Renewable heat in Scotland, 2013

A report by the Energy Saving Trust for the Scottish Government

June 2014

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About the Energy Saving Trust

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

This work was carried out by the Energy Saving Trust on behalf of the Scottish Government. The report draws on various sources of data from the Energy Saving Trust and other organisations working in Scotland, and was written by Rosalyn Foreman with input from Cate Lyon.

EST would like to thank all individuals and organisations who provided data, with particular thanks to the Forestry Commission Scotland and Hudson Consulting.

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 come 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 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 2013, and new installations which are in development. As a result, we estimate that in 2013, **0.662GW of renewable heat capacity was operational in Scotland, producing an estimated 2,904GWh of useful renewable heat**.

This represents an 18% increase of 0.101GW (101MW) of capacity from 0.561MW in 2012, and a **17% increase** (423GWh) **of heat generated from renewable sources** compared to 2,481GWh in 2012.[2]

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

[1] Renewable Heat Action Plan for Scotland, Scottish Government, November 2009.
http://www.scotland.gov.uk/Publications/2009/11/04154534/0
[2] Renewable Heat in Scotland 2012 Report
http://www.energysavingtrust.org.uk/scotland/Take-action/Get-business-funding/Renewable-Heat-in-Scotland-2012

Figure 1. Estimated renewable heat capacity in Scotland, 2008/09 - 2013

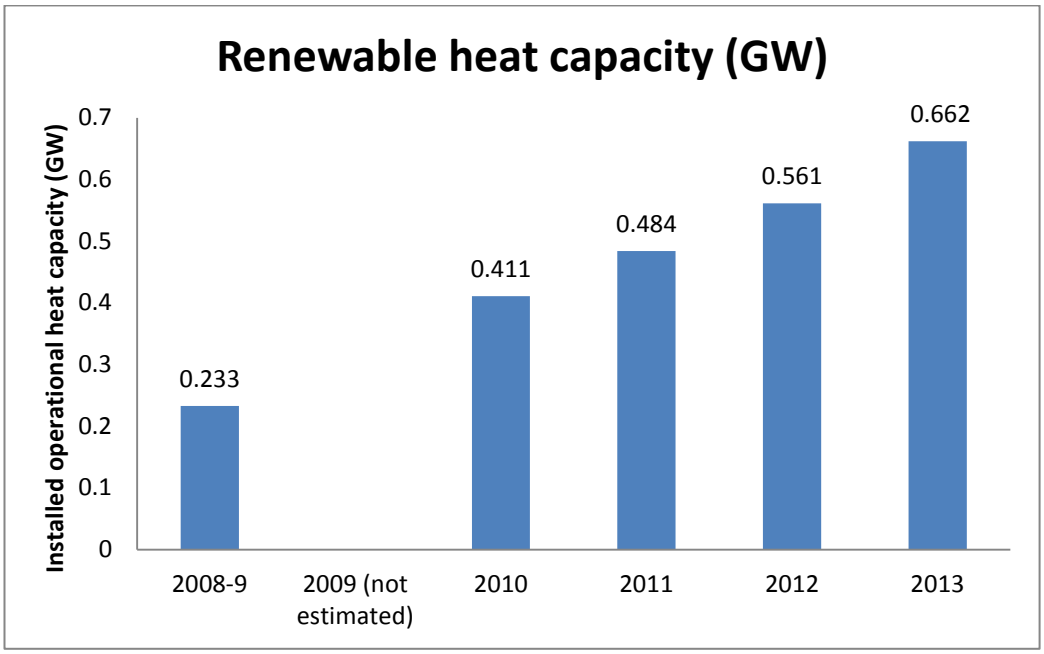
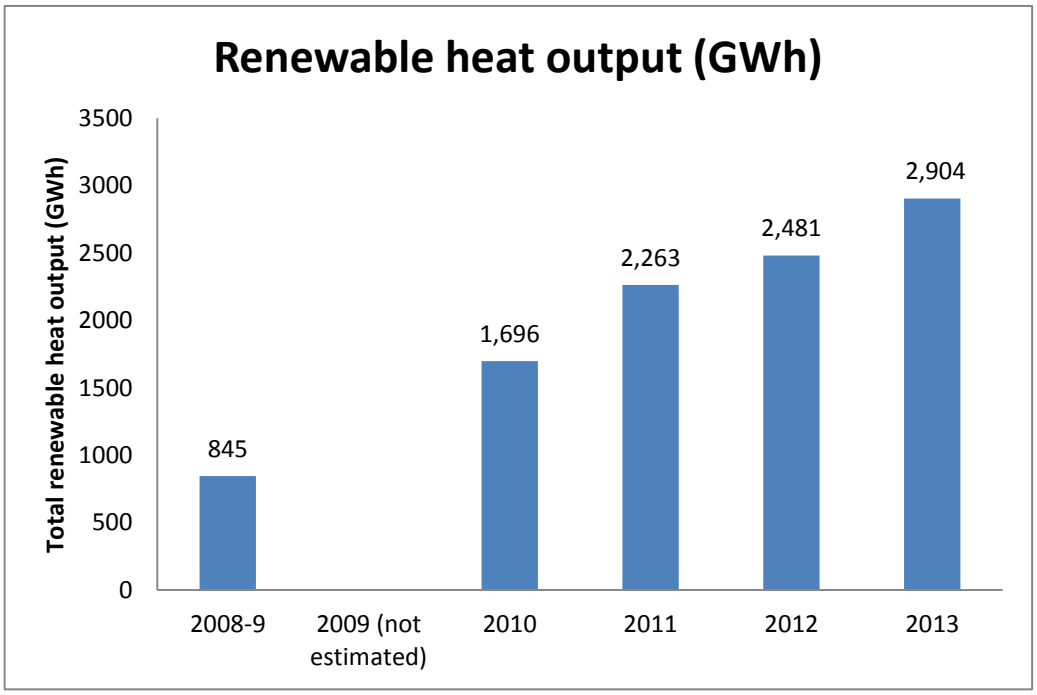


Figure 2. Estimated renewable heat output in Scotland, 2008/09 - 2013



The Scottish Government is now tracking progress towards the renewable heat target using a new methodology. (See appendix 3 for more information.) Using this improved methodology allows progress towards the target to be estimated against the current level of heat demand as opposed to a projection for 2020. 2011 is now the latest available estimate due to a lag in the final energy consumption data for Scotland[3] published by the Department of Energy and Climate Change (DECC). Non-electrical heat demand in Scotland in 2011 was estimated to be 86,800GWh.[4] Renewable heat output in 2011 was estimated to be 2,263GWh[5]. Therefore, it is estimated that **renewable heat generation in 2011 equated to 2.6% of Scotland's non-electrical heat demand in 2011**.

Table 1 presents the progress under the new heat target methodology compared to the previous measure to demonstrate the effect of this methodological improvement.

Table 1: Renewable heat target - renewable heat as a percentage of heat demand

	2009	2010	2011	2012	2013
Total renewable heat output (GWh)[6]	845	1,696	2,263	2,481	2,904
New measure: % of annual estimate of total non-electrical heat demand[7]	1.0%	1.9%	2.6%	-	-
Previous measure: % of forecast 2020 non-electrical heat demand.[8]	1.4%	2.8%	3.8%	4.1%	4.8%

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

[3] DECC Sub national final energy consumption data
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/274024/sub_national_total_final_energy_consumption_statistics_2005_2011.xlsx
[4] Scottish Government, Energy in Scotland 2014
http://www.scotland.gov.uk/Resource/0044/00444530.pdf
[5] Renewable Heat in Scotland 2012 Report
http://www.energysavingtrust.org.uk/scotland/Take-action/Get-business-funding/Renewable-Heat-in-Scotland-2012
[6] As published in Energy Saving Trust 'Renewable Heat in Scotland' reports by year
[7] Scottish Government, Energy in Scotland 2014
http://www.scotland.gov.uk/Resource/0044/00444530.pdf
[8] 2020 heat demand as published here: Scottish Energy Study, Vol 1 (2006).
http://www.scotland.gov.uk/Publications/2006/01/19092748/0

2. Methodology

2.1 Approach taken

Two main outputs are required from the renewable heat database which the Energy Saving Trust maintains on behalf of the Scottish Government. The first is an estimate of operational renewable heat capacity. Capacity refers to the maximum instantaneous power output of a renewable heating system such as a biomass boiler, and is usually measured in kilowatt therms (kWth) or megawatt therms (MWth), depending on the size of the installation. Total heat capacity is presented in this report as gigawatts (GW)[9] or megawatts (MW), rather than as GWth or MWth, to avoid confusion with the units of heat output (GWh). Installations are classified by their capacity, into large (1MW and above), medium (between 1MW and 45kW) and micro (less than or equal to 45kW).

The second main output required from the database is an estimate of useful renewable heat energy produced over a year. 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).[10]

Useful heat output is hard to measure, and only some renewable heat installations monitor the heat generated from their systems.[11] Therefore the results presented in this report are mainly estimates of heat output, based on what data are available for each installation. Where possible, results are based on data received about fuel inputs to particular installations and assumptions about their efficiency, which are used to estimate *actual* heat output during 2013. This figure may be different to estimates of *potential* 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. However, where data on fuel inputs were not available, the figure for potential output has been used.

The information available on each installation varies, depending upon the data sources used. Where they are supplied, estimates of fuel input are used as the preferred basis for estimating annual heat output. Where information on capacity is not available, this is estimated based on information on heat output and assumptions about typical running hours, based on installation size and the heat use (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.

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

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[9] 1GW = 1,000MW = 1,000,000kW.
[10] 1GWh = 1,000MWh = 1,000,000kWh.
[11] Although non-domestic installations claiming the renewable heat incentive (RHI) are required to submit regular heat meter readings to Ofgem, data from individual Scottish installations registered for the RHI were not available.

Results are reported here for calendar year 2013, rather than financial year 2013/14. This is because the Forestry Commission Scotland data set on wood fuel use, which provides a large portion of the data on which total output has been estimated, is currently updated on a calendar year basis.

2.2 Technologies included

The following technologies produce heat from renewable sources, and are included in our estimate of progress towards the target:

- 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.

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

- fuel cell biomass
- deep geothermal.

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.[13]

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.

[12] Excluding the parasitic heat used to maintain the anaerobic digestion process.
[13] 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

- 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 updated the renewable heat database for the Scottish Government in March 2011, March 2012, and March 2013 to give an estimate of renewable heat capacity and output in 2010, 2011 and 2012 respectively. The new estimate for renewable heat output in 2013 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, which also produce the largest amounts of heat.

Multiple sources of data were used to update the renewable heat database. 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 and Hudson Consulting contain estimates of all wood fuel usage for the year 2013 and estimates for 2014 and 2015 for large biomass plants only.

Table 2. Main datasets used for 2013 figures and estimates of future output

Organisation	Dataset
Forestry Commission Scotland (based on report by Hudson Consulting)	Annual woodfuel demand and usage in Scotland 2013 (estimated)
Ricardo-AEA, on behalf of the Department of Energy and Climate Change (DECC)	The Renewable Energy Planning Database (REPD)[14]
Energy Saving Trust, on behalf of the Scottish Government	• Energy Saving Scotland small business loans • applications to the district heating loan fund • community and locally owned renewable energy database[15]
Scottish Environment Protection Agency (SEPA)	Information on installations covered by the Pollution Prevention and Control license in Scotland

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

Gemserv	Microgeneration Certification Scheme (MCS) data
Scotch Whisky Association	Environmental Report http://www.scotch-whisky.org.uk/what-we-do/environmental-strategy

In addition, information on installations in development was sourced from local planning authority planning departments via online searches.

2.4 Assumptions used

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. These data were then converted into estimates of heat output, 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.[16]

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

Installation size	Boiler efficiency assumed	MWh heat output per ODT burnt
Large installations (>1MW, or >10,000 ODT)	90%	4.43
Medium installations (45kW – 1MW, or <10,000 ODT)	85%	4.18
Small (≤45kW) non-domestic	80%	3.94
Domestic[17]	35%	1.74

For biomass combined heat and power, a calculation was used to work out the estimate of heat energy produced from oven-dried tonnes of wood, based on the values given for electrical power (MWe) and heat output (MWth). An example is given in figure 3 below.

[16] Mitchell, Hudson, Gardner, Storry and Gray, 1990. Wood Fuel Supply Strategies Vol 1. The Report: ETSU B 1176-P1.
[17] Efficiency reflects average system installed in a domestic situation whereby 90% are assumed to be open fires.

Figure 3. Formula used to estimate efficiency of heat production from burning biomass, in a biomass CHP plant.

Example calculation: a 20MWe and 80MWth biomass CHP unit.
Total efficiency = 90% (as for large biomass combustion plant)
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%

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 running hours per year by size of installation or sector. These hours are given in table 4. The same running hours were used to derive an estimate of output for those installations where information on capacity was provided but an estimate of heat 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

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

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

- capacity per m^2: 0.7kW, from the Solar Trade Association

- useful heat output per m^2: 0.34MWh, derived from SAP 2009 calculations.

In line with assumptions used in DECC's RESTATS methodology,[18] municipal solid waste 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.

For anaerobic digestion facilities, 30% of the renewable 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 is a significant change from the previous year's assumptions which assumed only a 4% reduction. This is due to an improved estimate from Zero Waste Scotland.[19]

In certain circumstances assumptions have been made about the operating status:

If information for a project has been found in previous years but no further information has been found for the 2013 update the following assumptions have been made:

- if a project has been previously recorded as 'in scoping' and no further information has been found, then the assumption has been made that it is still at the same stage of development
- projects that have had planning permission granted but there is no further information the status is 'consented but not built'
- micro or small to medium projects that were 'under construction' in 2012 are now assumed to be operating
- large-scale projects which were 'under construction' in 2012 have remained the same if no evidence that the project is operational has been found
- there are some projects recorded in the database that have no evidence of status; these are classed as unknown.

3. Renewable heat capacity and renewable heat output in 2013

3.1 Results for 2013

In 2013, **2,904GWh** of heat was produced from renewable sources, from an installed capacity of **0.662GW.**

0.662GW of capacity and 2,904GWh of output represent an **increase of 18%** (0.101GW) **in capacity** compared to 2012, and an **increase of 17%** (423GWh) **in output** since 2012. Since the Sustainable Development Commission Scotland's[20] estimate of renewable heat output in Scotland during 2008/9,

[18] 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
[19] Based on an estimate provided by Zero Waste Scotland in April 2013.
[20] Renewable Heat in Scotland. A report to the Scottish Government from the Sustainable Development Commission Scotland, June 2009. http://www.sd-commission.org.uk/publications.php?id=1015

renewable heat capacity has almost trebled (up by 0.429GW) and output more than trebled (up by 2,059GWh). Table 5 and figures 4 and 5 show the full time series of data (please note that data were not gathered for calendar year 2009).

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

	2008/2009	2010	2011	2012	2013
Total renewable heat output (GWh)[21]	845	1,696	2,263	2,481	2,904
New measure: % of annual estimate of total non-electrical heat demand) [22]	1.0%	1.9%	2.6%	-	-
Previous measure: % of forecast 2020 non-electrical heat demand. [23]	1.4%	2.8%	3.8%	4.1%	4.8%

The Scottish Government is now tracking progress towards the renewable heat target using a new methodology. (See appendix 3 for more information.) Using this improved methodology allows progress towards the target to be estimated against the current level of heat demand as opposed to a projection for 2020. 2011 is now the latest available estimate due to a lag in the final energy consumption data for Scotland[5] published by the Department of Energy and Climate Change (DECC). Non-electrical heat demand in Scotland in 2011 was estimated to be 86,800GWh.[6] Renewable heat output in 2011 was estimated to be 2,263GWh.[7] Therefore, it is estimated that renewable heat generation in 2011 equated to 2.6% of Scotland's non-electrical heat demand in 2011.

Table 5 shows the comparison between the two target measures. As heat demand in 2011 is higher than the forecast heat demand in 2020, this results in a lower percentage of renewable heat generation. The 2012 update using the new methodology will be available when DECC publishes the updated final energy consumption data in September 2014.

[21] As published in Energy Saving Trust 'Renewable Heat in Scotland' reports by year.
[22] Scottish Government, Energy in Scotland 2014
http://www.scotland.gov.uk/Resource/0044/00444530.pdf
[23] 2020 heat demand as published here: Scottish Energy Study, Vol 1 (2006).
http://www.scotland.gov.uk/Publications/2006/01/19092748/0

Figure 4. Estimated renewable heat output, 2008/09 - 2013

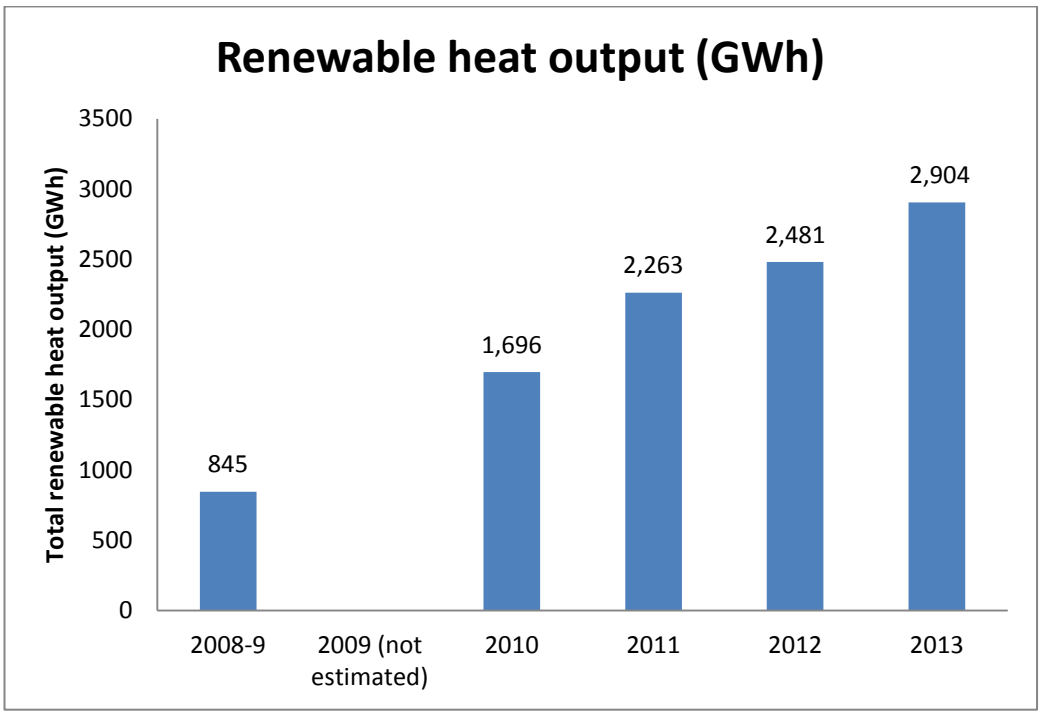
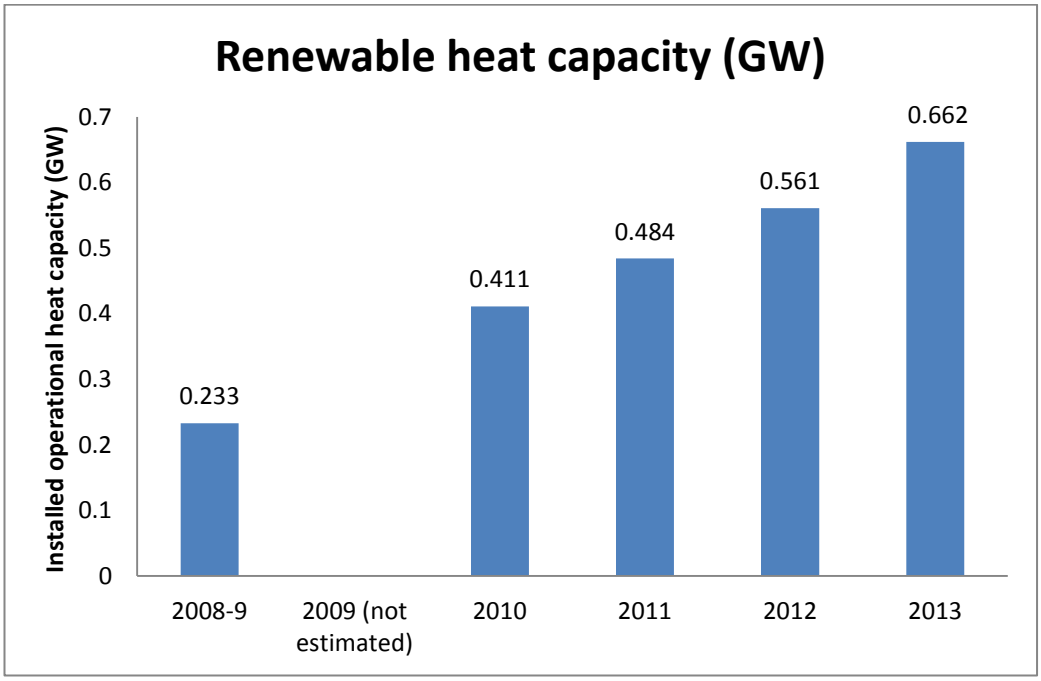


Figure 5. Estimated renewable heat capacity, 2008/09 – 2013



The majority of renewable heat output in 2013 continues to come from large (1MW+) installations (table 6), as in previous years. The number of large (1MW+) installations contributed 62% of the renewable heat capacity and 81% of the annual output. However, they represent only 0.4% of the number of installations. Large installations contribute a larger percentage of heat output (81%) than of installed capacity (62%), compared with small to medium (45kW-1MW) and micro (≤45kW) installations. This reflects the longer running hours and (in some cases) higher efficiencies seen in large installations.

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 waste disposal, 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.

Table 6. Renewable heat output and capacity in Scotland, 2013, by size of installation

	Renewable heat capacity (MW)	% renewable heat capacity	Annual output (MWh)	% annual output	Number of installations	% of installations
Large (1MWth+)	413	62%	2,360,995	81%	36	0.4%
Small to medium (>45kWth and <1MWth)	104	16%	249,917	9%	567	6.9%
Micro (≤45kWth)	145	22%	292,592	10%	7,504	90.7%
Unknown	-	0%	574	0%	163	2.0%
Total	**662**	100%	**2,904,078**	100%	**8,270**	100%

Note: totals may not equal sum due to rounding up or rounding down

3.2 Results by technology

The majority of both output and capacity in 2013 came from biomass primary combustion and biomass combined heat and power (table 7, and figures 6 and 7). 83% of renewable heat capacity, and 90% of renewable heat output came from installations which used biomass primary combustion or biomass combined heat and power.

Table 7. Renewable heat output and capacity in Scotland, 2013, by technology

	Renewable heat capacity (MW)	% renewable heat capacity	Annual output (MWh)	% annual output
Biomass	290	44%	1,198,051	41%
Biomass CHP	261	39%	1,419,400	49%
Energy from waste	16	2%	120,811	4%
Heat pump	64	10%	151,162	5%
Solar thermal	30	5%	14,654	0.5%
Unknown	0.25	0%	-	0%
Total	662	100%	2,904,078	100%

Note: totals may not equal sums due to rounding up or rounding down

Figure 6. Renewable heat capacity in Scotland, 2013, by technology

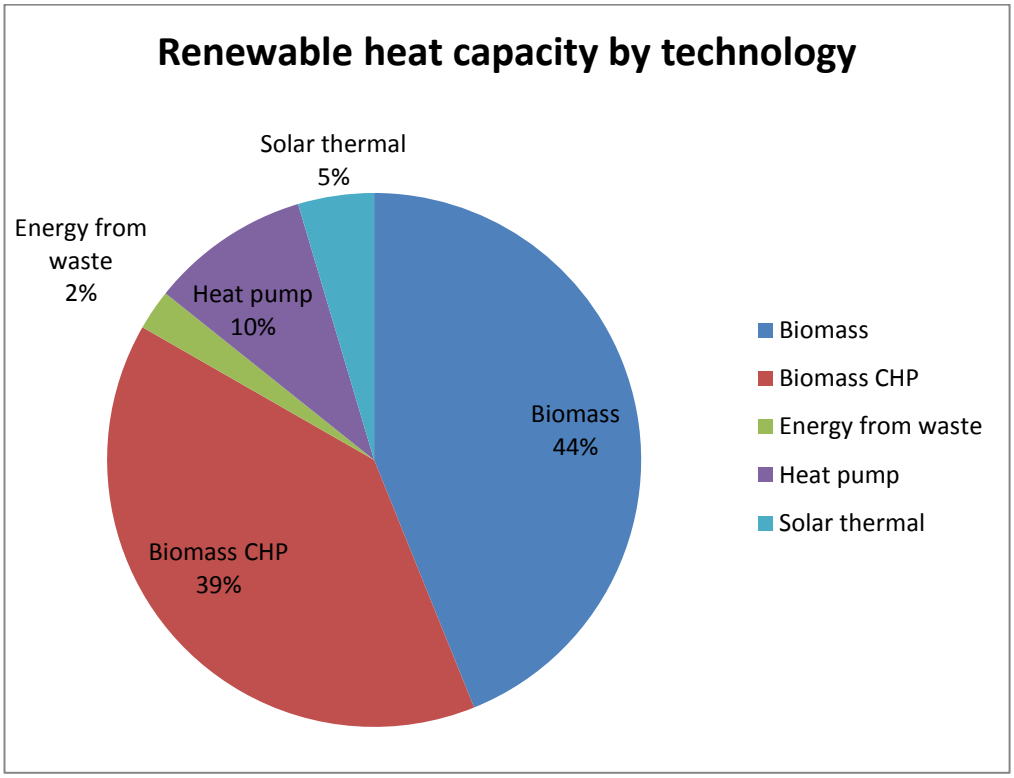
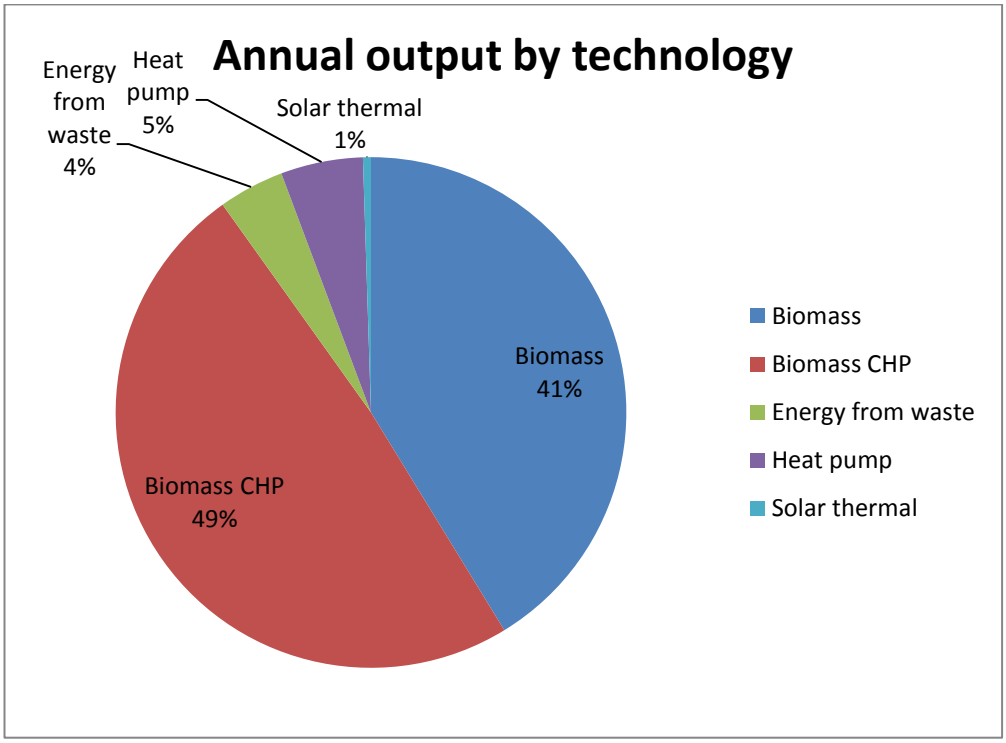


Figure 7. Renewable heat output in Scotland in 2013, by technology



3.3 Change in output and capacity by technology since 2013

Three notable developments since 2012 account for significant differences in 'operational' output and capacity between 2012 and 2013. These are:

- The estimated capacity of renewable heat in energy from biomass CHP has almost doubled from 144MW reported in 2012 to 261MW in 2013, an increase of 117MW. This is mainly due to the Markinch Biomass CHP plant coming into operation within the last year. In the 2012 report it was listed as under construction.
- A significant drop in both the estimated capacity and output of renewable heat in energy from waste. Two of the larger energy from waste projects were listed as operating in the 2012 report; however, this year's research has meant the status in this year's report has been updated to 'completed: not operating'. This means its capacity and output has not been included in the final operational figures. An improved estimate of the percentage of heat lost to parasitic load (an increase from 4% to 30%) will also have an effect on these numbers (see Section 2.4).
- Capacity and output of heat pumps has increased from last year due to the addition of almost 1,000 individual domestic installations into the database. This was new data for installations this year received from Gemserv and the Microgeneration Certification Scheme dataset.

Table 8. Changes in renewable heat output and capacity in Scotland from 2012 to 2013, by technology

	2013 Total capacity (MW)	Change since 2012	Percentage change	2013 Total annual output (MWh)	Change since 2013	Percentage change
Biomass	290	- 10	-3%	1,198,051	48,092	4%
Biomass CHP	261	117	81%	1,419,400	526,980	59%
Energy from waste	16	- 25	-61%	120,811	- 179,681	-60%
Heat pump	64	15	31%	151,162	28,951	24%
Solar thermal	30	2	9%	14,654	- 890	-6%
Total	**662**	**101**	18%	**2,904,078**	423,452	17%
	0.662GW	**0.101GW**		**2,904GW**	**423GW**	

Note: totals may not equal sums due to rounding up or rounding down

4. Further renewable heat capacity in development

The renewable heat database has also been updated to include information (where available) on renewable heat installations which are in development: under construction, consented but not yet built, in planning or in scoping. These can be used to provide an estimate of future renewable heat output in Scotland, although there is necessarily a large degree of uncertainty around such figures.

An estimated **0.043GW** of installed capacity from projects is currently under construction, which could provide a further **476GWh** of renewable heat. Adding these figures to current operational installations will provide a total of **0.705GW** of renewable heat capacity and **3,380GWh** of renewable heat output.

In addition, an estimated 0.163GW of capacity is either consented but not built, or submitted to local planning authorities for planning permission. These installations, which are all large scale, could provide around 2,286GWh of renewable heat. However, this consented capacity figure is significantly lower than last year primarily due to Forth Energy's announcement in March 2014, that it was not continuing with renewable energy projects in Grangemouth and Rosyth and was seeking new backers for the schemes. Alongside that they also advised the withdrawal of the planning application for the Dundee site.[24] Assuming that 50% of these projects come to fruition before 2020 (providing 0.081GW

[24] http://www.forthenergy.co.uk/latest-news-20140326.asp

and 1,143GWh of heat), and adding in those installations currently under construction or already operational, could result in a total capacity of **0.786W** and **4,523GWh** of renewable heat output.

A further 0.058GW of heat capacity is estimated from projects which are still at the 'scoping' phase i.e. they have not yet submitted an application for planning permission. These could provide a further 797GWh 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.

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.
- Actual 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 upon firstly a suitable heat user being agreed or established nearby; and secondly how much heat that user requires, either for process heat or space heating.

5.1 Estimating micro installations: capacity and output

Germserv supplied data from the MSC database. Gemserv are the administrators of the Microgeneration Certification Scheme (MSC) which is a quality assurance scheme for microgeneration technologies and installers. This provided the database with 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 for micro installations now includes MCS data from 2012 and 2013, and also includes installations estimated before the MCS data became available in 2012. This remaining 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. The same range of data has not been used this year to avoid double counting.

We are aware that there are a number of installations that could be operational that have not received government grants or funding and will not be evident on the MSC database. This means that the numbers for systems that are smaller than 45kWp are likely to be an underestimate. There was no data available that would provide the missing information without risking double counting.

5.2 Energy from waste installations

Energy from waste technologies (primary combustion of non-wood biomass, anaerobic digestion, and combustion of landfill gas) now provides 2% of renewable heat capacity and 4% of renewable heat output (table 7). This represents a relatively large decrease from the 2012 figures, which were 7% and 12% respectively, and are more similar to the 2011 figures.

5.3 Recommendations for future updates

- In the 2012 report it was suggested that Scottish Government should work closely with DECC and Ofgem to share information from the Renewable Heat Initiative (RHI) database which collects actual meter readings on heat production for large installations. This real-time data will be a very accurate way of updating data on projects within the renewable heat database which also claim RHI. This is still a valid recommendation.
- Given the 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. (See section 3.3)

Appendix 1. Individual technology descriptions

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.

Had an example 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)[25] considers hospital waste as non-biodegradable, so installations burning only hospital waste are not counted as producing renewable heat. However, installations which burn other wastes that are considered biodegradable such as municipal waste, in addition to hospital waste, have been included in the database**.**

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

- **Passive renewable heating**

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

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

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

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

The following assumed capacities were used in the renewable heat database where information on capacity was not available.

Ownership category[26]	Building type	Technology	Estimate of likely installed capacity	Derived from
Community	Community buildings	Heat pumps (ASHP and GSHP)	16kWth	Average for other heat pumps in public sector, LA non-domestic and community buildings recorded in the database
	All	Biomass	45kWth	Average for other community biomass

[25] 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

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

				installations recorded in the database
	All	Biomass district heating	250kWth	Average for other community biomass district heating installations recorded in the database
Other public sector and charity	All	Solar thermal	13kWth	Average for other public sector and charity solar thermal installations recorded in the database
	All	Heat pumps (ASHP and GSHP)	16kWth	Average for other heat pumps in public sector, LA non-domestic and community buildings recorded in the database
	All except hospitals	Biomass	150kWth	Average for other public sector and charity biomass installations, excluding hospital installations, recorded in the database
	Hospitals	Biomass	1.7MWth (1,700kWth)	Average for other hospital biomass installations recorded in the database
Farms and Estates	All	Biomass	150kWth	Average for other farm and estate biomass installations recorded in the database
	All	Biomass district heating	150kWth	Average for other farm and estate biomass district heating installations recorded in the database
Local businesses	All	ASHP	16kWth	Average for other local business ASHP's recorded in the database
	All	GSHP	30kWth	Average for other local business GSHP's recorded in the database
	All	Biomass	200kWth	Average for other local business biomass recorded in the database
	All	Biomass district heating	150kWth	Average for other local business biomass district heating recorded in the database

Local authority	Domestic properties	Solar thermal	3.4m^2	Analysis of Energy Saving Scotland home renewables grants[27]
	Domestic properties	Heat pumps (ASHP and GSHP)	7kWth	Average for other LA- and HA-owned heat pumps in domestic properties recorded in the database
	Schools	Solar thermal	7kWth	Average for other school solar thermal installations recorded in the database
	Schools	ASHP	10kWth	Average for school ASHP installations recorded in the database
	Schools	Biomass	200kWth	Average for other school biomass boiler installations recorded in the database
	Other buildings	Heat pumps (ASHP and GSHP)	16kWth	Average for 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[28]
	Domestic properties	Heat pumps (ASHP and GSHP)	7kWth	Average for other LA- and HA-owned heat pumps in domestic properties, recorded in the database
	Domestic properties	ASHP - EAHR[29]	4kWth	Average for other LA- and HA-owned ASHP-EAHR's in domestic properties, recorded in the database
Industrial	Commercial	Energy from waste	1.6MW	Average for all energy from waste plants in the database
Unknown	Unknown	Solar Thermal	4.14kWth	Average for all systems <45kWp in database
Unknown	Unknown	Biomass	0.341MW	Average of all biomass

[27] 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.
[28] 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.
[29] 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 to the building.

				systems in database
Unknown	Unknown	ASHP	20kWp	Average for all systems <45kWp in database
Unknown	Unknown	GSHP	31kWp	Average for all systems <45kWp in database

Appendix 3. Measurement of heat demand in Scotland

1. This appendix sets out:
    - how Scottish Government derived the original 11% renewable heat target
    - how until recently the Scottish Government monitored progress on renewable heat as a percentage of projected 2020 heat demand
    - an explanation of how improved data and a new methodology is now being used to monitor renewable heat as a percentage of annual non-electrical heat demand in Scotland.

Background

2. Heat has been estimated to account for more than half of Scotland's total energy use.[30] 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[31] set a target of delivering 11% of Scotland's projected 2020 (non-electrical)[32] heat demand from renewable sources.

3. In 2006, the Scottish Energy Study[33] 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.

[30] Energy in Scotland 2014 (Article 5), Scottish Government, http://www.scotland.gov.uk/Resource/0044/00444530.pdf
[31] Renewable Heat Action Plan (2009). http://www.scotland.gov.uk/Publications/2009/11/04154534/0
[32] 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.
[33] Scottish Energy Study, Vol 1 (2006). http://www.scotland.gov.uk/Publications/2006/01/19092748/0

Derivation of the 11% heat target

4. 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 9).

Table 9: 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[34])	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%**

Improving data on heat demand in Scotland

5. 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[35] 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.

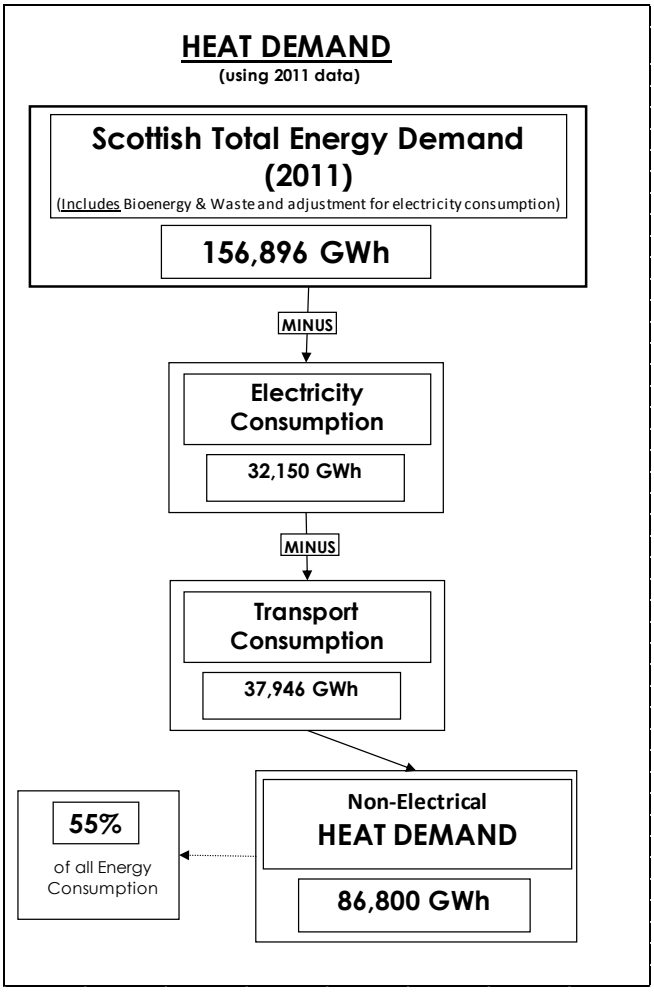
6. The DECC data shows a breakdown of final energy consumption by end use for Scotland down to local authority level. By subtracting electricity and transport consumption from the final energy consumption figure (as well as making adjustments for bioenergy & waste and electricity consumption[36]), this results in an estimate for non-electrical heat demand in Scotland (see the flow chart in figure 1 below for more detail).

[34] 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

[35] 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

[36] 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 8: Heat demand methodology



7. The methodological differences between the 2006 Scottish Energy Study and DECC's annual estimates of final energy consumption has implications for the monitoring of the renewable heat target. Table 10 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.

Table 10: Renewable heat target - renewable heat as a % of heat demand

	2009	2010	2011	2012	2013
Total renewable heat output (GWh)[1]	845	1,696	2,263	2,481	2,904
Non-electrical heat demand: fixed 2020 forecast (GWh)	*60,089*	*60,089*	*60,089*	*60,089*	*60,089*
Non-electrical heat demand: annual estimate (GWh)	**87,045**	**89,135**	**86,800**		

New measure: % of Renewable Heat Output (annually) [2]	**1.0%**	**1.9%**	**2.6%**	-	-
Previous measure: % of Renewable Heat Output (2020 demand) [3]	*1.4%*	*2.8%*	*3.8%*	*4.1%*	*4.8%*

8. 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 – 2012 data will not be available until September 2014
- 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.

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

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