Renewable heat in Scotland, 2014

A report by the Energy Saving Trust for the Scottish Government

October 2015

Prepared by Chloë Duxbury, Kalina Georgieva and Fiona Young, Energy Saving Trust

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 Chloë Duxbury, Kalina Georgieva and Fiona Young.

Energy Saving Trust would like to thank all individuals and organisations who provided data, with particular thanks to the Department of Energy and Climate Change, the Forestry Commission Scotland and Hudson Consulting Ltd.

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. Summary of findings

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 maintains a database of renewable heat installations (referred to as the EST 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 and contains data on the capacity and yearly heat output of those installations.

The database has now been updated with new information on heat generated from renewable sources during 2014 and new installations which are in development. This report also includes commentary on accreditations under domestic and non-domestic RHI schemes between December 2014 and June 2015. As a result, we estimate that:

- In 2014 Scotland generated an estimated 3.7 – 3.8% of its non-electrical heat demand from renewable sources[2].

- 1.022GW of renewable heat capacity was operational in Scotland by the end of 2014 (**up 42%** from 2013), producing an estimated 3,031GWh of useful renewable heat in the 2014 calendar year, an **increase of 36%** from 2013.

- The capacity of micro renewable heat generating systems installed in Scotland **grew by a third** in 2014 to 0.194GW (194MW) and the number of micro systems operational by the end of 2014 was estimated to be **9,670**.

- **The Highland local authority** area contributed **18%** of the total heat output for 2014 and has the largest number of installations across all size categories.

- By the end of December 2014 **3,000 domestic RHI installations in Scotland** were accredited; this number more than doubled **by the end of August 2015 to 8063**[3].

- Under both the **domestic and non-domestic RHI schemes, approximately 20% of all accredited installations are in Scotland**. 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.

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[1] Renewable Heat Action Plan for Scotland, Scottish Government, November 2009. http://www.scotland.gov.uk/Publications/2009/11/04154534/0

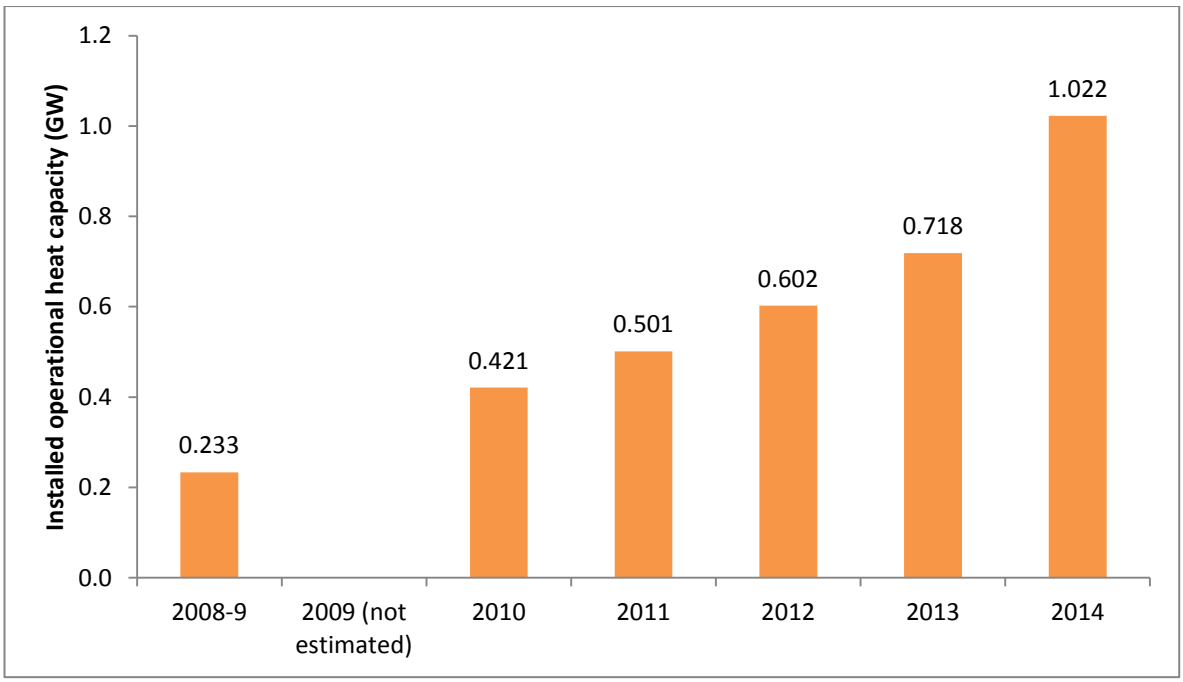
[2] Based on a range of scenarios to estimate non-electrical heat demand in 2014. The final estimate will be reported in October 2016 when the 2014 data is available. See section 3 for more detail on this.

[3] These figures include legacy applications. Legacy applications were installed prior to April 2014.

During the update process for 2014 the assumptions used to estimate useful renewable heat output have been substantially revised, due to improved information relating to the largest heat generating sites in the database. As a result, all figures (back to 2010) have been revised to take account of this new methodology, so that progress towards the heat target can be more accurately monitored. Sections 2.4 and 5.4 discuss the changes made in more detail.

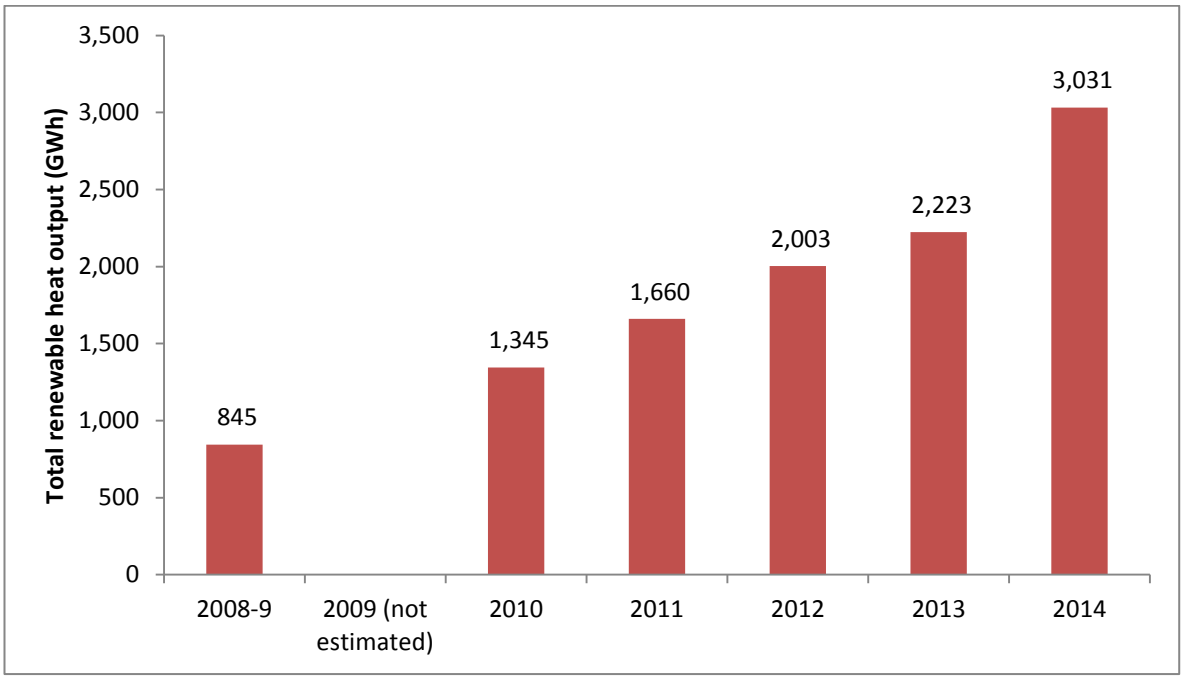
Figures 1 and 2 (below) show the change over time for both renewable heat capacity and output in Scotland (please note that data was not gathered for calendar year 2009)[4].

Figure 1. Estimated renewable heat capacity in Scotland (GW), 2008/09 - 2014



[4] All figures in the table for 2010 – 2013 have been amended to account for changes to the methodology for calculating heat output due to newly available information (see footnote 2).

Figure 2. Estimated renewable heat output in Scotland (GWh), 2008/09 – 2014



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 DECC on an annual basis. This monitoring methodology was first used in the 2012 report (published June 2013). See appendix 3 for more information on the difference between the current and previously used methodologies and how non-electrical heat demand is calculated.

Due to a time lag in the publication of the energy consumption data, the most recent year we have non-electrical heat demand figures for is 2013. For this report all historic heat output figures have been revised following the provision of more detailed and better information for the larger biomass sites. Progress towards the target has also been revised to account for these updates. For 2014, progress is shown against estimated non-electrical heat demand based on three scenarios that have been inferred from historic trends.[5]

Table 1 presents a summary of progress under the new heat target methodology. See section 3.1 for more detail on progress towards the targets.

[5] The three scenarios are that heat demand:

i. Average annual change (2008-2013)
ii. Same change as most recent year (2012-13)
iii. Stays constant (from 2013)

Table 1: Renewable heat target - renewable heat as a percentage of non-electrical heat demand[6]

Measure	2008/9	2009	2010	2011	2012	2013	2014
Total renewable heat output (GWh)	845	-	1,345	1,660	2,003	2,223	3,031
% of annual estimate of total non-electrical heat demand	**0.9%**	**-**	**1.5%**	**1.9%**	**2.4%**	**2.7%**	**3.7% - 3.8%**

The underlying database also includes information on district or 'communal' heating schemes throughout Scotland[7]. However, heat associated with these schemes which is not derived from a renewable source is not included in progress towards the renewable heat target.

[6] Figures above have been revised from those published in previous years' reports. See Appendix 3 for more information on the methodology for calculating non-electrical heat demand in Scotland.
[7] 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.

2. Methodology

2.1 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)[8] or megawatts (MW), rather than as GWth or MWth, to avoid confusion with the units of heat output (GWh). Installations are classified by their capacity, into large (1MW and above), medium (between 1MW and 45kW) and micro (less than or equal to 45kW) categories.

The second output required from the database is an estimate of useful renewable heat energy produced over the reported year (1 January 2014 to 31December 2014). Useful heat is the heat delivered to the end user or process, taking into account the technology efficiency. 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).[9]

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' 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 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

[8] 1GW = 1,000MW = 1,000,000kW.
[9] 1GWh = 1,000MWh = 1,000,000kWh.

obligations under these schemes. The data held by the CHPQA is confidential and so not available at site level. Full access to the non-domestic RHI data was also not available for the 2014 update.

As site level data for systems accredited under the domestic and non-domestic RHI schemes was not available at the time of writing this report, the Department of Energy and Climate Change (DECC) provided aggregated data for the schemes to the Energy Saving Trust for inclusion in this report. Analysis was carried out 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 DECC and those calculated from the EST dataset provide the most accurate measure of 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 5.1 and appendix 4.

In previous years the Forestry Commission Scotland (FCS) has conducted a woodfuel usage survey to determine the amount of woodfuel being used for heat generation purposes in Scotland. For this report we asked the FCS to also collate 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 1MW, as this had not been fully updated in previous years. The data received back from this survey is the best data we have to date for the useful heat output attributable to these sites. 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 results 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 2014 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 operating hours and which might therefore be higher.

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. Two thirds of the heat output recorded is from sites where fuel input or metered heat data is known.

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

[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.

size and the type of application the heat is used for (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 2.4. In all cases only the renewable portion of the heat output has been included in the figures reported.

Where possible, data has been checked against estimates provided by industry figures and/or trade bodies for the different sectors and technologies.

2.2 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 one):

- 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 (the first gas to grid site commissioned in December 2014 and so no heat output from this technology has been included in the 2014 figures).

Had examples been found, the following technologies could also have been included:

- Fuel cell biomass.
- Deep geothermal[13].

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]

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[12] Excluding the parasitic heat used to maintain the anaerobic digestion process.
[13] The Geothermal Energy Challenge Fund has provided grants to 5 projects to look at the feasibility of deploying this technology. Projects are still at a feasibility stage.

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.

Descriptions of all these technologies are provided in appendix 1.

2.3 Data sources used

The Energy Saving Trust has maintained and updated the renewable heat database for the Scottish Government on an annual basis since 2011. The estimate contained in this report for heat output in 2014 has been generated by a further update of the information held in the database. Effort has focused on updating information from the installations with the largest capacities and including data from the non-domestic RHI database.

Multiple sources of data were used to update the renewable heat database for 2014. The main sources used and the organisations which supplied them, are listed in table 2. 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 Hudson Consulting Ltd) contain estimates of all wood fuel usage for the year 2014, for large sites only.

[14] In line with assumptions used in the Department of Energy and Climate Change (DECC) RESTATS methodology, clinical waste is considered non-biodegradable and therefore non-renewable. Renewable Energy Statistics: Data Sources and Methodologies, Department of Energy and Climate Change. http://www.decc.gov.uk/en/content/cms/statistics/energy_stats/source/renewables/renewables.aspx

Table 2. Main datasets used for 2014 figures and estimates of future output

Organisation	Dataset
Department of Energy and Climate Change (DECC)	Aggregated non-domestic RHI data covering installations in Scotland– summaries of capacity and heat output for 2009-2015 inclusive, merged with EST data to generate a dataset of entries not already covered by EST database.
Forestry Commission Scotland (based on survey by Hudson Consulting Ltd)	Woodfuel demand and usage and estimated heat output in Scotland, 2014 (surveyed with some assumed values).
Ricardo-AEA, on behalf of the Department of Energy and Climate Change (DECC)	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].
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 planning authority planning departments via online searches.

2.4 Assumptions used

Converting biomass woodfuel use to heat output

For the majority of large- and medium-sized installations burning biomass wood for primary combustion or CHP, the main source of information available was estimates of wood fuel use from Hudson Consulting's annual survey of wood fuel use in Scotland for the Forestry Commission Scotland. Where metered data was not available, woodfuel useage figures were converted into estimates of heat output,

[15] https://restats.decc.gov.uk/cms/welcome-to-the-restats-web-site/
[16] http://www.energysavingtrust.org.uk/scotland/Publications2/Communities/Community-and-locally-owned-renewable-energy-PDF

based on the assumptions about combustion efficiency given in table 3. One oven-dried tonne (ODT) of wood at 30% moisture content is assumed to contain 4.92MWh of energy.[17]

For this report we have updated our assumed biomass efficiencies. In June 2015 Steve Luker Associates published the results of their analysis on *in situ* performance of biomass boilers[18]. One of the key findings from this study was that the biomass boilers included in the study performed below the expected efficiencies for their size and application (based on the data available). Although the data in the report does not represent a wide range of installations and sizes of boiler, in most cases the performance was not as expected. In consultation with Hudson Consulting Ltd we have therefore revised our biomass efficiencies to those given in table 3 below.

Table 3. Boiler efficiencies assumed for converting oven-dried tonnes of wood burnt to heat output

Installation size	Previously assumed boiler efficiency	Previously assumed MWh heat output per ODT burnt	New assumed boiler efficiency	New MWh heat output per ODT burnt
Large installations (>1MW, or >10,000 ODT)	90%	4.43	80%	3.94
Small to medium installations (45kW – 1MW, or <10,000 ODT) providing process heat	85%	4.18	80%	3.94
Small to medium installations (45kW – 1MW, or <10,000 ODT) providing space heating	80%	3.94	75%	3.69
Micro (≤45kW) (not MCS)[19]	-	-	70%	3.20
Domestic[20]	35%	1.74	-	-

Combined heat and power (CHP)

For biomass combined heat and power, metered heat figures (or otherwise measured 'actual' heat figures) reported to the FCS or directly to the Energy Saving Trust have been used. The metered data

[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] This is a newly added category. Previous boiler efficiencies and assumed heat output per ODT were unavailable
[20] This factor has been used in previous versions of the report. However due to efforts to reduce double counting with MID or RHI data there are no longer records in the database that use this figure. Efficiency reflects average system installed in a domestic situation whereby 90% are assumed to be open fires

provided prompted a review of the calculation used to estimate useful heat output for biomass CHP sites where no metered data is available. The calculation used in previous years to work out the estimated heat energy produced from a known weight of oven-dried wood is shown in section 5.4, along with an explanation of the changes made for this year's report.

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

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

Using known information to determine missing values

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

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

- Capacity per m2: 0.7kW, from the Solar Trade Association.

- Useful heat output per m2: 0.441MWh, derived from SAP 2012 calculations for all regions in Scotland.[21]

Energy from waste

In line with assumptions used in DECC's RESTATS methodology,[22] municipal solid waste (MSW) is considered to contain 63.5% biodegradable waste. Therefore an installation producing heat from burning municipal solid waste will have 63.5% of its capacity and output recorded as renewable heat in the database. This assumption has been used for a number of years and it is assumed that this value will decrease as the amount of biodegradable material in MSW reduces (due to increases in recycling rates). However no reliable source has yet been found to justify a reduced percentage for this figure.

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. This assumption is the same as that used last year as no update has been found for this figure.

Operating status

In certain circumstances assumptions have been made about the operating status of projects. If information for a project has been found in previous years but no further information has been found for the 2014 update the following assumptions have been made:

Table 5. Status change map for 2013 to 2014

2013 status	New information available	2014 status
'In scoping'	None	'In scoping'
'In scoping' or 'In planning'	Planning permission granted	'Consented, not built'
'Under construction'[23]	None	'Under construction'
'Unknown'	None	'Unknown'

2.5 Accounting for sites that commissioned part-way through 2014

Most new additions to the renewable heat in Scotland database have only been operational for part of 2014. Where commissioning date is known, this has been used to determine the portion (in percent) of 2014 for which the site has been operational. Where commissioning date is not known, an estimate has been used, based on when the data was collated and what information was given at the time. The

[21] This assumption has changed from 2013 when 0.34MWh per m^2 was used. This is due to revisions to SAP.
[22] Renewable Energy Statistics: Data Sources and Methodologies, Department of Energy and Climate Change. http://www.decc.gov.uk/en/content/cms/statistics/energy_stats/source/renewables/renewables.aspx
[23] This is different to the report published in June 2014 (regarding heat output in 2013) for which the status of these projects would be updated to 'operating' automatically. This year's method is now consistent with the way the 'Community and locally owned renewables in Scotland' database is updated. As the 'Community and locally owned renewables in Scotland' database contributes significantly to the data in the renewable heat database, it makes sense to align the status update process.

estimated annual heat output for each site has been multiplied by the portion of 2014 for which it was operational.

3. Renewable heat capacity and renewable heat output in 2014

3.1 Results for 2014

In 2014, **3,031GWh** of heat was produced from renewable sources, from an installed capacity of **1.022GW.**

In 2014 Scotland produced enough heat from renewable sources to meet between 3.7% and 3.8% of non-electrical heat demand. The final estimate will be reported in October 2016 when the 2014 data is available.

The improvements to the data (set out at the end of this section) have been applied to the full times series. This has resulted in revisions to the target figures for previous years. **In 2013, the equivalent of 2.7% of non-electrical heat demand was met from renewable sources, up from 2.4% in 2012**.

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 DECC on an annual basis. This monitoring methodology was first used in the 2012 report (published June 2013). See appendix 3 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 2014. These scenarios are based on published final sub-national energy consumption figures from DECC[24] and have allowed us to present the target progress shown in table 6. The three scenarios calculated were:

- Scenario 1 – assuming heat demand between 2013 and 2014 reduces by the average annual reduction seen between 2008 and 2013 (low heat demand).
- Scenario 2 - applying the 2012-13 percentage heat demand reduction for 2013-14 (medium heat demand).
- Scenario 3 - assuming heat demand does not change from 2013 (high heat demand).

Table 6 also shows progress against the previous measure for reference.

[24] See 2005-2013 figures here: https://www.gov.uk/government/statistical-data-sets/total-final-energy-consumption-at-regional-and-local-authority-level-2005-to-2010

Table 6: Renewable heat target - renewable heat as a percentage of heat demand[25]

	2008/ 2009	2009	2010	2011	2012	2013	2014
Total renewable heat output (GWh)	845	-	1,345	1,660	2,003	2,223	3,031
New measure: % of annual estimate of total non-electrical heat demand	0.9%	-	1.5%	1.9%	2.4%	2.7%	-
Progress - scenario 1 (low demand)							*3.8%*
Progress - scenario 2 (medium demand)							*3.8%*
Progress - scenario 3 (high demand)							*3.7%*
New heat demand measure (GWh)	95,271[26]	87,046	89,270	86,374	83,836	82,136	-
Heat demand scenario 1 (average annual change 2008-2013)							*79,788*
Heat demand scenario 2 (same change as 2012-13)							*80,471*
Heat demand scenario 3 (same as 2013)							*82,136*
Previous measure: % of forecast 2020 non-electrical heat demand	1.4%	-	2.2%	2.8%	3.3%	3.7%	5.0%
Previous 2020 heat demand estimate	*60,089*	*60,089*	*60,089*	*60,089*	*60,089*	*60,089*	*60,089*

Between 2013 and 2014 the overall renewable heat output from operational sites in Scotland increased by 808GWh, which is an increase of 36% on the previous year (2,223GWh). A significant portion of this increase was due to the useful renewable heat provided by RWE Markinch to the Tullis Russell paper mill.

The increase in capacity between 2013 and 2014 was 0.304GW (304MW), which is an increase of 42%. The majority of this increase was seen in the 'biomass (wood)' technology category, reflecting a continued interest in this technology in Scotland. Annual figures for capacity and useful renewable heat output since 2008/09 can be seen in figures 4 and 5. All figures from 2010 to 2014 have been amended to take account of the new methodology used for this report (see sections 2.4 and 5.4 for details).

[25] See Appendix 3 for more information on the methodology for calculating non-electrical heat demand in Scotland.
[26] This non-electrical heat demand figure is for 2008.

Figure 3. Estimated renewable heat capacity in Scotland (GW), 2008/09 - 2014

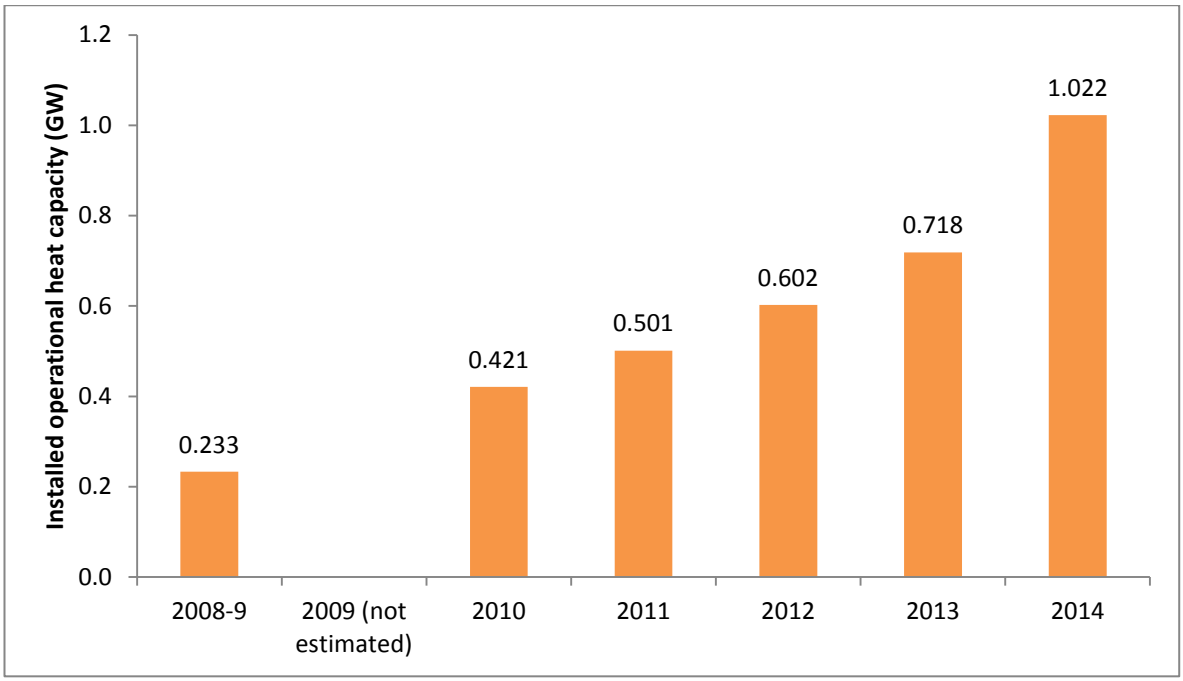


Figure 4. Estimated renewable heat output in Scotland (GWh), 2008/09 – 2014

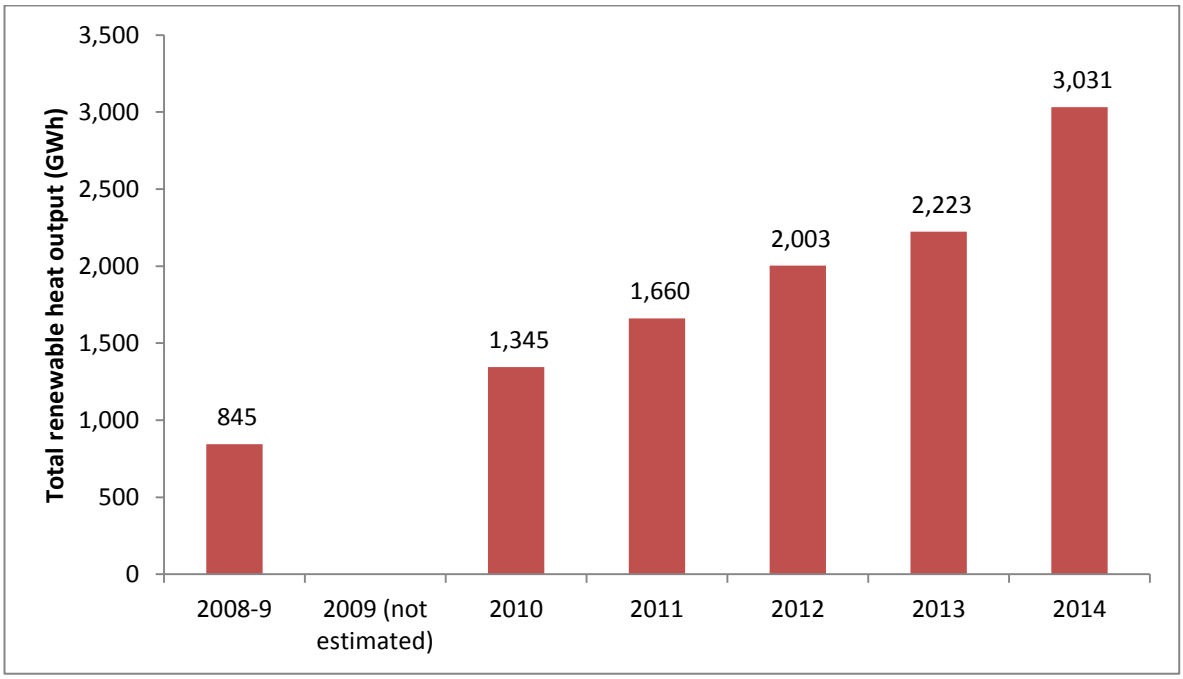
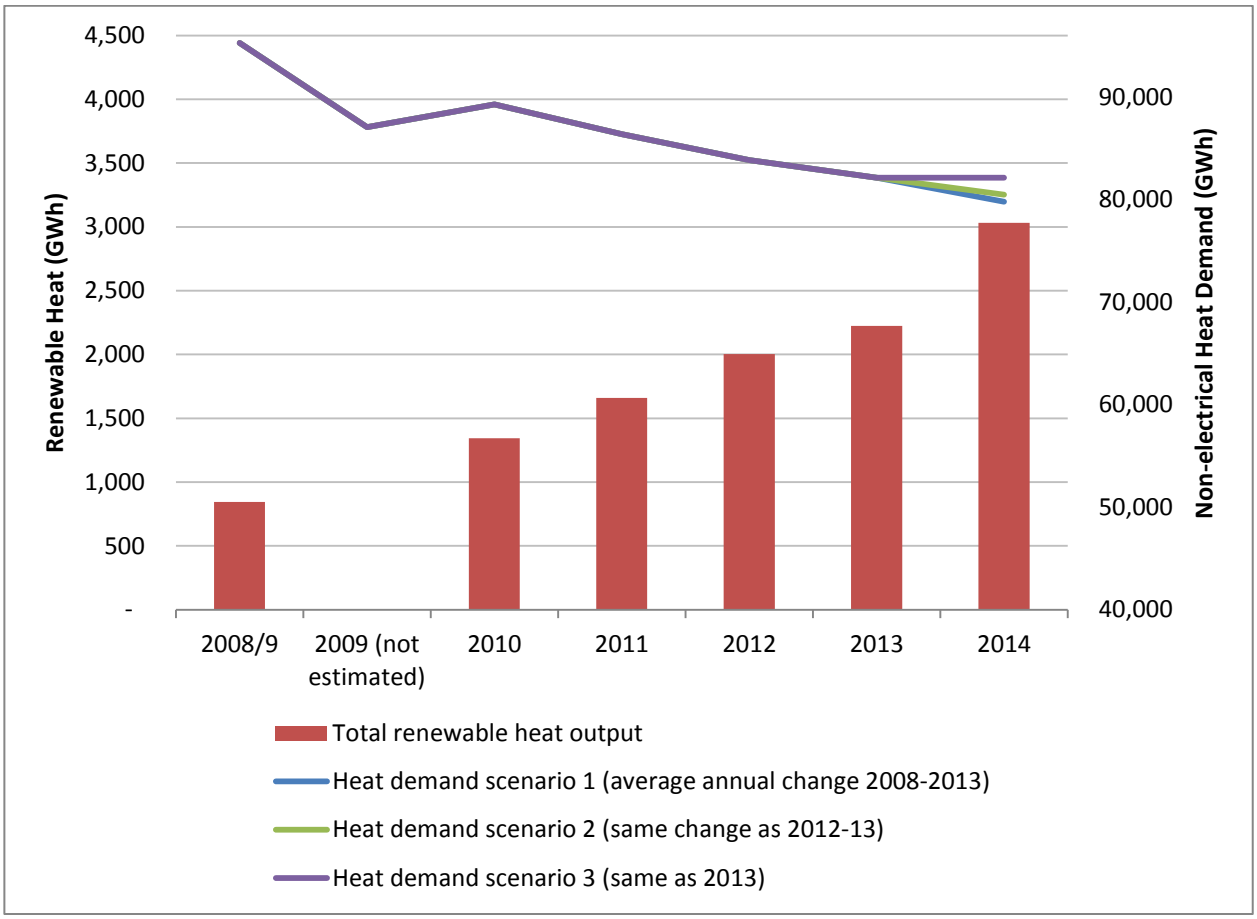


Figure 5. Estimated renewable heat output and non-electrical heat demand in Scotland, 2008/9-2014



The majority of renewable heat output in 2014 continues to come from large (1MW+) installations (see table 7). There are 7 sites that generate more than 100GWh heat per year; together these sites provided 55% (1,680GWh) of the total renewable heat output in Scotland in 2014 and 31% (0.321GW) of the operational renewable heat capacity.

In total, large installations (all sites with capacity of 1MW or more) contributed 48% of the renewable heat capacity and 77% of the annual output. However, they represent only 0.4% of the number of installations. This emphasises the requirement to ensure that data for these sites continues to be improved upon as small changes in the information used for any one of these sites will result in potentially significant changes to the heat output total.

In addition, 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 for 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.

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

Size category	Renewable heat capacity (GW)	% Renewable heat capacity	Annual output (GWh)	% Annual output	Number of installations (rounded to the nearest 10)	% Number of installations
Large (1MWth+)	0.488	48%	2,329	77%	50	0.4%
Small to medium (>45kWth and <1MWth)	0.340	33%	381	13%	1,180	11%
Micro (≤45kWth)	0.194	19%	321	11%	9,670	89%
Unknown	<0.001	0%	<1	0%	<10	0.0%
Total	**1.022**	100%	**3,031**	100%	**10,900**	100%

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

Table 8. Renewable heat capacity and output in Scotland, 2013 (output and capacity revised from that reported in 2013 to account for methodology changes and addition of RHI data)

Size category	Revised renewable heat capacity (GW)	% Renewable heat capacity	Revised annual output (GWh)	% Annual output	Revised number of installations (rounded to nearest 10)	% Number of installations
Large (1MWth+)	0.391	54%	1,671	75%	40	0.4%
Small to medium (>45kWth and <1MWth)	0.183	25%	259	12%	970	11%
Micro (≤45kWth)	0.145	20%	292	13%	7,500	87%
Unknown	<0.001	0%	<1	0%	160	1.9%
Total	**0.718**	100%	**2,223**	100%	**8,670**	100%

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

The key points to take from tables 7 and 8 are:

- Small to medium (>45kWth and <1MWth) systems make up 11% of the overall renewable heat installations in Scotland (by number). Capacity from these systems almost doubled between 2013 and 2014 to 0.340GW and output grew by 47%.

- Micro heat capacity increased by 36% between 2013 and 2014. Since 2008/9 capacity has more than trebled (from 0.045GW) and output has increased by 131% (from 139GWh). Although the 2014 figure is likely to be an underestimate of the total number of installations in this category in Scotland, it does show the impact of the domestic RHI (and RHPP scheme) on this sector. The increase in output between 2008/9 and 2014 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, this could be impacted by a large number of micro installations having only been operational for part of 2014.

- The capacity of 'large' systems also increased by almost 25% (up by 97MW from 391MW). This is largely due to improved information provided by the FCS and additions made to the overall total from the non-domestic RHI aggregate tables provided by DECC.

Methodological changes to note:

Since last year's report (2013) the methodology used to calculate heat output has been revised due to:

- Improved information from the Forestry Commission Scotland's woodfuel usage survey.
- Revised biomass operating efficiencies.
- Receipt of aggregated data from the non-domestic RHI scheme.

More detail on points 1 and 2 can be found in the methodology section (2.4) above. A description of the analysis undertaken to merge the data with the non-domestic RHI dataset can be found in appendix 4.

This improved information has been used to revise previous years' figures, back to 2010 (inclusive). The 2008/09 figure has not been amended as this figure was provided by research carried out by the Sustainable Development Commission. The revisions made to the data have resulted in lower figures than those reported previously. However since the revisions have been applied to all years, we are able to show year-on-year progress without a break in the methodology. The figures included in this report represent the most accurate estimate of Scotland's non-electrical heat demand to date.

3.2 Results by technology

The majority of both output and capacity in 2014 came from biomass primary combustion and biomass combined heat and power (table 9, and figures 6 and 7). 84% 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[27], as well as from previous years' renewable heat in Scotland reports[28].

Tables 9 and 10 and figures 6 and 7 show the breakdown of renewable heat capacity and renewable heat output operational in Scotland in 2014:

Table 9. Renewable heat output and capacity in Scotland, 2014, by technology[29]

Technology	Renewable heat capacity (GW)	% Renewable heat capacity	Annual output (GWh)	% Annual output
Biomass	0.647	63%	1,716	57%
Biomass CHP	0.217	21%	965	32%
Energy from waste	0.043	4%	171	6%
Heat pump	0.085	8%	165	5%
Solar thermal	0.030	3%	15	<1%
Unknown	-	-	-	-
Total	**1.022**	100%	**3,031**	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 10 below.

Table 10. Renewable heat output and capacity in Scotland, 2014, energy from waste technologies

EfW Technology	Renewable heat capacity (GW)	% Renewable heat capacity	Annual output (GWh)	% Annual output
Energy from waste - advanced conversion technologies[30]	0.031	3%	90	3%
Energy from waste - incineration	0.010	1%	80	3%
Energy from waste - landfill gas	0.002	0%	1	<0.1%
Total	**0.043**	**4%**	**171**	**6%**

[27] See DECC's website : https://www.gov.uk/government/collections/renewable-heat-incentive-statistics for monthly updates on both schemes.
[28] http://www.energysavingtrust.org.uk/reports
[29] Totals may not match column sums due to rounding.
[30] 'Advanced conversion technologies' includes anaerobic digestion, gasification and pyrolysis.

Figure 6. Renewable heat capacity in Scotland, 2014, by technology

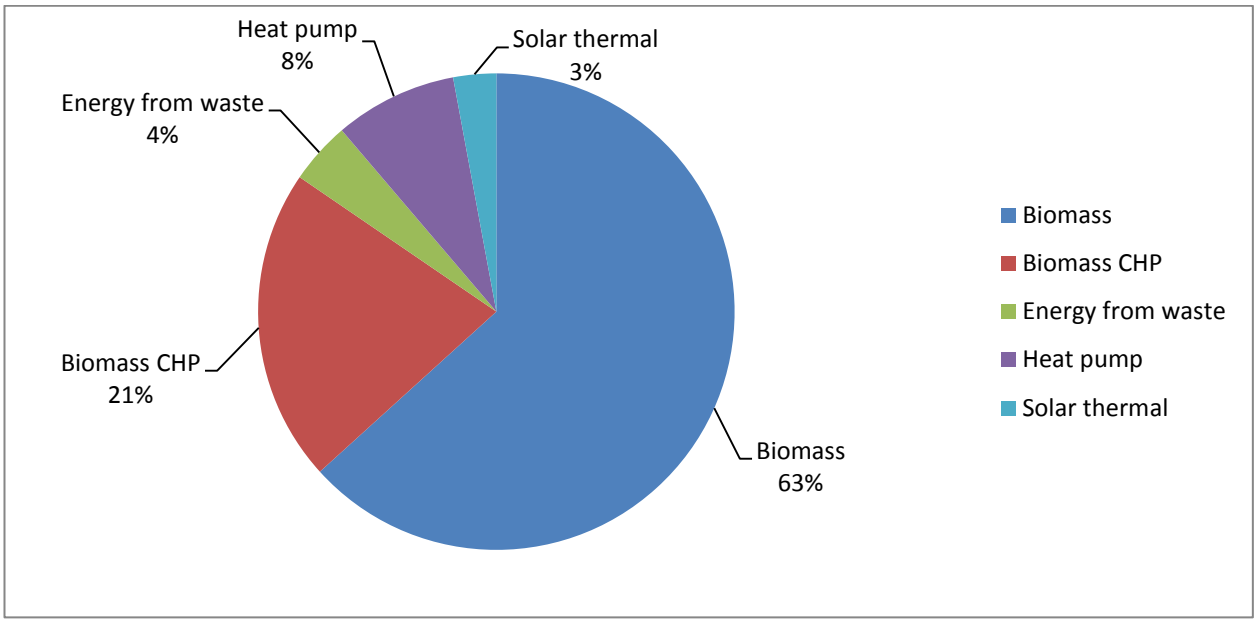
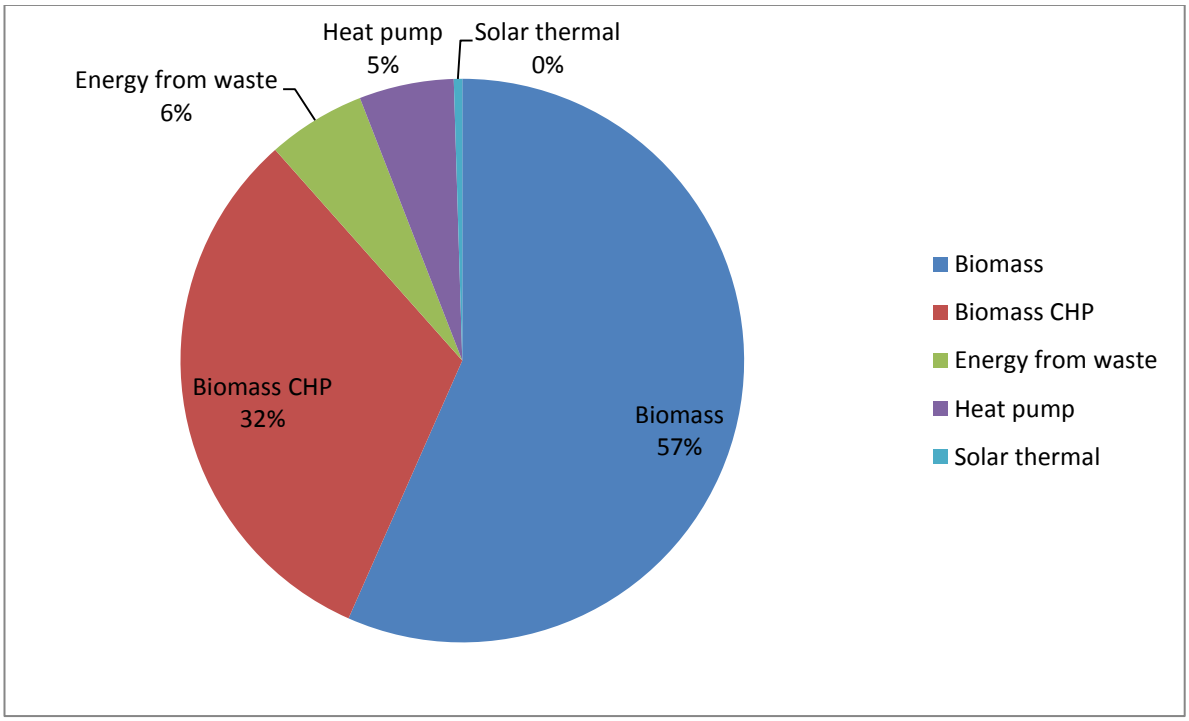


Figure 7. Renewable heat output in Scotland in 2014, by technology



Energy from waste continues to grow in deployment in Scotland, with on-site anaerobic digestion and other advanced conversion technologies (such as gasification or pyrolysis) being used by some of Scotland's largest food and drinks manufacturers[31], as a way of making efficient use of waste created on site. Energy from waste, including advanced conversion technologies as well as incineration, now accounts for 4% of Scotland's renewable heat capacity and 6% of renewable heat output (compared to 2% and 5% respectively in 2013 according to revised figures).

Less noticeable in the figures is the large increase in the number of heat pumps from 2013 to 2014. According to the MSC Installation Database (MID) extract provided by MCS, over 4,000 new micro heat pumps were installed in Scotland in 2014. This resulted in an increase in capacity of 18MW (up by 27% from 2013).

Innovative projects such as those funded through the Low Carbon Infrastructure Transition Programme (LCITP), District Heating Loan Fund, Local Energy Challenge Fund (LECF) and Geothermal Challenge Fund (GCF) may increase the contribution from non-biomass technologies in the short to medium-term, if the projects come to fruition. More information on the types of projects being supported under these funds is available in section 4: 'Further renewable heat capacity in development'.

3.3 Results by size and technology

Biomass primary combustion is currently the only renewable heat technology within the database that has a noticeable spread over the different size categories (large, small to medium and micro). Almost all biomass CHP and Energy from waste sites are within the 'large' size bracket, whereas solar thermal and heat pumps are almost entirely within the 'micro' size bracket. A breakdown of technology and size (as percent of the overall total for each technology) is shown in figures 8 and 9 below:

[31] For example, see the Scotch Whisky Association's case studies for some of Scotland's largest distillers: www.scotch-whisky.org.uk/what-we-do/case-studies

Figure 8. Capacity by size and technology (% of total technology operational capacity), 2014

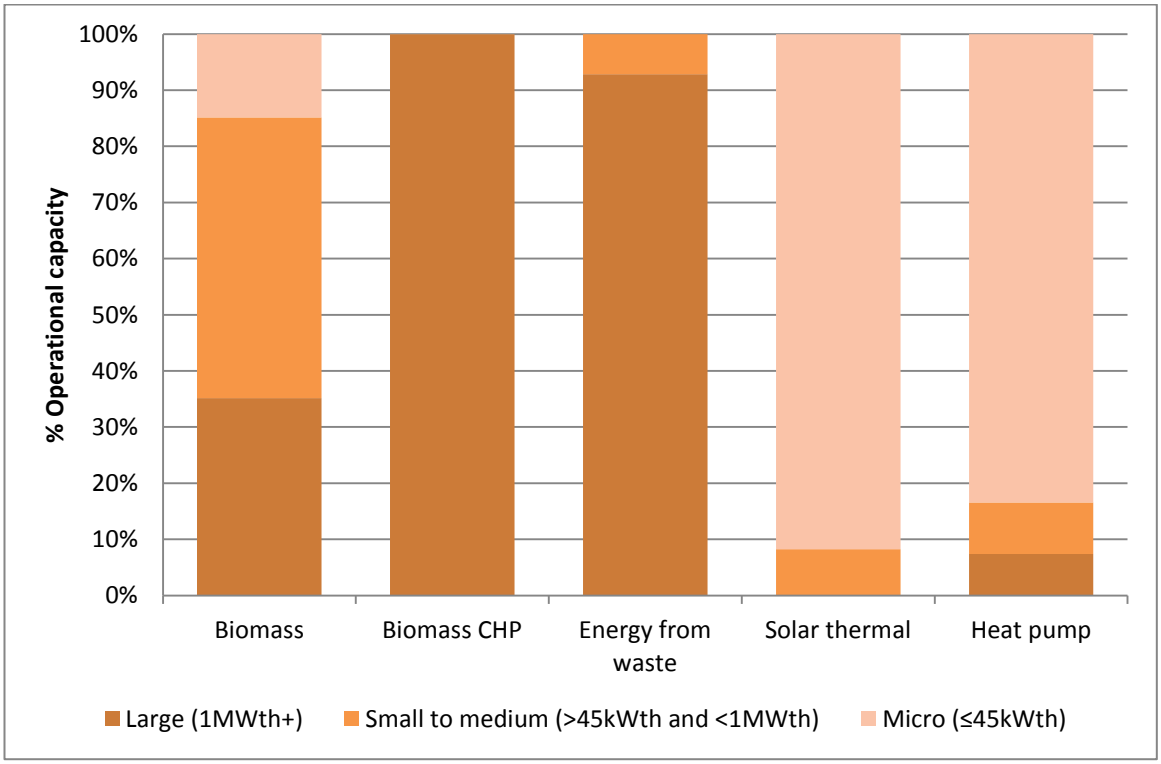
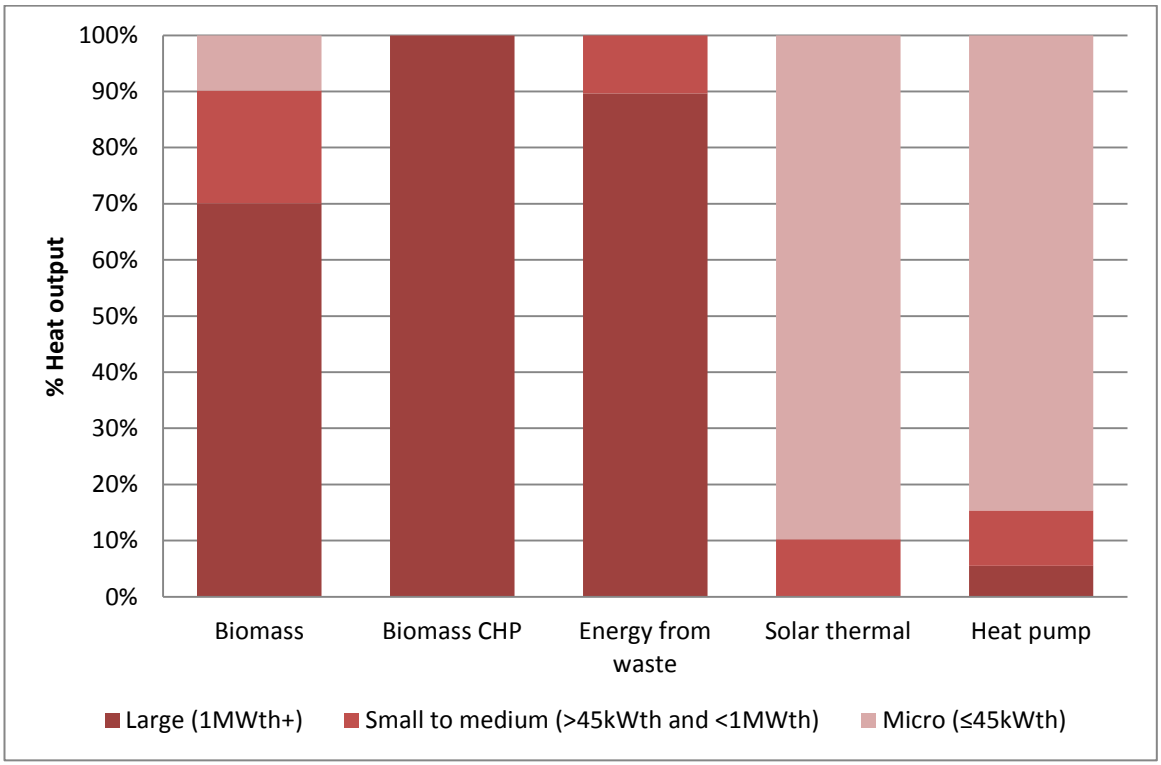


Figure 9. Output by size and technology (percent of total technology heat output), 2014



3.4 Change in output and capacity by technology since 2013

Three notable developments since 2013 account for significant differences in renewable heat output and operational capacity between 2013 and 2014, after the revisions to methodology mentioned above have been taken into account and RHI data added. These developments are discussed below:

3.4.1 Biomass primary combustion:
The estimated capacity and output of biomass (non-CHP) have increased by 65% and 37% respectively. A large portion of this increase is accounted for by the additional capacity and output added to the totals from the aggregated RHI data provided by DECC. Small and medium sized biomass systems are popular technologies for use on farms and estates[32], as well as in the public sector, for example NHS Scotland has had a wide roll-out of biomass systems across its property portfolio.

3.4.2 Biomass CHP:
Biomass CHP capacity has been amended for 2013 and 2014 due to improved information from the FCS woodfuel survey for 2014. The overall increase in output from this technology has risen by 42% since 2013. This is largely due to the RWE Markinch site selling heat to the Tullis Russell paper mill for the majority of 2014. However, the paper mill went into financial administration in Spring 2015 and so the 2015 output for this technology category will be affected.

3.4.3 Energy from waste:
Increases seen for this technology in capacity and output are attributable to continued uptake of energy from waste technologies (largely anaerobic digestion) in the agricultural and food and beverages sectors.

A summary of all changes since 2013 by technology is given in table 11.

[32] This trend can be clearly seen in the "Community and locally owned renewables in Scotland, 2014" (EST, 2015) report, as well as in the publically available RHI deployment statistics published by DECC.

Table 11. Changes in renewable heat output and capacity in Scotland from 2013 to 2014, by technology (capacity rounded to nearest MW and output rounded to nearest GWh)

Technology category	2014 Total capacity (GW)	Change since 2013 (GW)	Percentage change	2014 Total annual output (GWh)	Change since 2013 (GWh)	Percentage change
Biomass	0.647	+0.256	+65%	1,716	+462	+37%
Biomass CHP	0.217	+0.003	+1%	965	+285	+42%
Energy from waste[33]	0.043	+0.027	+167%	171	+49	+41%
Heat pump	0.085	+0.018	+27%	165	+12	+8%
Solar thermal	0.030	+0.000	+1%	15	+0	+3%
Total	**1.022**	+0.304	+42%	**3,031**	+809	+36%

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

The comparatively large increase in CHP output, compared to the much smaller increase in capacity, is due to some large sites operating for the full 2014 year when they were only operational for part of 2013.

3.5 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 (1MW+) or small and medium (>45kW and <1MW) size categories. Information on each local authority is not available for micro (≤45hWth) installations as location information for these records has not been disclosed to the Energy Saving Trust from MCS (used from 2012 onwards), and is not available for aggregated data from previous schemes (used for 2008/9-2011).

The key findings from looking at the non-micro installations by local authority area are:

- **Highland** accounted for **18% of Scotland's total heat output** in 2014 (539GWh) and has **13% of the overall operational capacity** (0.131GW).
- **71%** of the 2014 heat output came from just **7 areas**, each of which contributed **over 100GWh** of renewable heat in 2014 (East Ayrshire, Fife, Highland, Moray, North Ayrshire, South Ayrshire, Stirling).

[33] 'Energy from waste' includes incineration as well as advanced conversion technologies and landfill gas.

Table 12. Heat output and capacity by local authority area, Scotland, 2014 (not including micro-generation installations)[34].

Local authority area	Renewable heat output, 2014 (GWh)	Operational renewable heat capacity, 2014 (GW)
Aberdeen City	7	0.002
Aberdeenshire	49	0.016
Angus	14	0.005
Argyll and Bute	21	0.007
Clackmannanshire	#	#
Comhairle nan Eilean Siar	4	0.002
Dumfries and Galloway	59	0.018
Dundee City	#	#
East Ayrshire	163	0.020
East Dunbartonshire	#	#
East Lothian	5	0.002
East Renfrewshire	#	#
Edinburgh, City of	36	0.008
Falkirk	11	0.001
Fife	395	0.082
Glasgow City	4	0.002
Highland	539	0.131
Inverclyde	#	#
Midlothian	10	0.003
Moray	133	0.018
North Ayrshire	318	0.099
North Lanarkshire	42	0.008
Orkney Islands	3	0.001
Perth and Kinross	43	0.013
Renfrewshire	13	0.009
Scottish Borders	18	0.006
Shetland Islands	24	0.003
South Ayrshire	116	0.016
South Lanarkshire	14	0.005
Stirling	495	0.068
West Dunbartonshire	#	#
West Lothian	2	0.001
Local authority unknown	482	0.472
TOTAL	**3,031**	**1.022**

[34] # Marks where fewer than 5 installations are recorded in an area this information has been withheld to avoid disclosing information about individual sites.

Figure 10. Map showing operational renewable heat capacity by local authority area, 2014

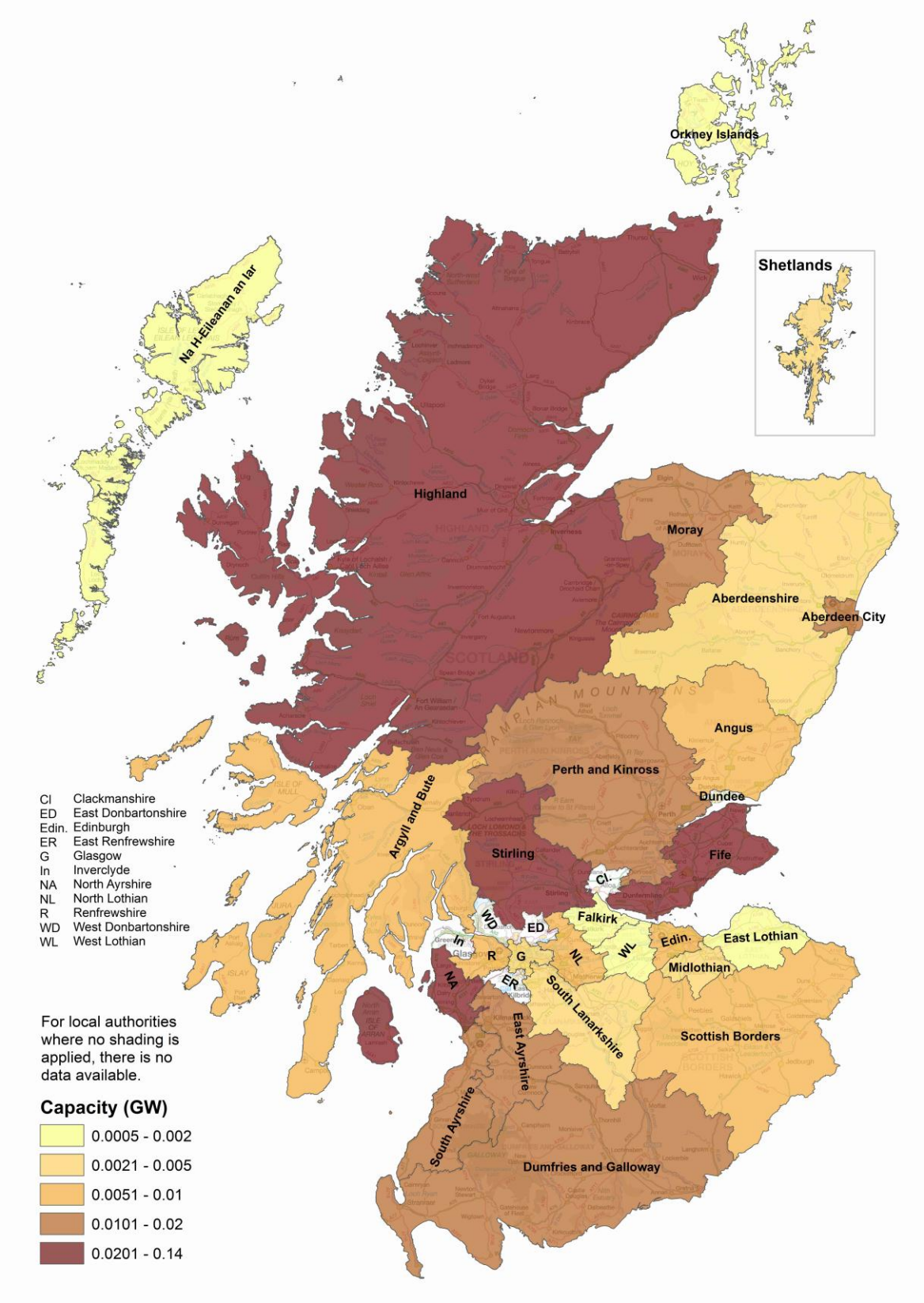
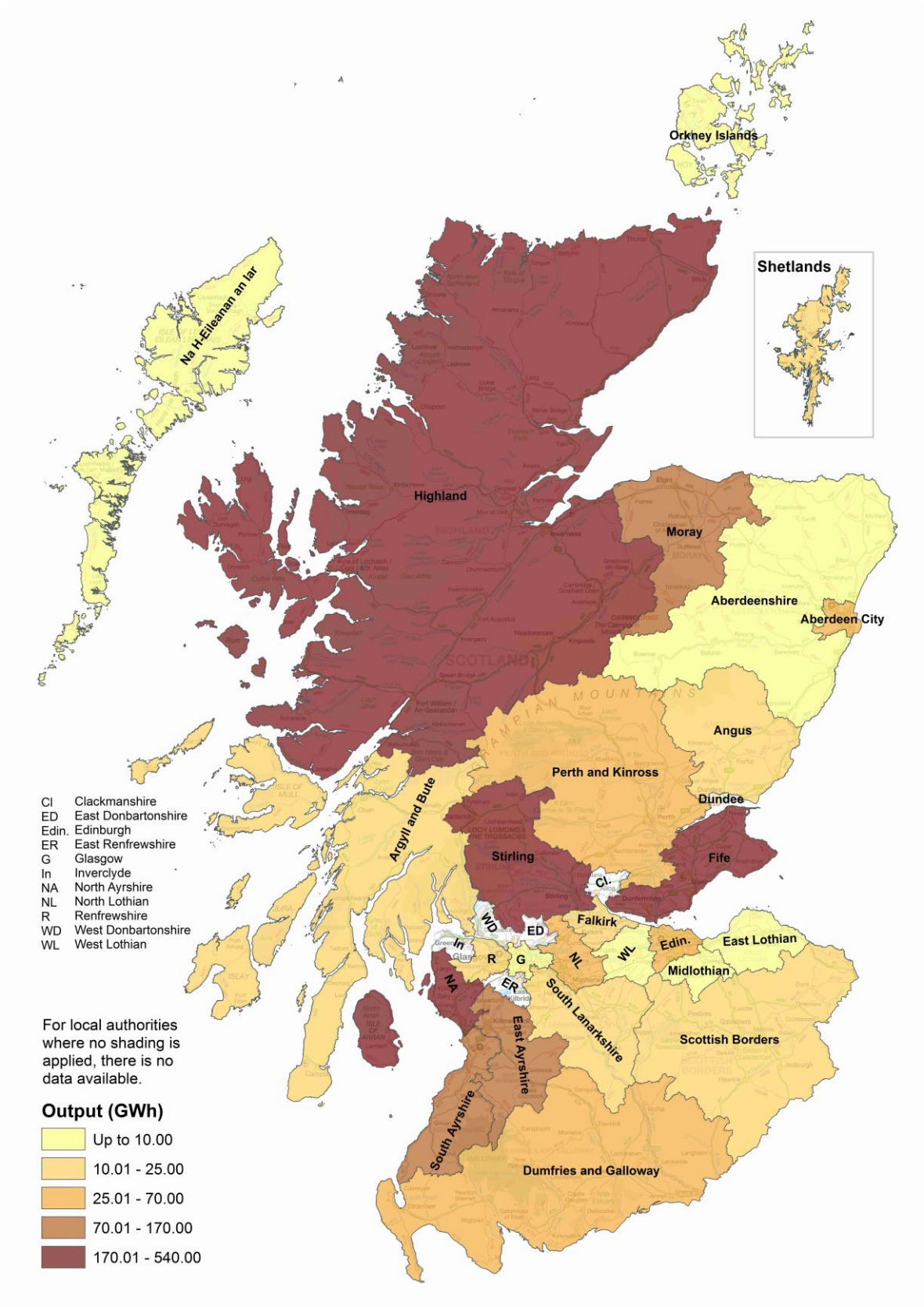


Figure 11. Map showing operational renewable heat output by local authority area, 2014



Aggregated RHI scheme data provided by DECC to the Energy Saving Trust does not show local authority area as doing so would risk disclosing information about individual sites (combined with the other data provided). Therefore, in the table above, 16% of the overall heat output and 45% of the overall capacity reported for 2014 is not assigned to a local authority. A breakdown of number and capacity of accreditations under the non-domestic RHI is available from DECC[35] but has not been included in this report to avoid confusion.

As mentioned above, the EST database does not record local authority area for microgeneration technologies. However, DECC do publish tables of domestic RHI accreditation numbers by local authority area. The data for Scotland from the December 2014 data is given below in table 13.

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

Table 13. Number of installations by local authority area accredited in Scotland under the domestic RHI scheme as of December 2014[36]

Local Authority Area	Number of installations	% Installations
Aberdeen City	24	1%
Aberdeenshire	273	9%
Angus	71	2%
Argyll & Bute	181	6%
Clackmannanshire	11	<1%
Dumfries & Galloway	179	6%
Dundee City	48	2%
East Ayrshire	55	2%
East Dunbartonshire	15	1%
East Lothian	65	2%
East Renfrewshire	11	<1%
Edinburgh, City of	23	1%
Na h-Eileanan an Iar	129	4%
Falkirk	23	1%
Fife	142	5%
Glasgow City	#	-
Highland	592	20%
Inverclyde	*	-
Midlothian	24	1%
Moray	117	4%
North Ayrshire	31	1%
North Lanarkshire	17	1%
Orkney Islands	96	3%
Perth & Kinross	212	7%
Renfrewshire	19	1%
Scottish Borders	160	5%
Shetland Islands	59	2%
South Ayrshire	53	2%
South Lanarkshire	167	6%
Stirling	134	4%
West Dunbartonshire	9	<1%
West Lothian	49	2%
Total	**3,000**	**100%**

These data show that the Highland local authority area is leading in the deployment of microgeneration systems, with 20% of the domestic RHI installations in Scotland located in this area.

[36] # Marks where fewer than 5 installations are recorded in an area this information has been withheld to avoid disclosing information about individual sites.
* refers to values greater than 5 which have been supressed where only one other value within the group was suppressed to prevent disclosure. The total number of the supressed values relating to installations is 88. (source: DECC Non-Domestic RHI and Domestic RHI monthly deployment data: June 2015)

Aberdeenshire, Argyll and Bute, Dumfries and Galloway, Perth and Kinross, Scottish Borders and South Lanarkshire all had over 100 domestic RHI accreditations as of December 2014. Since December 2014 the domestic RHI has continued to incentivise uptake in all eligible technologies. Please refer to section 4.2 for further commentary on the trends seen in both the domestic and non-domestic RHI between December 2014 and August 2015.

4. Further renewable heat capacity in development

4.1 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 in a way to show the current situation 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); in planning (where planning application or otherwise has been submitted, but with no formal approval yet received) and in scoping (where the project is in its initial phase).

It is estimated that as of December 2014:

- 0.349GW of renewable heat capacity was in one of the development stages, potentially contributing a further 1.621GWh of renewable heat output.

- If all the projects in development are completed the total renewable heat capacity in Scotland would be 1.371GW and output could increase to 4,652GWh per year - a 25% increase in capacity and 35% increase in output.

These figures can be used to provide an estimate of future renewable heat output in Scotland, although there is inherently a large degree of uncertainty around such figures. Furthermore there is also no guarantee that all possible projects are captured within the scope of this database. These two uncertainties should be taken into account when the data presented here are interpreted.

Figure 12: Capacity of the technologies in development

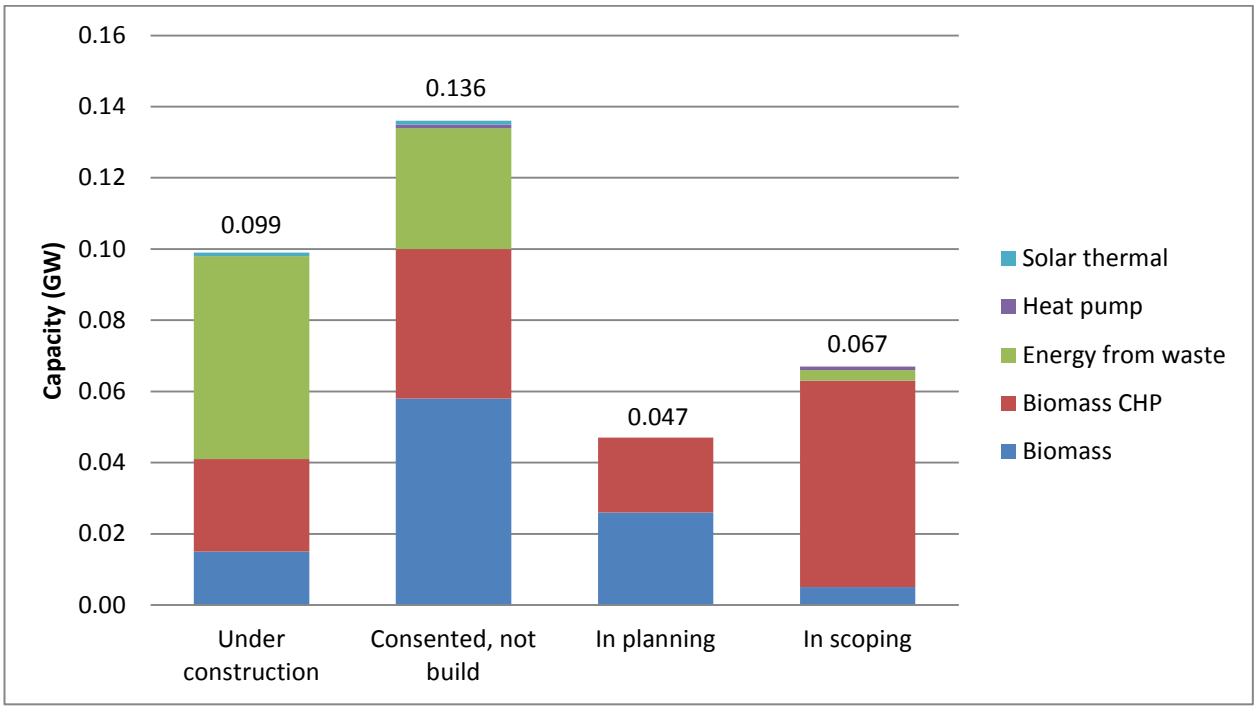
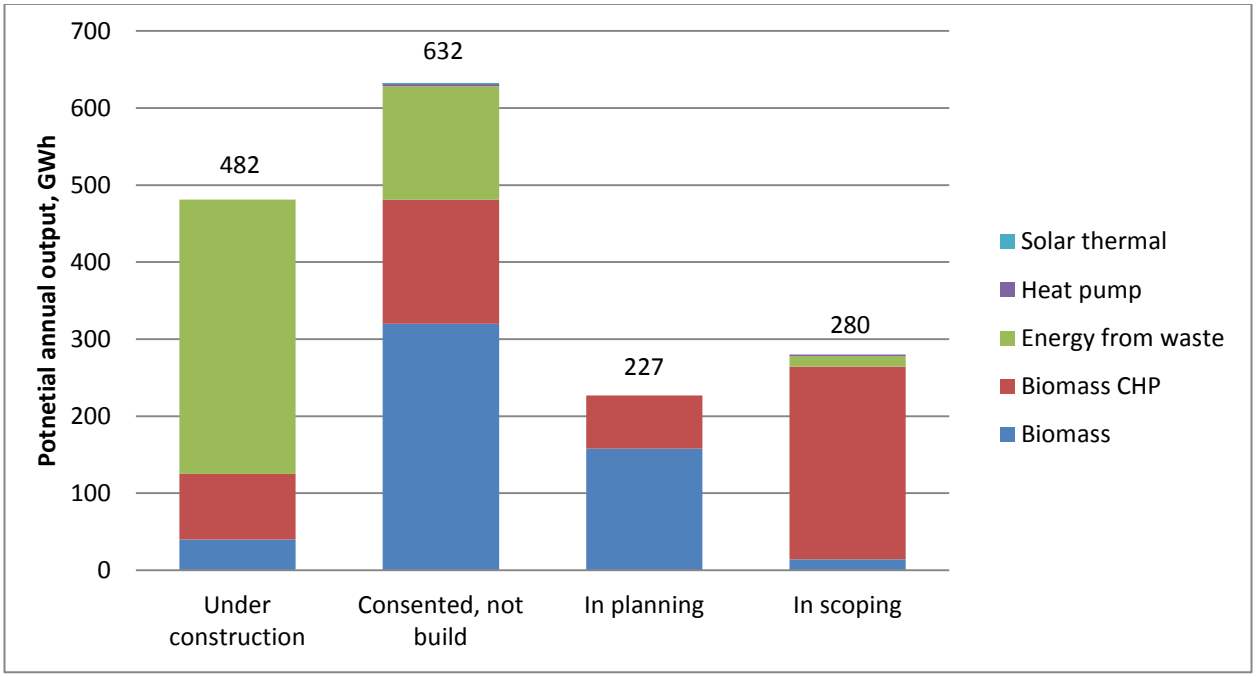


Figure 13: Output of the technologies in development



Projects ‘under construction’ have a total capacity of 0.099GW and an estimated heat output of 482GWh. The technology with highest contribution to this is energy from waste, for both capacity and output. This includes the Polmadie energy from waste site near Glasgow and Viridor’s new plant in Dunbar.

The ‘consented, not built’ projects have a total capacity of 0.136GW with an estimated heat output of 632GWh. Here, the most prominent technology is biomass with 0.058GW capacity, followed by biomass CHP and energy from waste with 0.042 and 0.034GW capacity respectively. There are a few projects in the pipeline that contribute significantly to these numbers, including the Speyside biomass CHP plant which is being developed by Estover energy which will supply heat to the nearby Macallan distillery in Moray[37].

A further 0.047GW of heat capacity was in the ‘planning’ phase as of December 2014, with the highest contributors being biomass and combined heat and power stations. This would generate a further 277GWh of heat output. It is interesting to note that as of December 2014 there was no capacity in planning for further energy from waste sites, however an application was submitted in March to upgrade an existing waste recycling facility in Glasgow to incorporate an energy recovery facility.

The projects currently in scoping could provide another 280GWh of heat. However, these numbers should be treated with caution as:

- It is not known how many of these projects will ultimately become operational.
- Numbers are likely to be an underestimate as not all projects in scoping will have been captured in the renewable heat database. In particular the Renewable Energy Planning database (REPD) has stopped monitoring projects with a capacity less than 1MW. This has had a detrimental impact on our ability to monitor the small and medium scale projects (>45kWth and <1MWth) that, as seen in section 3 above make up a significant portion of the renewable heat capacity and output in Scotland.

4.2 Trends seen in the RHI monthly statistics

Since December 2014, there has been a steady increase in the number of full applications[38] under the non-domestic RHI scheme and a very large increase in applications under the domestic scheme. Between December 2014 and August 2015 the schemes have seen[39]:

[37] See http://speysiderenewableenergy.co.uk/ for further information.
[38] Under the non-domestic RHI ‘Full application’ refers to applications that are not preliminary. This means that the site will have been commissioned, but can be either accredited or currently going through the accreditation process.
[39] Numbers of installations have been rounded to the nearest 10 for ease of reading

- 24% increase in the number of non-domestic RHI 'full applications' in Scotland, with a 16% increase in capacity.

- 169% increase in accreditations for systems in Scotland under the domestic RHI.

- 335% increase in the number of air source heat pumps accredited under the domestic RHI (from 840 as of December 2014 to 3,190 as of August 2015).

- The number of domestic ground source heat pumps accredited under the domestic RHI from December 2014 to August 2015 has grown 85%, from 410 to 760 systems.

- There has been a steady increase in the uptake of domestic biomass, with accreditations increasing by 119% from 1,260 to 2,760 over the 8 month period to August 2015.

In the first six months of 2015, the non-domestic RHI has paid for more renewable heat than the total paid for in 2014. This follows the trend seen between 2013 and 2014 where the amount of heat paid for in 2014 was 2.5 times the amount of heat paid for in 2013[40]. We are unlikely to see a doubling of the overall output shown in this report over the next year, due to the dominance of the 7 very large sites as mentioned in section 3.1 (accounting for 13% of capacity and 55% of heat output in 2014), which are already assumed to be operating at full capacity.

For the non-domestic scheme tables showing the capacity and heat paid for under different technology categories are not available by region, so determining the trend in Scotland is less clear than with the domestic scheme. However, the general trend across all regions (England, Wales and Scotland) is for continued interest in biomass (small and medium systems). Interest in large ground and water source heat pump technologies is increasing steeply, despite very small overall numbers; the total number of full applications under this technology category was up to 86 in August 2015, from 35 in December 2014.

Systems in Scotland account for around 20% of the total number (and capacity for the non-domestic scheme) of accreditations under both domestic and non-domestic RHI schemes. 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.

4.3 Emerging technologies and innovative projects in the pipeline

Keithick Biogas is a new 'biomethane to gas grid injection' (BtG) site that is expected to produce 3 million cubic metres of biomethane each year[41]. Assuming an average gross calorific value (GCV) of biomethane to be 38 megajoules per cubic metre (38MJ/m^3)[42], this site could contribute up to 32GWh of

[40] https://www.gov.uk/government/collections/renewable-heat-incentive-statistics#monthly-deployment-data
[41] http://www.ionacapital.co.uk/page/113/Keithick-Biogas-Limited.htm
[42] http://adbioresources.org/wp-content/uploads/2013/06/59-80_chapter5_v41.pdf

renewable heat in Scotland[43]. This project will be followed by a sister plant near Melrose in the Scottish Borders[44]. There is also some evidence that other AD sites are converting some or all of their capacity to BtG[45], such as Girvan Distillery in Ayrshire[46]. 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. It is important to note that BtG is expected to make a contribution to decarbonisation of the gas grid[47]. Although there will be some low conversion losses, gas to grid injection should avoid higher heat losses from combusting the gas on site (or flaring the excess gas and wasting the energy).

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 technologies can be used but also to reduce heat demand through a holistic approach. Not many of the projects are 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:

4.3.1 District Heating Loan Fund

The district heating loan fund has part funded a large number of district heating schemes in Scotland to date, and continues to provide a vital funding stream for projects that may be seen as high risk by other lenders[48].

4.3.2 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 are to have high impact not only in terms of helping to achieve Scottish Government targets but also in showcasing new ways of using renewables. A few of the heat related projects are briefly outlined below to show the scale and impact these projects could have:

- Hillfoots Heat and Hydro Power - the project will install hydropower turbines at up to 100 sites which will be combined with a water source heat pump (WSHP) to generate genuinely 'green' heat and electricity which could potentially be extended to help reduce fuel poverty for local communities across Scotland.

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[43] Formula used to calculate MWh is: (3,000,000 cubic metres x 38MJ/m^3) ÷ (3600 MWh/MJ) = 31,666 MWh, which is equivalent to approximately 32GWh.
[44] http://www.waste-management-world.com/articles/2014/10/biogas-to-grid-anaerobic-digestions-project-selects-chesterfield-biogas-tech-in-scottish-borders.html
[45] http://www.biogas-info.co.uk/resources/biogas-map/
[46] Girvan Distillery has been kept as an AD site for the 2014 report but will likely contribute to both AD and BtG output for 2015.
[47] See the Scottish Government's Heat Policy Statement, 2015 for more information on this subject http://www.gov.scot/Resource/0047/00478997.pdf
[48] Please see http://www.energysavingtrust.org.uk/district-heating-loan for details of the fund and projects that have been awarded funding.

- Clyde Gateway Community Renewable Energy Initiative – seeks to use heat pump technology to recover heat from wastewater with the aim of providing lower cost heating within the local community, via a low cost district heating network.

- Large scale ASHP District Heating Exemplar - the primary purpose of this project will be to provide a technological exemplar of off-grid heat pump-based district heating to dwellings in multi-storey buildings built in the 1970s. The project aims to demonstrate that heat pumps, with a good enough performance, are a practical alternative to fossil fuelled (gas or electric) heating networks.

4.3.3 Geothermal Energy Challenge Fund

This fund is administered directly by the Scottish Government and supports feasibility projects looking at how the thermal energy in the ground can be used to heat homes and businesses in Scotland. Five projects around Scotland have been awarded grants through the fund in order to 'explore the technical feasibility, economic viability and environmental sustainability of the emerging technology'[49]. These projects are in various locations over Scotland and will look at the feasibility of harnessing geothermal energy in a range of applications, from district heating to individual buildings, and from commercial to domestic applications. Please see the Scottish Government's website for more details on the projects that have been awarded funding to date.

4.4 Other developments from 2015 onwards

One of the major combined heat and power plants, RWE Markinch, supplied renewable heat to the Tullis Russell paper mill for most of 2014. However, the paper mill went into administration in spring 2015. Relevant stakeholders are currently looking at options to use the heat output from the plant to supply the local population through a set of district heating schemes. Success in moving any of these plans forward could result in a large contribution to Scotland's district heating targets. This will not show up as additional heat compared to the 2014 report but would be efficient use of the available heat.

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 for export to other heat users. If authorities were to use their full powers to encourage heat networks (where feasible to do so) this could make a difference to heat security in Scotland and meeting Scotland's renewable heat targets.

[49] http://news.scotland.gov.uk/News/Geothermal-energy-projects-awarded-quarter-million-19ed.aspx

5. 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 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.

5.1 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 of Energy and Climate Change (DECC). Previous reports[50] have recommended that access to the RHI database be given to the Energy Saving Trust 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. 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 the Energy Saving Trust 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 EST 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 EST database on medium sized installations is therefore more likely to be uncertain (in terms of renewable

[50] http://www.energysavingtrust.org.uk/reports/renewable-heat-scotland-2013

useful heat output) and likely to be underreported. It has therefore become increasingly important to be able to cross-reference the EST database with the RHI database as the RHI continues to see an increase in interest in this size range of biomass boilers[51]. 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, DECC offered a considerable amount of analytical support by carrying out analysis on the EST and RHI databases. By doing so they were able to provide the Energy Saving Trust with aggregated figures for the capacity, heat output and number of RHI accredited installations that are not already accounted for in the EST database. Full details of the work carried out and the steps taken to avoid double counting are available in appendix 4.

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

5.2 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 were installed by MCS certified installers.

The current data in the EST database for micro installations now includes MCS accreditation data from 2012-2014 (inclusive). For the 2011 report the number of micro installations was estimated as MCS data from the MID was not available to the Energy Saving Trust 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 EST 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 output for micro systems (smaller than 45kWth) 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.

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

5.4 Estimating useful heat output for large-scale combined heat and power

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 due to 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[52].

For previous years' reports, where actual 'useful heat' data for the large CHP sites was unknown, an estimate was derived by the following formula:

Estimated heat output = Total fuel input x Energy content of fuel x Thermal efficiency of CHP plant

The 'heat efficiency of the plant' was determined by taking the electrical and heat capacities and an overall assumed efficiency, an example is given below:

Example calculation: a 20MWe and 80MWth biomass CHP unit.
Total efficiency = 90% (as for large biomass combustion plant in previous reports)
Total output (electricity + heat) = 20 + 80 = 100MW
Total input = output / total efficiency = 100 / 0.9 = 111MW
Electrical efficiency = electrical output / total input = 20 / 111 = 18%
Thermal efficiency = heat output / total input = 80 / 111 = 72%

In previous years the thermal efficiencies of the biomass CHP plant included in the renewable heat database have been around 70% - 75%. With actual heat data from the relevant sites we can see that the thermal efficiency for large scale biomass CHP is typically between 35% and 50%. This figure is now more in line with the average CHP efficiencies set out in chapter 7 of DUKES 2013[53].

For some sites, this more accurate measure of useful heat at site level has required us to revise down historic heat output figures for Scotland. As the large biomass CHP sites make up a significant portion of heat output in Scotland, the result of this downward revision is clearly noticeable, compared to the figures included in the report published in June 2014[54].

[52] For information on 'good quality' CHP please see DECC's website: https://www.gov.uk/combined-heat-power-quality-assurance-programme
[53] https://www.gov.uk/government/statistics/combined-heat-and-power-chapter-7-digest-of-united-kingdom-energy-statistics-dukes
[54] http://www.energysavingtrust.org.uk/reports/renewable-heat-scotland-2013

5.5 Potential useful heat output that is not currently utilised

In previous reports the potential for leftover heat from sites that are currently underusing the heat produced has not been quantified. It is beyond the current scope of this report to go into detail on this subject, as this would require detailed data on total energy in, heat and electricity out and leftover 'useful heat' including the form the heat is in (for example warm or hot water, steam, hot air), and some agreed methodology for assessing the size of nearby potential heat customers relative to type and scale of heat availability present from the plant.

5.6 Recommendations for future updates

5.6.1 Recommendation 1 – RHI data

This is the first year in which RHI data has been merged with the EST database, thus providing a much more comprehensive picture of the deployment of renewable heat technologies in Scotland. It is highly recommended that the UK Government continue to provide analytical support to the Scottish Government in order that the Scottish Government can publish annual monitoring data on their progress towards their 2020 targets. However, the compilation of data required to publish monitoring figures would be much more accurate and efficient if full access to the RHI data for installations in Scotland was available. Urgent consideration should be given by UK Government to amending regulations to enable Scottish Ministers access to the RHI data for reporting purposes. This would provide the detail required by the Scottish Government to inform and direct policy action on the ground.

5.6.2 Recommendation 2 – energy from waste

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 pyrolyisis 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 on 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.

5.6.3 Recommendation 3 – CHP data

Considerable effort has been made to ensure accuracy of 'useful heat output' 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,

either by using information on heat output directly from the operator, or by working with the administrators of the CHPQA scheme where commercial confidentiality permits.

5.6.4 Recommendation 4 – unused ‘useful heat’

Given the uncertainties around the quantity of available unused but useful heat as mentioned in section 5.5 above, it is recommended that further research is conducted to better assess the availability of excess heat for export to nearby customers.

Appendix 1. Technical terms used

6.1 References to 'heat output'

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

- **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.

- **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.

- **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 4; alternatively the total heat output potentially generated by a site if it operated at the assumed capacity stated in table 3.

- **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.

- **Useful heat output**

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

6.2 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. Only one example of this which is currently providing useful heat for buildings was found, and this is the Dunfermline landfill gas plant in Fife.

  - **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'[55] 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.

Had examples been found, the following technologies could also have been included:

- **Fuel cell biomass**

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

- **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. There is a deep geothermal district heating plant in Southampton.

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.

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

The Digest of UK Energy Statistics (DECC)[56] 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.

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[55] '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.
[56] Renewable Energy Statistics: Data Sources and Methodologies, Department of Energy and Climate Change. http://www.decc.gov.uk/en/content/cms/statistics/energy_stats/source/renewables/renewables.aspx

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.

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

7.1 Capacity assumptions

The following table 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, 2014

Ownership category	Building type	Technology	Estimate of likely installed capacity	Derived from
Community	Community buildings	Solar PV	8kWe	Average of other community PV installations recorded in the database.
	Community buildings	Solar thermal	6kWth	Average of other community solar thermal installations recorded in the database.
	Community buildings	Wind (including wind to heat) – grant funded	6kWe	Average of other community wind installations recorded in the database.[57]
	Community buildings	Heat pumps (ASHP and GSHP)	16kWth	Average of other heat pumps in public sector, LA non-domestic and community buildings, recorded in the database.
	All	Biomass	45kWth	Average of other community biomass installations recorded in the database.
	All	Biomass district heating	250kWth	Average of other community biomass district heating installations recorded in the database.
Other public	All	Solar thermal	13kWth	Average of other public sector and charity solar thermal

[57] This average excludes large-scale wind developments, and was used as the assumed capacity for wind turbines installed under SCHRI or CARES grant schemes (where this information was not provided), and in cases where other information provided indicated that the turbine was associated with a community hall or other small building, rather than being part of a larger development. Revenue-generating wind projects (which are typically not grant funded) are more variable in size. However as these tend to be large in size (typically 800kW and over), effort has been made to determine the exact size of each installation for non-grant funded community wind projects.

sector and charity				installations recorded in the database.
	All	Wind – grant funded	6kWe	Average of other public sector and charity wind installations recorded in the database.[58]
	All	Heat pumps (ASHP and GSHP)	16kWth	Average of other heat pumps in public sector, LA non-domestic and community buildings recorded in the database.
	All except hospitals	Biomass	150kWth	Average of other public sector and charity biomass installations, excluding hospital installations, recorded in the database.
	Hospitals	Biomass	1.7MWth (1,700kWth)	Average of other hospital biomass installations recorded in the database.
Farms and Estates	All	Biomass	150kWth	Average of other farm and estate biomass installations recorded in the database.
	All	Biomass district heating	150kWth	Average of other farm and estate biomass district heating installations recorded in the database.
	All - Scotland Rural Development Programme (SRDP) grant recipients only	Hydro	9kWe	Average of other farm and estate hydro installations recorded in the database.[59]
Local businesses	All	ASHP	16kWth	Average of other local business ASHP's recorded in the database.
	All	GSHP	30kWth	Average of other local business GSHP's recorded in the

[58] This average excludes large-scale wind developments, and was used as the assumed capacity for wind turbines installed under SCHRI or CARES grant schemes (where this information was not provided), and in cases where other information provided indicated that the turbine was associated with a small building, rather than being part of a larger development. Revenue-generating wind projects (which are typically not grant funded) are more variable in size. However as these tend to be large in size (typically 800kW and over), effort has been made to determine the exact size of each installation for non-grant funded wind projects.

[59] Based on information received on size of hydro capacity installed under SRDP, therefore only used for other SRDP hydro installations where capacity was not known. Revenue-generating hydro projects (which are typically not grant funded) are more variable in size. However as these tend to be large in size (typically 100kW and over), effort has been made to determine the exact size of each installation for non-grant funded hydro projects.

				database.
	All	Biomass	200kWth	Average of other local business biomass recorded in the database.
	All	Biomass district heating	150kWth	Average of other local business biomass district heating recorded in the database.
Local authority	Domestic properties	Solar thermal – installed in 2011, 2012 or 2013	3.4m^2	Analysis of Energy Saving Scotland home renewables grants.[60]
	Domestic properties	Solar thermal – installed in 2014	4m^2	Analysis of Energy Saving Scotland home renewables grants paid in 2014.[61]
	Domestic properties	Solar PV – installed in 2011 or 2012	2.8kWe	Analysis of installations registered for FITs in Scotland.[62]
	Domestic properties	Solar PV – installed in 2013	3.6kWe	Analysis of installations registered for FITs in Scotland.[63]
	Domestic properties	Solar PV – installed in 2014	4.0kWe	Analysis of installations registered for FITs in Scotland.[64]
	Domestic properties	Heat pumps (ASHP and GSHP)	7kWth	Average of other LA- and HA-owned heat pumps in domestic properties recorded in the database.
	Schools	Solar thermal	7kWth	Average of other school solar thermal installations recorded in the database.
	Schools	Solar PV	8kWe	Average of other school solar PV installations recorded in the database.
	Schools	Wind – grant funded	6kWe	Average of other school wind installations recorded in the database.

[60] Energy Saving Scotland home renewables grants are grants for domestic renewables, administered by the Energy Saving Trust on behalf of the Scottish Government.
[61] Energy Saving Scotland home renewables grants are grants for domestic renewables, administered by the Energy Saving Trust on behalf of the Scottish Government.
[62] Central FIT's register, Ofgem. https://www.renewablesandchp.ofgem.gov.uk/
[63] Central FIT's register, Ofgem. https://www.renewablesandchp.ofgem.gov.uk/
[64] Central FIT's register, Ofgem. https://www.renewablesandchp.ofgem.gov.uk/

	Schools	ASHP	10kWth	Average of school ASHP installations recorded in the database.
	Schools	Biomass	200kWth	Average of other school biomass boiler installations recorded in the database.
	Other buildings	Heat pumps (ASHP and GSHP)	16kWth	Average of other heat pumps in public sector, LA and community buildings, recorded in the database.
Housing Association	Domestic properties	Solar thermal	3.4m^2	Analysis of Energy Saving Scotland home renewables grants.[65]
	Domestic properties	Solar thermal – installed in 2014	4m^2	Analysis of Energy Saving Scotland home renewables grants paid in 2014.[66]
	Domestic properties	Solar PV – installed in 2011 or 2012	2.8kWe	Analysis of installations registered for FITs in Scotland.[67]
	Domestic properties	Solar PV – installed in 2013	3.6kWe	Analysis of installations registered for FITs in Scotland.[68]
	Domestic properties	Solar PV – installed in 2014	4.0kWe	Analysis of installations registered for FITs in Scotland.[69]
	Domestic properties	Heat pumps (ASHP and GSHP)	7kWth	Average of other LA- and HA-owned heat pumps in domestic properties, recorded in the database.
	Domestic properties	ASHP - EAHR[70]	4.5kWth	Average of other LA- and HA-owned ASHP-EAHRs in domestic properties, recorded in the database.

[65] Energy Saving Scotland home renewables grants (no longer available) were grants for domestic renewables, administered by the Energy Saving Trust on behalf of the Scottish Government.
[66] Energy Saving Scotland home renewables grants are grants for domestic renewables, administered by the Energy Saving Trust on behalf of the Scottish Government.
[67] Central FIT's register, Ofgem. https://www.renewablesandchp.ofgem.gov.uk/
[68] Central FIT's register, Ofgem. https://www.renewablesandchp.ofgem.gov.uk/
[69] Central FIT's register, Ofgem. https://www.renewablesandchp.ofgem.gov.uk/
[70] 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. 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.

8.1 Background

Heat has been estimated to account for more than half of Scotland's total energy use.[71] 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[72] set a target of delivering 11% of Scotland's projected 2020 (non-electrical)[73] heat demand from renewable sources.

In 2006, the Scottish Energy Study[74] 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.

8.2 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 6,420GWh 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 60,089GWh using data from the Scottish Energy Study. Therefore, the target was set at 11% (See table 15).

[71] Energy in Scotland 2015, Scottish Government, http://www.gov.scot/Topics/Statistics/Browse/Business/Energy/EIS2015
[72] Renewable Heat Action Plan (2009). http://www.scotland.gov.uk/Publications/2009/11/04154534/0
[73] 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 (2011) estimates that around 15% of households in Scotland use electricity as their primary heating fuel.
[74] Scottish Energy Study, Vol 1 (2006). http://www.scotland.gov.uk/Publications/2006/01/19092748/0

Table 15: 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[75])	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%**

8.3 Improving data on heat demand in Scotland

in the years following the publication of the Scottish Energy Study, the Department of Energy and Climate Change (DECC) began publishing more detailed sub-UK estimates of energy consumption[76] 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 DECC to derive a heat demand methodology for Scotland which will allow more accurate annual measurement of progress towards the renewable heat target.

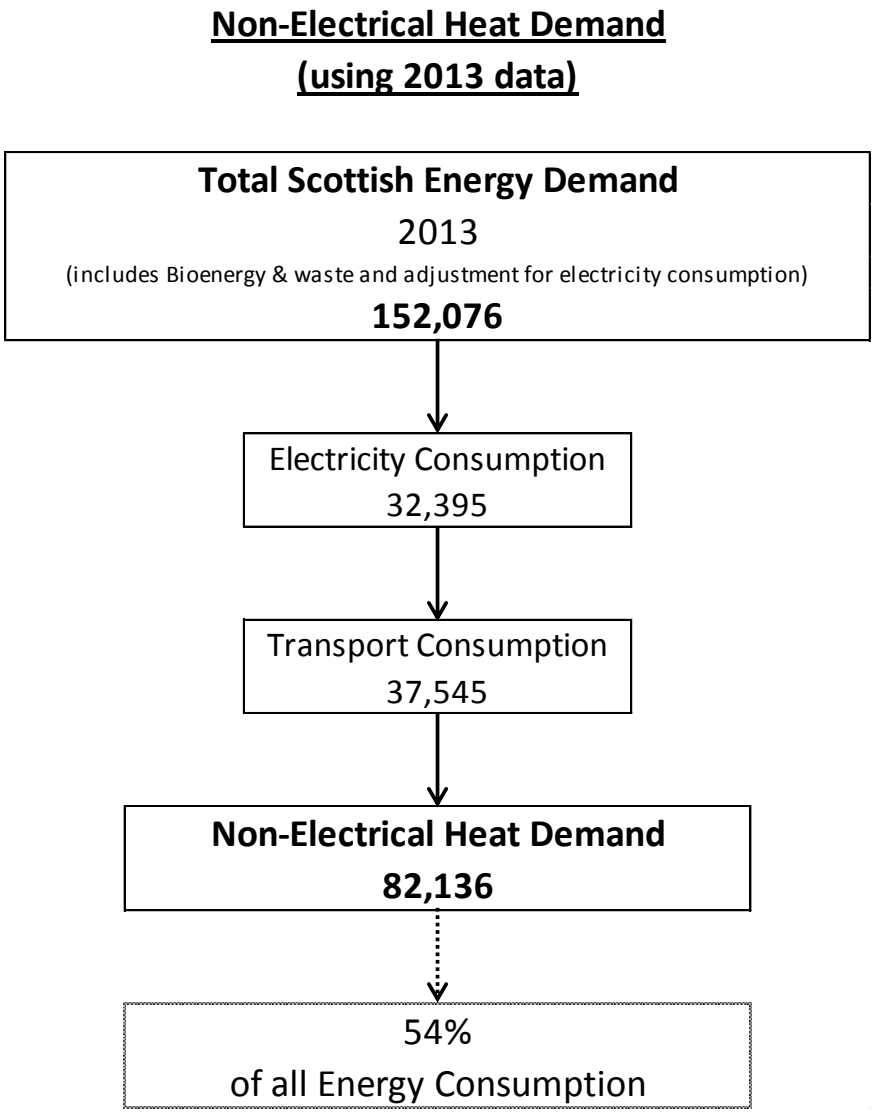
The DECC data shows a breakdown of final energy consumption by end use for Scotland down to local authority level. By subtracting electricity and transport consumption from the final energy consumption figure (as well as making adjustments for bioenergy & waste and electricity consumption[77]), this results in an estimate for non-electrical heat demand in Scotland (see the flow chart in figure 14 below for more detail).

[75] 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

[76] Total final energy consumption at sub-national level, DECC. https://www.gov.uk/government/organisations/department-of-energy-climate-change/series/total-final-energy-consumption-at-sub-national-level

[77] The total energy demand figure is adjusted to account for an inconsistency with the electricity consumption figures presented within the energy tables published by DECC. 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 (27,391GWh and 33,736GWh respectively). https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/65842/7363-elec-gen-supply-figures-et-art-sheet.xls

Figure 14: Heat demand methodology



The methodological differences between the 2006 Scottish Energy Study and DECC's annual estimates of final energy consumption have implications for the monitoring of the renewable heat target. Table 16 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 DECC'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 16: Renewable heat target - renewable heat as a % of heat demand 2008/09 to 2014[78]

	2008/ 2009	2009	2010	2011	2012	2013	2014
Total renewable heat output (GWh)	845	-	1,345	1,660	2,003	2,223	3,031
New measure: % of annual estimate of total non-electrical heat demand	0.9%	-	1.5%	1.9%	2.4%	2.7%	-
Progress - scenario 1 (low demand)							*3.8%*
Progress - scenario 2 (medium demand)							*3.8%*
Progress - scenario 3 (high demand)							*3.7%*
New heat demand measure (GWh)	95,271[79]	87,046	89,270	86,374	83,836	82,136	-
Heat demand scenario 1 (average annual change 2008-2013)							*79,788*
Heat demand scenario 2 (same change as 2012-13)							*80,471*
Heat demand scenario 3 (same as 2013)							*82,136*
Previous measure: % of forecast 2020 non-electrical heat demand	1.4%	-	2.2%	2.8%	3.3%	3.7%	5.0%
Previous 2020 heat demand estimate	*60,089*	*60,089*	*60,089*	*60,089*	*60,089*	*60,089*	*60,089*

8.4 A summary of the changes as a result of the new methodology are listed below

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 DECC sub-UK consumption data – 2014 data will not be available until September 2016.
- 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 DECC datasets.

[78] See Appendix 3 for more information on the methodology for calculating non-electrical heat demand in Scotland.
[79] This non-electrical heat demand figure is for 2008.

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

Appendix 4. 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[80]. The RHI is administered by Ofgem on behalf of DECC.

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 proption of the uptake of renewable heat technologies, particularly in the small to medium technology size bracket (>45kWth and <1MWth). A substantial proportion of the micro (45kWth 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 project, press releases and relevant organisation contacts. However, small and medium sized projects are harder to track especially now as the REPD no longer monitors projects have a capacity of less than 1MW. It has therefore become increasingly important to reconcile the EST 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, DECC 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 EST renewable heat database.
- The **eligible heat** output of systems accredited under the RHI where no match exists in the EST renewable heat database.

[80] 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.

9.2 Methodology

The analysis undertaken by DECC was done using an extract of the EST database as of 25 June 2015.[81] On receipt of the data DECC carried out cleansing of postcodes, organisation names and site names before matching with the RHI database. For all sites with a capacity of 0.5MW (500kW) or higher, the data were manually cross-referenced to ensure accurate matching of sites with the largest capacity. The remaining data were 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). A random sample of the results was tested to ensure accuracy.

For all systems on the RHI database where no match was found in the EST database, the capacity and 'heat paid for' were aggregated and provided by year for 2009 to 2014 (2012 to 2014 for output as the first payments for eligible heat were not made until 2012).

The variables provided by DECC were:

- Operational capacity by technology or each calendar year, taken from the commissioning date of the site.

- 'Heat paid for' under the RHI scheme, by technology, in each calendar year. 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[82], 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 MCS accredited 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 DECC may still include output and capacity for sites that are already listed in the EST database. This will be because either a match wasn't found or because the record was not sent to DECC (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 17 below.

Table 17. Risk indicators assigned to EST database records

[81] 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.
[82] 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

Risk	Descriptor
Very low	• The record is for a microgeneration system (capacity ≤45kW). All microgeneration systems were removed from the RHI data after merging to avoid double counting. Or • The record has a capacity of 0.5MW 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[83]. These sites cannot claim support under the RHI as well.
Low	• The record was sent to DECC for merging with the RHI database and has good location information in the EST database. Or • The EST database records that the system was commissioned before November 2009, which would mean that the site is too old to claim RHI support.
Medium	• The record was sent to DECC but has no, or poor, location information in the EST database. Or • The record was not sent to DECC, 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 DECC. 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 DECC, is not a micro technology and commissioned late 2011 and is an RHI-eligible technology. These systems will not have been included in the DECC 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.[84] The aggregated RHI figures were then added to the relevant EST database summary figures to provide total capacity and heat figures for Scotland.

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

9.4 Results

The addition of RHI data has resulted in an overall increase in capacity of 34% and in output of 6% for 2014. As mentioned in section 3.1 the majority of additional RHI capacity and output is from the small to medium (>45kWth and < 1MWth) biomass technologies. Although there are a lot of these systems deployed in Scotland they are likely to have lower peak running hours than large systems, which still dominate the heat output in Scotland.

This point raises one further implication, however, and that is that although we have revised down our biomass efficiencies it is possible that heat output for biomass and other technologies is still overestimated. It is therefore important to continue to scrutinise the assumptions used for this report. Having access to site-level RHI data would be very useful in being able to properly analyse the actual performance of systems and determine evidence-based assumptions for different sizes of boiler and different uses of heat.

Energy Saving Trust, 2nd Floor, Ocean Point 1, 94 Ocean Drive, Edinburgh, EH6 6JH
energysavingtrust.org.uk
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