a capacity of 0.5 MW (500 kW) or higher, the data

[56] Community 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.
[57] 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 DECC.

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 2015.

The variables provided by BEIS were:

- 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[58], 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 15 below.

[58] 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 15. 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[59]. 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 the 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'. The 'High' and 'Medium' records have been excluded from the overall figures.[60] The aggregated RHI figures were then added to the relevant renewable heat database summary figures to provide total capacity and heat figures for Scotland.

[59] For details please see https://www.ofgem.gov.uk/sites/default/files/docs/2015/02/guidance_volume_one_-_july_2015_-.pdf
[60] These sites are still recorded in the renewable heat database for reference.

Appendix 4. Measurement of heat demand in Scotland

This Appendix sets out:

- How 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.

10.1 Background

Heat has been estimated to account for more than half of Scotland's total energy use.[61] 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 Plan[62] set a target of delivering 11% of Scotland's projected 2020 (non-electrical)[63] heat demand from renewable sources.

In 2006, the Scottish Energy Study[64] described Scotland's current energy supply, energy consumption and energy-related CO_2 emissions during 2002 and 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. However, it was not feasible to monitor heat demand on an annual basis. This study produced estimates for 2002 and subsequently a figure for 2020 heat demand was derived from these estimates. Therefore, to date, the heat target has been monitored using the latest annual renewable heat output estimate against this forecast 2020 figure for heat demand.

10.2 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 estimated to be 60,089 GWh using data from the Scottish Energy Study. Therefore, the target was set at 11% (See Table 16).

[61] Energy in Scotland 2016, Scottish Government, http://www.gov.scot/Topics/Statistics/Browse/Business/Energy/EIS2016
[62] Renewable Heat Action Plan (2009). http://www.scotland.gov.uk/Publications/2009/11/04154534/0
[63] 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 14% of households in Scotland use electricity as their primary heating fuel.
[64] Scottish Energy Study, Vol 1 (2006). http://www.scotland.gov.uk/Publications/2006/01/19092748/0

Table 16: 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[65])	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%**

10.3 Improving data on heat demand in Scotland

In the years following the publication of the Scottish Energy Study, the Department Business, Energy and Industrial Strategy (BEIS) began publishing more detailed sub-UK estimates of energy consumption[66] 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.

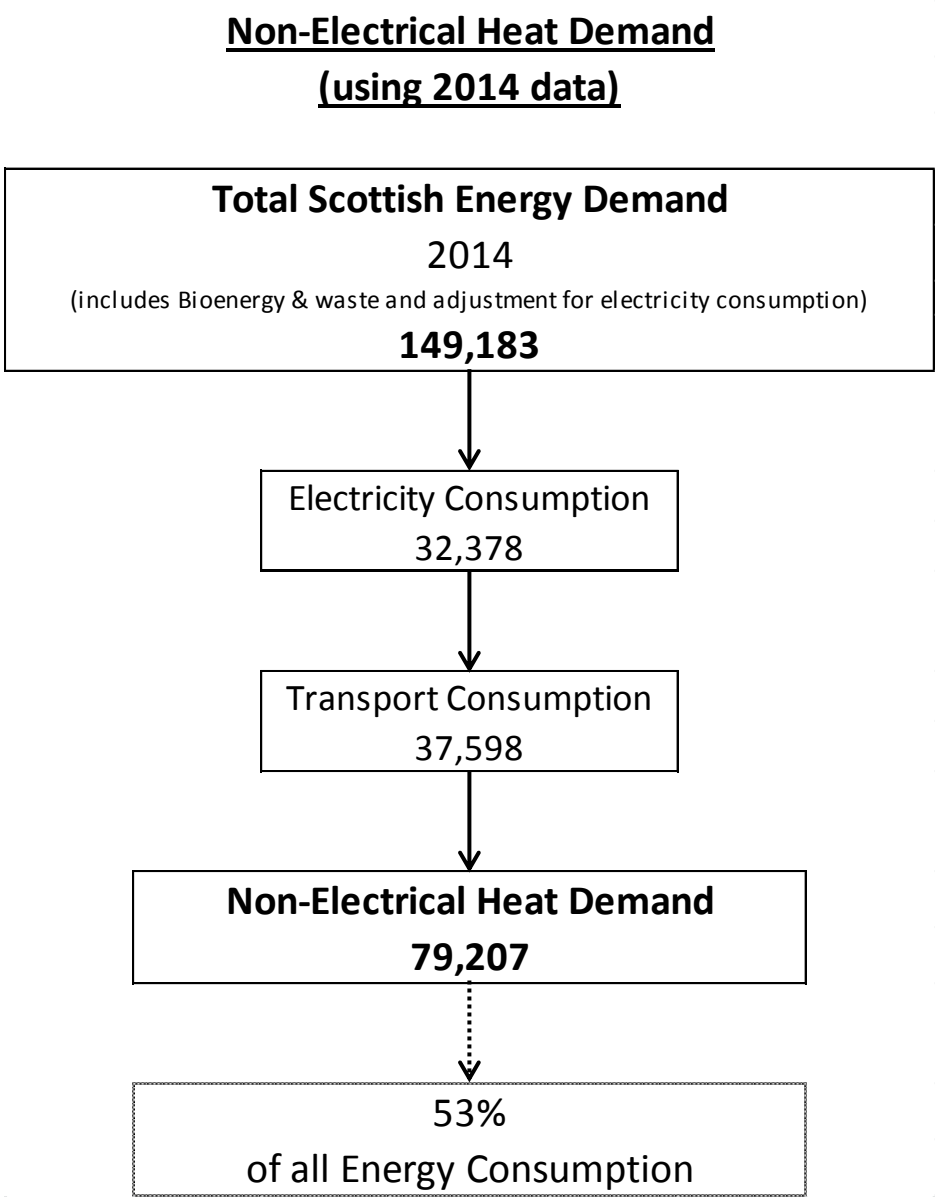
The BEIS data shows a breakdown of final energy consumption by end use for Scotland down to local authority level. By subtracting electricity and transport consumption from the final energy consumption figure (as well as making adjustments for bioenergy & waste and electricity consumption[67]), this results in an estimate for non-electrical heat demand in Scotland (see the flow chart in Figure 13 below for more detail).

[65] 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

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

[67] The total energy demand figure is adjusted to account for an inconsistency with the electricity consumption figures presented within the energy tables published by BEIS. In 2010, there was a difference of 6,345 GWh between the electricity consumption figure in the sub-national consumption table and that in the sub-national electricity supply table (27,391 GWh and 33,736 GWh respectively). https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/65842/7363-elec-gen-supply-figures-et-art-sheet.xls

Figure 13: 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 17 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 17: Renewable heat target - renewable heat as a % of heat demand 2008/09 to 2015

	2008/9	2009 (not estimated)	2010	2011	2012	2013	2014	2015
Total renewable heat output (GWh)	845	:[68]	1,345	1,660	2,003	2,223	3,031	4,165
New measure: % of annual estimate of total non-electrical heat demand	**0.9%**	**:**	**1.5%**	**1.9%**	**2.3%**	**2.7%**	**3.8%**	**-**
Progress - scenario 1								5.4%
Progress - scenario 2								5.6%
Progress - scenario 3								5.3%
Heat demand	97,053	89,155	91,156	88,269	86,447	83,805	79,207	-
Heat demand scenario 1 (average % annual reduction 2008-2014)								76,611
Heat demand scenario 2 (same % reduction per year as 2013-14)								74,862
Heat demand scenario 3 (same as 2014)								79,207
Previous measure: % of forecast 2020 non-electrical heat demand	1.4%	:	2.2%	2.8%	3.3%	3.7%	5.0%	6.9%
Previous heat demand measure	*60,089*	*60,089*	*60,089*	*60,089*	*60,089*	*60,089*	*60,089*	*60,089*

10.4 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 the BEIS sub-UK consumption data – 2015 data will not be available until September 2017.
- 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 the BEIS datasets.

[68] ':' marks where data was unavailable.

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