



Forestry Commission Scotland
Coimisean na Coilltearachd Alba

Woodfuel

Demand and Usage in Scotland
Report 2015



Woodfuel Demand and Usage in Scotland Report 2015

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Report prepared for Forestry Commission Scotland by Hudson Consulting Ltd and John Clegg Consulting Ltd.



Executive summary

1. This report on existing and potential woodfuel use covers the years 2013 and 2014 and assesses the possible additional use of woodfuel up to the end of 2018. The methodology used to collect woodfuel information in this report has been further developed from that used in the last survey published in 2013.
2. At the end of 2013 there were an estimated 1,784 boilers using woodfuel in Scotland. During 2014 a large number of boilers were accredited into the Government's Renewable Heat Incentive (RHI) schemes resulting in an overall total of 3,906 boilers using woodfuel in Scotland by the end of 2014, with 99% of the installations being heat only installations with a thermal capacity of less than 1,000kW.
3. Total woodfuel used in Scotland in 2013 was 775k oven dry tonnes (odt) and by the end of 2014 the total had risen to 1,098k odt. In 2012 the total woodfuel used was estimated to be 737k odt so there was an overall increase of 49% in the amount used in this two-year period.
4. In 2014, the number of large boilers with a capacity of 1,000 kilowatt thermal (kWth) and above represented 1% of all boilers using woodfuel in Scotland. The amount of woodfuel used by the boilers in this category dropped as percentage of total woodfuel use from 94% in 2012 to 89% in 2013 and 84% in 2014.
5. The highest numbers of wood-fuelled boilers are in Highland Council (>20%), Dumfries & Galloway (<12%), and Aberdeenshire (>9%) Local Authority areas, but other Council's with predominantly rural areas also contain significant numbers. The number of boilers using woodfuel in urban areas is relatively low.
6. The majority of woodfuel used in Scotland continues to be virgin fibre, sawmill co-products and process residues (59% in 2013 and 53% in 2014), but recycled wood remains very important source of fuel for the largest boilers and accounted for 38% and 42% of all woodfuel used in Scotland in 2013 and 2014 respectively. Pellets accounted for 2% in 2013 and 4% in 2014.
7. No new woodfuel projects involving boilers with a capacity of 1,000kWth and above are presently foreseen in the next 3 years. Assuming that proposals for five commercial plants less than 1000kWth in capacity and the expansion of another proceed as planned, they may increase the total woodfuel use by some 268,000 odt per year by the end of 2018. Continued 'degression' of tariff rates offered by the Department of Energy and Climate Change (DECC) as a result of a high uptake of RHI schemes and the reduction in the price of oil, may slow the rate of installations in the heat category of less than 200 kWth, which has seen the highest increase in the number of boilers in the last two years.
8. No new wood pellet plants have been opened since 2012 so the total in Scotland remains at 5. The quantity of wood used for the manufacture of pellets in 2013 was approximately 294k odt and in 2014 the total rose to 304k odt.
9. Woodfuel boilers in Scotland contributed 2,036k megawatt hours (MWh) in 2013 and 2,744k MWh in 2014 to the Scottish Government's renewable heat targets.
10. Wood-fuelled boilers in Scotland are estimated to have saved 845k tonnes of CO₂e in 2013, which is slightly less than in 2012, mainly due to changes in the methodology used, and in 2014 saved 1,272k tonnes of CO₂e.

1. The brief

To update the Woodfuel Demand and Usage in Scotland Report and to provide data for the period from 1st January 2013 to 31st December 2014, with the figures for 2013 and 2014 being given separately. In each of these years the use of woodfuel is presented using three heat capacity bands.

2. Methodology

2.1 Data collection

Data for this report was collected by email correspondence, telephone calls and face-to-face interviews with woodfuel users, installers and other stakeholders, as has been done for previous reports. Figures provided by woodfuel users were used on strict conditions of confidentiality and are therefore only reported on an aggregated basis. In addition, information was received from the Statistics Branch of the Forestry Commission on woodfuel use, as reported by companies in response to a range of surveys and data requests.

Unlike in previous years, this report has also been able to make extensive use of the data collected and published by the Department of Energy and Climate Change (DECC) on Renewable Heat Incentive (RHI) accredited boilers in the domestic and non-domestic schemes plus earlier Scottish Biomass Heat Scheme (SBHS) survey data.

Further information about the datasets is given below and which periods they cover is presented on a timeline graph in Figure 1:

Non-domestic boilers

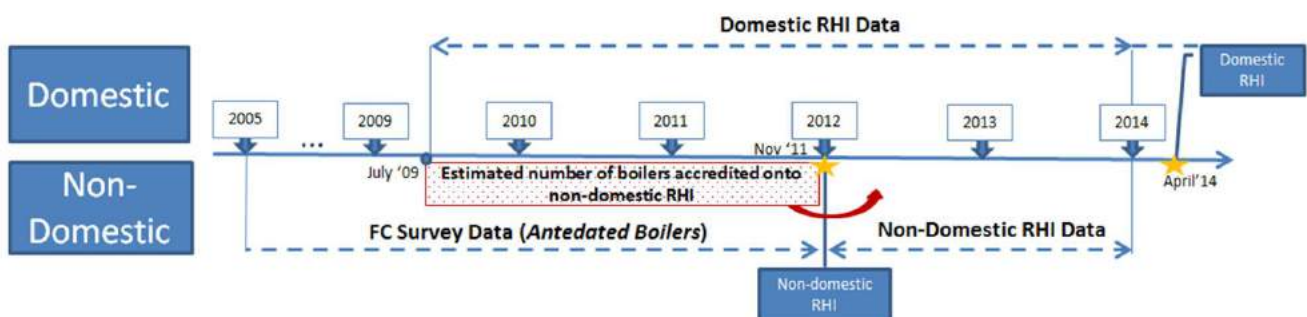
- The RHI scheme for non-domestic buildings was introduced in November 2011, although it is assumed in this study that no new boilers were commissioned until January 2012.
- Biomass boilers installed after July 2009 were eligible to be subsequently accredited onto the RHI scheme ('RHI backdating').
- FC survey data covers non-domestic boilers installed between 2005 and 2012. However, the 2012 survey data is only included in the calculations of the average woodfuel use per installation. The aggregate number of boilers for that year has been replaced with the number of boilers obtained from the non-domestic RHI data.
- Boilers included in the FC's survey data, which were installed by the end of 2011, are referred to as '**antedated boilers**' for the purpose of this report. DECC refers to boilers installed between July 2009 and November 2011 and subsequently accredited onto the RHI scheme as 'legacy' boilers.

- Allowing backdating within the RHI scheme meant that FC and RHI datasets overlapped and introduced a potential issue of **double-counting** for a number of non-domestic boilers installed prior to 2012. Due to the confidentiality of the RHI data, individual legacy boilers could not be identified. The problem was however minimised using information on grant repayment levels for boilers originally funded by the Scottish Biomass Heat Scheme (SBHS). Owners who wished to enter the RHI scheme with a legacy boiler had to pay back the SBHS grant to avoid double funding. Based on this information, it has been estimated that approximately 30% of antedated boilers (installed before 2012) were subsequently accredited onto the non-domestic RHI scheme after its inception. This figure was then applied to the overall number of boilers included in the FC survey data for 2009-2011 and 42 boilers, using an estimated 4,600 odt/year, were removed from that dataset.
- Based on the FC survey data (2005-2012) on boilers using less than 1,000 odt per year the average boiler size was 164.52kW and the average woodfuel consumption per boiler was 98.334 odt/year or the equivalent of **0.5977 odt per year per kW of boiler heat capacity**. In the absence of this information in the RHI data, this conversion number has been applied to 2013 and 2014 estimates.

Domestic boilers

- The RHI scheme for biomass boilers installed in domestic buildings was launched on 9th April 2014, but boilers installed after 15th July 2009 were eligible to be subsequently accredited to either of the schemes.
- No information is available on wood-fuelled boilers installed in domestic buildings prior to 15th July 2009.
- According to UK Housing Energy Fact file (DECC, 2013) and the estimates provided by the industry experts¹, **the average woodfuel consumption per domestic installation has been estimated to be approximately 4 odt of woodfuel per annum**.
- This research excludes firewood used in open fires or wood burning stoves in domestic homes.

Figure 1: Datasets timeline



¹ W. Richardson Jan 2016, pers. comm. and UK Housing Energy Fact File (DECC, 2013)



Data for domestic and non-domestic boilers

- The data available on the amount of heat generated by boilers accredited into the domestic and non-domestic RHI schemes differs. The payments received by owners of boilers in non-domestic buildings are related to the actual amounts of heat generated, which is metered on site, so this information is collected and recorded by DECC. The owners of boilers in the domestic RHI scheme are not required to record the actual amounts of heat generated. Their payments are based on an estimate related to the energy consumption of a property at time of installation and these payments are made annually irrespective of the amount of heat generated.
- This study assumes that since the inception of the RHI schemes, all newly installed biomass boilers will be registered to receive the RHI, or, where they are electricity or combined heat and power (CHP) plants, they will be participating in the government's Renewables Obligation (RO) incentive scheme and data available from DECC will therefore include them.
- Boilers installed for generating heat in the larger wood processing plants will normally be fuelled with as much on-site process residue as possible such as bark, offcuts and sander dust. Where necessary companies can supplement their on-site supplies by diverting some of their existing roundwood or sawmill co-product purchases to make up quantities rather than separately buying-in virgin material such as logs, wood chips or recycled timber to fuel their biomass boilers. It has not been possible to obtain data that will allow separation of the quantities of these different fuel types that have been used. They have therefore all been classified together as 'virgin fibre, sawmill co-products and process residues' for the purposes of this report.

2.2 Scope and structure of report

The results in this report are presented separately for 2013 and 2014 and are based on calendar years.

In previous reports, the focus was on collecting data on the amount of woodfuel used by industrial / commercial plants and the results were presented according to the scale of wood use broken into three size categories: industrial / commercial plants using >10,000 odt/year of woodfuel, plants using 1,001 to 10,000 odt /year of woodfuel, and those plants using up to 1,000 odt /year of woodfuel.

As a result of the introduction of the Domestic RHI scheme and the availability of RHI data, two changes have been made in the way the results are presented in this report:

- The estimated quantity of woodfuel used by boilers installed for domestic use under the RHI scheme has been included.

- The results are now presented using the following three heat banding categories, which correspond to the three tariff bands used by DECC in the Non-Domestic RHI scheme:
 - Plants with an installed capacity² of 1,000kWth and above (sections 3.1.1 and 4.1.1)
 - Plants with an installed capacity of 200kWth and above, but less than 1000kWth (sections 3.1.2 and 4.1.2)
 - Plants with an installed capacity of less than 200kWth (sections 3.1.3 and 4.1.3)

Information on the types and quantities of woodfuel used in boilers with a heat generating capacity of 1,000kWth and above was collected as part of this research. For non-domestic boilers with a capacity of less than 1,000kWth, the estimate of wood fuel consumption is based on previously collected data and for domestic boilers on the Wood Heat Association (WHA) analysis.

3. Results for 2013

3.1 Woodfuel used by operational boilers

The total number of antedated and RHI accredited woodfuel boilers commissioned by the end of 2013 in Scotland is estimated to have been 1,784. This total has been compiled using survey information on the number of boilers in non-domestic buildings that was collected prior to 2012 (antedated boilers) and DECC RHI data from, and including, 2012. The total of 1,784 also now includes boilers accredited onto the Domestic RHI scheme commissioned between July 2009 and December 2013.

3.1.1 Woodfuel used by boilers providing 1,000kWth and above

At the end of 2012, there were 20 biomass boilers identified that were operating in industrial / commercial premises in Scotland that had the capacity to provide more than 1,000 kW of heat. At the end of 2013, there were a total of 24 boilers operating in this category. Four of these plants were Combined Heat and Power (CHP) plants and the rest provided only heat. **The boilers in this heat category used a total of 691,680 odt of woodfuel during 2013.**

² Capacity refers to the maximum instantaneous power output of a biomass boiler, and is usually measured in kilowatt thermal (kWth) or megawatt thermal (MWth).

3.1.2 Woodfuel used by boilers providing $\geq 200\text{kWth}$ but less than $1,000\text{ kWth}$

Survey data for the years 2005 – 2011 shows that 73 boilers were installed within this heat category with an average heat capacity of 365kW per boiler after correction for double-counting (see section 2.1).

From November 2011 onwards, when the Non-Domestic RHI scheme was introduced, DECC recorded details of all the commissioned boilers accredited into the Non-Domestic RHI scheme. The aggregated RHI data shows 27 and 37 boilers were accredited to the non-domestic scheme in 2012 & 2013 respectively, giving the total number of 137 boilers operational in non-domestic buildings in this heat band at the end of 2013.

Boilers in the Domestic RHI scheme must have a capacity of less than 45kW and so they are too small to be included in this heat capacity category.

Using the earlier calculated rate of 0.5977 odt per year per 1kW of boiler capacity (see section 2.1) it is possible to estimate the average woodfuel consumption per installation in this heat category equals 218 odt per year. As there were 137 boilers operating in this category, **it is estimated that they used a total of 29,888 odt of woodfuel during in 2013.**

3.1.3 Woodfuel used by boilers providing less than 200kWth

Previous woodfuel use surveys recorded that there were 186 boilers within this heat capacity range being used in non-domestic situations prior to the Non-Domestic RHI scheme being introduced in November 2011.

In 2012, 190 commissioned boilers were accredited to the Non-Domestic RHI scheme in this category, of which 28 were estimated to be antedated boilers which were removed to avoid double counting. This gives a total of 348 boilers at the end of 2012. A further 423 commissioned boilers were accredited to the Non-Domestic RHI scheme in 2013, bringing the total number of non-domestic boilers at the end of 2013 to 771.

For the Domestic RHI scheme, although it was only launched in 2014, boilers installed since July 2009 were eligible to join the scheme. DECC data available in 2015 shows that 448 boilers commissioned between 2009 and the end of 2012 were accredited into the Domestic RHI scheme. A further 404 accredited boilers were commissioned in 2013, giving a total of 852 domestic boilers operating in this heat category at the end of 2013.

Combining the number of boilers in non-domestic and domestic situations gives a total of 1,623 boilers operating at the end of 2013 in this heat band.

For 2012 and 2013, the weighted average capacity for Non-Domestic RHI boilers in this heat band was 109kW per installation. Using the previously calculated relationship of

0.5977 odt of woodfuel per year per 1kW of boiler heat gives average woodfuel consumption of 65.15 odt per year per installation. As there were 771 non-domestic boilers in this heat band at the end of 2013, their total estimated wood fuel consumption was 50,231 odt.

DECC data shows that the median capacity of boilers in the Domestic RHI scheme was 25kW using data available in August 2015. The maximum eligible capacity of boilers in the Domestic RHI scheme is 45kW. According to UK Housing Energy Fact file (DECC, 2013) and the estimates provided by the industry experts, an average woodfuel consumption per domestic installation has been estimated to be approximately 4 odt of woodfuel per year. As there were 852 boilers accredited into the domestic RHI scheme by the end of 2013, their total fuel consumption was estimated to be 3,408 odt.

The total amount of woodfuel used by the 1,623 boilers operating in <200kWth heat band at the end of 2013 was 53,639 odt.

3.1.4 Total woodfuel use

The estimated amount of woodfuel used by boilers in the three different heat categories is summarised in Table 1. The total amount of woodfuel used in Scotland in 2013 was 775k odt.

Table 1: Total amount of woodfuel used by boilers in three heat capacity categories in 2013.

Heat category of boiler	Number of boilers		As %	odt		As %
Boilers providing ≥1,000kWth	24		1	691,680		89
Boilers providing 200kWth – 999kWth	137		8	29,888		4
Boilers providing less than 200kWth	domestic 852	non-domestic 771	91	domestic 3,408	Non-domestic 50,231	7
Total	1,784		100	775,207		100

Of the total woodfuel used, 89% was consumed by boilers generating 1,000kWth or more with the next highest consuming category being boilers providing less than 200kWth. These figures cannot be compared directly with those in previous reports as the method of reporting has been changed this year.

The aggregate number of boilers in the Renewables Obligation (RO) (a government incentive scheme which covers combined heat and power and power-only biomass plants) and Non-Domestic RHI scheme can be shown by Local Authority area. The Domestic RHI

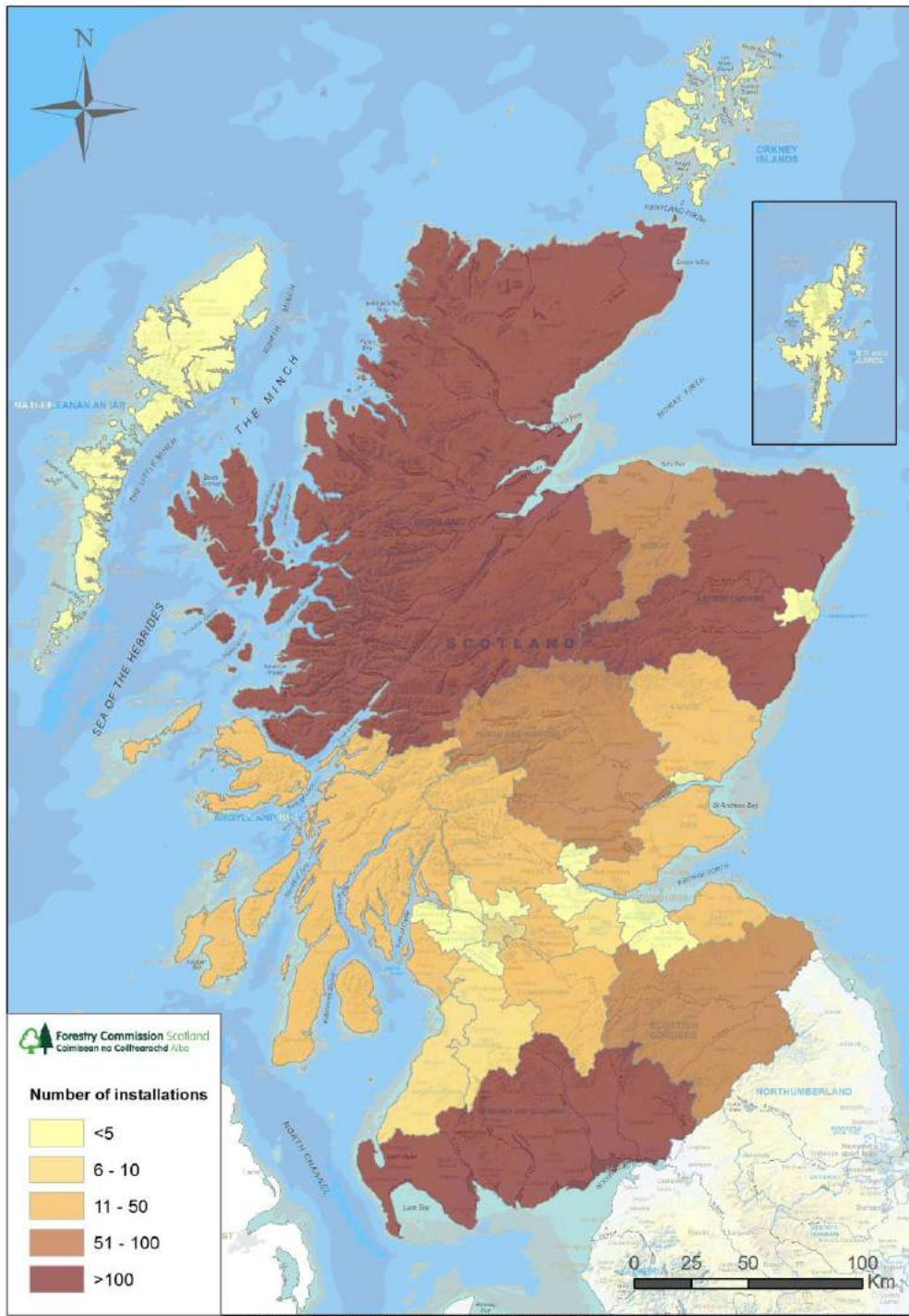


scheme was not yet in place in 2013 and information on the geographic location of legacy installations was not available.

Map 1 shows that the highest number of antedated and RO & RHI accredited non-domestic woodfuel boilers commissioned by the end of 2013 were situated in Highland, Dumfries & Galloway and Aberdeenshire³.

³ DECC RHI data does not identify Local Authorities where fewer than 5 boilers were accredited, but data is available on non-domestic RHI installations prior to 2012 based on earlier survey data and this has been included.

Map 1: Geographical distribution of antedated and Non-Domestic RHI & RO accredited boilers commissioned by the end of 2013 that use woodfuel by Local Authority area



It is important to note that the Local Authority areas with the highest number of boilers are not necessarily the Local Authority areas where the largest quantities of woodfuel are used. For example, some Local Authorities may not have a boiler generating 1,000kWth or more with a large woodfuel usage, but instead they may have a large number of very small ones consuming a relatively small amount of woodfuel.

3.2 Woodfuel use by fuel category

Information on the types and quantities of woodfuel used in boilers with a heat generating capacity of 1,000kWth or more in Scotland has been collected as part of the research for this report and is therefore available.

For boilers with a heat capacity of less than 1,000kWth, analysis of the types of woodfuel use was collected up to and including 2012 and showed that 73% of the woodfuel comprised wood chips and sawmill co-products, 25% comprised pellets and 2% other material. In the absence of more detailed information these percentages have been applied to estimate the woodfuel types used in Scotland for non-domestic boilers. A biomass fuel and capacity analysis of Ofgem Non-Domestic RHI data for GB by the Wood Heat Association (WHA)⁴ for the period up to September 2015 indicated that 50% of the woodfuel used was in the form of wood pellets, 33% in the form of woodchips and the rest logs. The percentage of pellets used in Scotland therefore looks significantly lower, but this may reflect a more readily available supply of coniferous woodchips compared with most other parts of the UK.

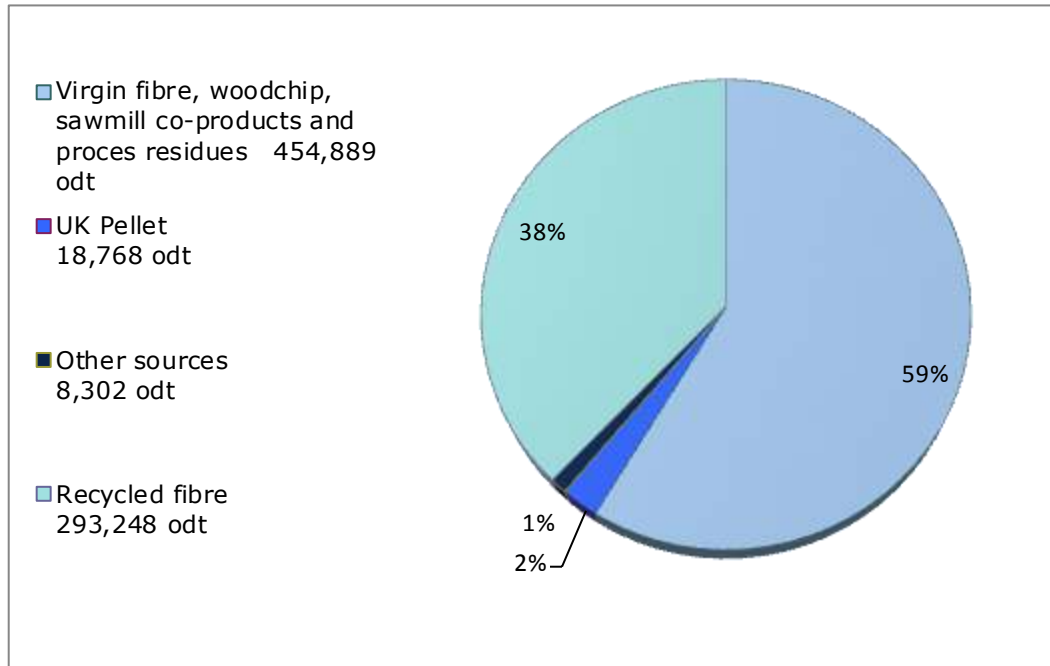
The WHA analysis of the type of fuel used in boilers accredited to the Domestic RHI scheme shows that some 90% of the domestic boilers in Great Britain use wood pellets and the remaining 10% use logs. In the absence of any other data it has been assumed that wood pellets account for 90% of the fuel used in domestic boilers in Scotland and the remaining 10% are logs, although it is possible that less wood pellets may be used in Scotland because wood chips and logs are more readily available in the rural parts of Scotland (where most of the boilers have been installed) compared with elsewhere in Great Britain.

Based on survey information and the above assumptions, the estimated total woodfuel used in 2013 by fuel category is set out in Figure 2.

The majority of woodfuel used in Scotland continues to be virgin fibre, sawmill co-products and process residues (59%), but recycled wood remains very important source of fuel (38%) especially for the largest boilers, and UK pellets accounted for the smallest amount (2%) of all woodfuel used in Scotland in 2013.

⁴ Wood Heat Association, 2015. RHI: Biomass Fuel and Capacity Analysis.

Figure 2: Woodfuel usage by fuel category in 2013



3.3 Pellet plants operating in Scotland

In 2013, no new pellet plants started operating in Scotland so the total remained at 5. Their total intake of logs and sawmill co-products was 294k odt.

3.4 Contributions towards Scottish Government renewable heat targets

Operational data on the contributions that wood-fuelled boilers made to the Scottish Government's renewable heat targets in 2013 is not available for all heat categories of boilers. However, operational data has been collected for boilers that provide $\geq 1,000\text{kWth}$ as part of this study.

The heat output obtained operationally from boilers with a heat capacity of less than $1,000\text{kWth}$ is not available, but the numbers of boilers in each heat category, and estimates of the average thermal capacity of the boilers, have been given in previous sections. As the number of operational hours is not known, these have been estimated by assuming that the boilers are only used for 6 months of the year (180 days) and they are then only operating 10 hours a day. Using these estimates, the annual operating hours work out at 1,800. This represents a 20.5% load capacity and equates very closely with DECC's assumed load capacity of 20%.

The contribution that woodfuel made towards the Scottish Government's renewable heat targets in 2013 has been estimated based on the above data and assumptions and is given in Table 2.



Table 2: Estimated contribution of woodfuel to Scottish Government renewable heat target in 2013

Boiler Heat Category	No of Boilers	Annual Operational hrs ¹	Av Boiler capacity kWth	Heat output MWh
Boilers ≥ 1,000kWth	24	Survey data	Survey data	1,756,784 ⁵
Boilers ≥ 200 - 999kWth	137	1,800	365	90,009
Non - domestic RHI boilers < 200kWth	771	1,800	109	151,270
Domestic RHI boilers < 200kWth	852	1,800	25	38,340
Total	1,784			2,036,403

Of the total heat output generated by woodfuel in 2013, 86% was contributed by boilers with a thermal capacity of 1,000 kWth or more.

3.5 Carbon savings

For wood-fuelled boilers that have been accredited into the Renewables Obligation scheme, the recorded actual annual production of electricity and heat has been used to calculate carbon savings rather than the thermal capacity of the boiler on which calculations have been based in previous years.

The carbon savings achieved as a result of using woodfuel rather than other energy sources can be calculated using conversion factors for different fuel types published annually by DECC⁶. The conversion factors for 2013 are given in Table 3.

⁵ Total obtained from survey reduced to account for heat generation for pellet production

⁶ DECC, 2015: Government CHG Conversion Factors for Company Reporting



Table 3: Conversion factors used to calculate greenhouse gas emissions savings for 2013

Substituted fuel (1kWth)	Conversion factor: net CV kg CO₂e
Electricity	0.5146
Compressed natural gas	0.20421
Burning oil (kerosene)	0.25836
Coal (industrial)	0.22991
LPG	0.28594

For boilers with a capacity of 1,000kWth or more it was feasible for most of the plants to record the substituted fuel to which the appropriate conversion factor has been applied. It is not possible to identify what type of fuel was being replaced in most boilers with a thermal capacity of less than 1,000kWth and it has therefore been assumed that it was oil (Burning oil – kerosene). The carbon savings have been calculated using a calorific value of wood of 5,000 kWh per tonne and are shown in Table 4.

Table 4: Carbon savings from woodfuel projects in Scotland in 2013

Heat category of boiler	Woodfuel use (odt / annum)	Annual CO₂e savings (tonnes/ annum)
≥1,000kWth	691,680	786,109
200kWth – 999kWth	29,888	38,609
less than 200kWth	53,639	69,290
Total	775,207	894,008

The estimated total carbon saving for 2013 is significantly lower than the estimated carbon saving calculated in 2012 (1,046k tonnes of CO₂e). There are a number of reasons for this. The method of calculating the carbon savings generated by CHP plants has changed and has now been calculated in accordance with more recent DECC guidelines. The actual production of heat and electricity has been obtained for the first time from the major woodfuel users, rather than basing the calculation on boiler capacity. There have been some small reductions in the amount of woodfuel used in some boilers due to replacement by other non-woody biomass materials and the DECC guidelines for the calculation of greenhouse gas emissions from burning oil as a substitute fuel has fallen from 0.30786 used in calculating carbon savings in 2012 (based on a 2010 figure), to 0.25836 in 2015.

4. Results for 2014

4.1 Woodfuel used by operational boilers

The total number of boilers using woodfuel at the end of 2013 is estimated to have been 1,784 boilers. In 2014, it is estimated that another 2,122 boilers were commissioned and accredited into RHI schemes bringing the total to 3,906. This is a very significant increase compared with previous years.

4.1.1 Woodfuel used by boilers providing 1,000kWth

At the end of 2013, there were 24 boilers operating in this heat category and a further 2 boilers became operational during 2014 bringing the total to 26 boilers of which 5 were CHP plants. **During 2014 these 26 boilers used a total of 921k odt of woodfuel.**

4.1.2 Woodfuel used by boilers providing ≥ 200 kWth but less than 1,000 kWth

At the end of 2013, there were 137 boilers operating in this heat category. Based on survey data and DECC Non-Domestic RHI data, it is calculated that a further 27 commissioned boilers were added in this size category in 2014, giving a total number of 164.

The estimated average woodfuel consumption per installation as used for 2013 (section 3.1.2) of 218.16 odt /year per installation, **the amount of woodfuel used in 2014 by the 164 installations is calculated to be 35,778 odt.**

4.1.3 Woodfuel used by boilers providing less than 200kWth

The number of antedated and RHI accredited boilers into the Non-Domestic and Domestic RHI schemes was calculated to be 1,623 boilers at the end of 2013 of which 771 were non-domestic boilers and 852 were commissioned boilers accredited into the Domestic RHI scheme. DECC RHI data shows that a further 1,124 commissioned boilers in this heat category were accredited into the Non-Domestic RHI scheme in 2014 giving a total of 1,895 and a further 969 commissioned boilers were accredited into the Domestic RHI scheme in 2014 giving a total of 1,821. The number of antedated and RHI accredited boilers in this heat category commissioned by the end of 2014 totalled to 3,716.

For 2012 - 2014, the weighted average capacity for Non-Domestic RHI boilers in this heat band was 118kW per installation. Using the previously calculated relationship of 0.5977 odt of woodfuel per year per 1kW of boiler heat gives an average woodfuel consumption per installation of 70.57 odt per year. **As there were 1,895 antedated and RHI accredited boilers in the Non-Domestic scheme in 2014, their total estimated wood fuel consumption was 133,730 odt.**

DECC data available in August 2015 shows that the median capacity of boilers accredited in the Domestic scheme was 25kW. According to UK Housing Energy Fact file (DECC, 2013) and the estimates provided by the industry experts⁷, an average woodfuel consumption per domestic installation equals to approximately 4 odt of woodfuel per year. **As there were 1,821 boilers accredited to the Domestic RHI scheme in this category, their total woodfuel consumption was estimated to be 7,284 odt in 2014.**

In total, there were 3,716 antedated and RHI accredited boilers commissioned by the end of 2014 in this heat category and the total wood fuel used is calculated to have been 141,014 odt.

4.1.4 Total woodfuel use

Over the 2014 calendar year, the total aggregated amount of woodfuel used by boilers in the three heat categories was 1,098k odt (Table 5). This is an increase of 323k odt (29%) compared with the previous calendar year.

Table 5: Total woodfuel used by heat capacity of boilers in 2014

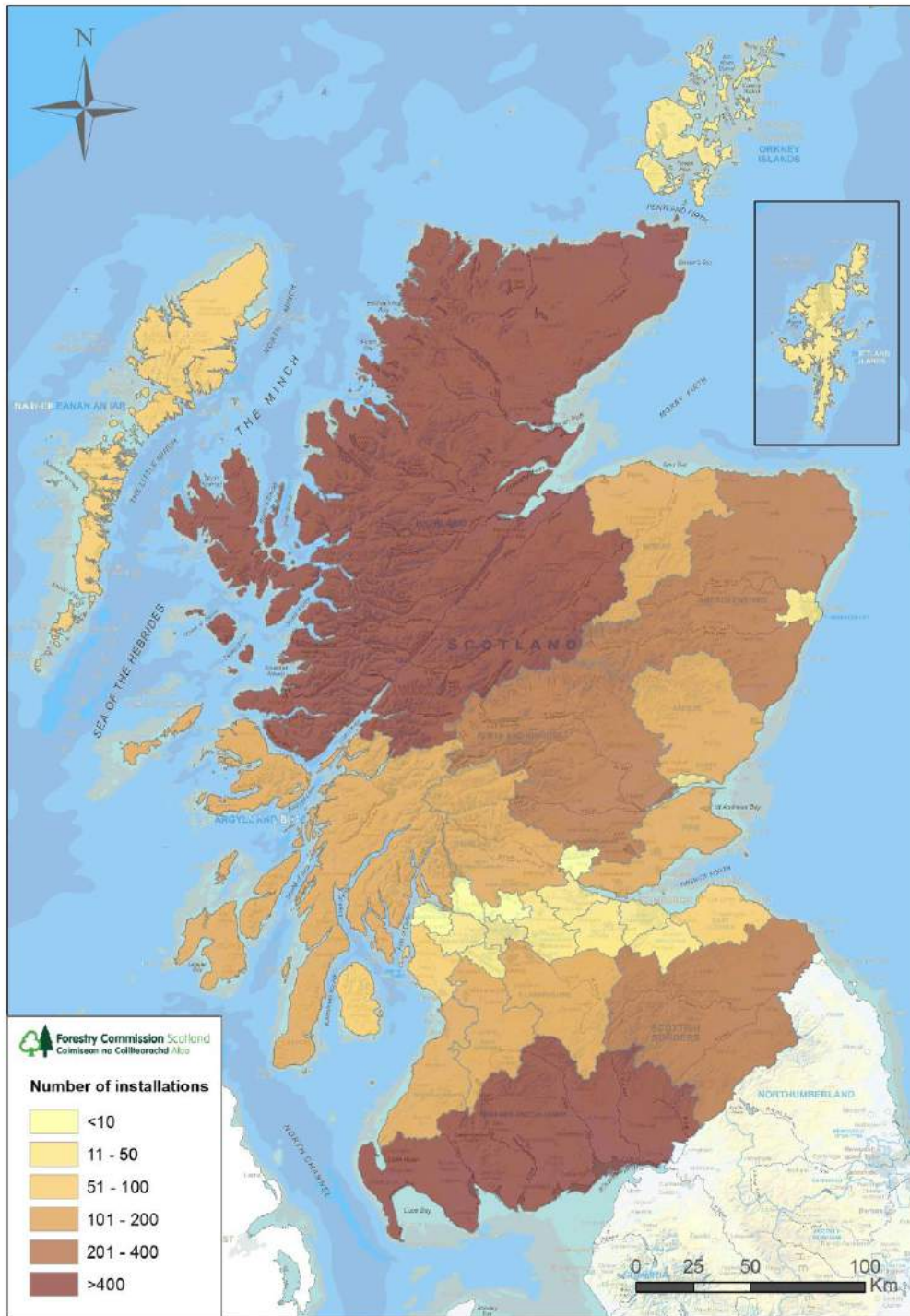
Heat category of boiler	Number of boilers		As %	odt		As %
≥1,000kWth	26		1	921,083		84
200kWth – 999kWth	164		4	35,778		3
less than 200kWth	domestic 1821	non-domestic 1895	95	domestic 7,284	non-domestic 133,730	13
Total	3,906		100	1,097,875		100

An estimated 84% of the total woodfuel used was consumed by boilers with capacity of 1,000kWth or more, with the next highest consuming category being boilers with capacity of less than 200kWth. Two large boilers came into operation in 2014, which accounts for the increase in woodfuel consumed by boilers providing 1,000kWth, but the most rapid increase in woodfuel consumption comparing to previous years occurred in the category for boilers with a capacity of less than 200kWth, where the increase was 163% compared with 2013, with the annual total accounting for 13% of all woodfuel used in 2014.

The aggregate number of antedated and accredited boilers to the Renewables Obligation, Non-Domestic and Domestic RHI schemes is shown by Local Authority area for 2014 in Map 2. For the first time, this provides a reasonably comprehensive picture of where boilers using woodfuel are located in Scotland.

⁷ W. Richardson Jan 2016, pers. comm. and UK Housing Energy Fact File (DECC, 2013)

Map 2: Geographical distribution of antedated and RHI & RO accredited boilers commissioned by the end of 2014 that use woodfuel by Local Authority area



Map 2 shows that the highest number of boilers using woodfuel in 2014 was located in Local Authorities with large rural areas. The highest number of boilers was installed in the Highland Local Authority (>800). Dumfries & Galloway had over 400 boilers and Scottish

Borders, Perth & Kinross, and Aberdeenshire all fell into the category containing between 200 and 400 boilers.

It is important to note that Local Authority areas with the highest number of boilers are not necessarily the Local Authority areas where the largest quantities of woodfuel are used. For example, some Local Authorities may not have a boiler of 1,000kWth or greater with a large woodfuel use, but have a large number of very small ones using a relatively small amount of fuel.

4.2 Woodfuel use by fuel category

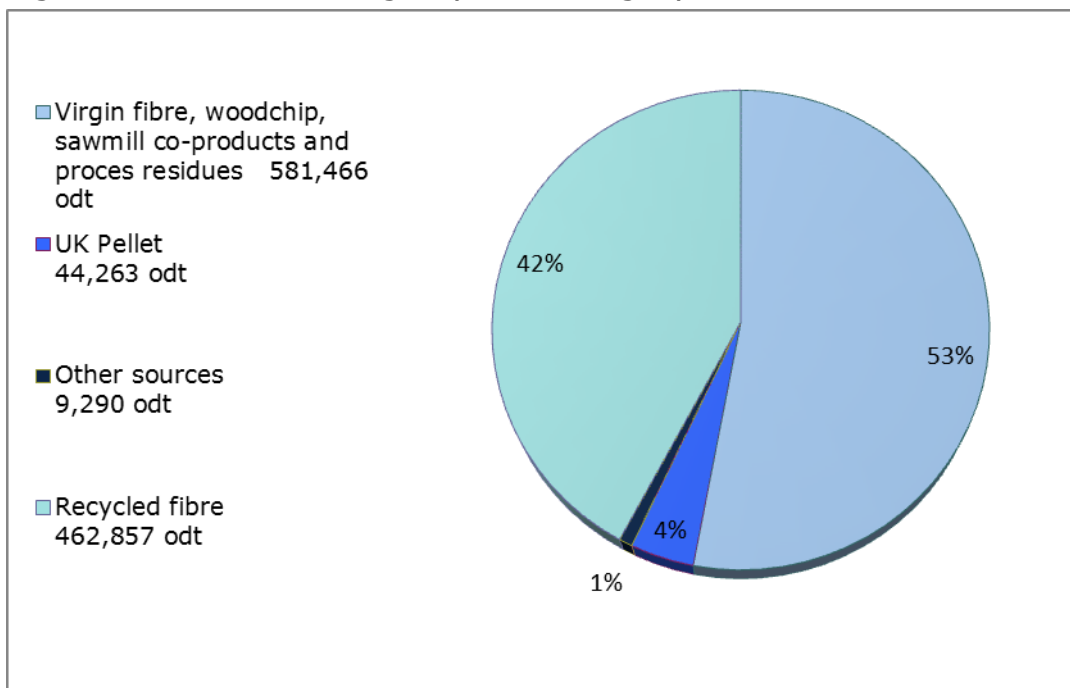
Confidential information on the types and quantities of woodfuel used in boilers with a heat capacity of 1,000kWth or more in Scotland has been collected as part of the research for this report.

To estimate the type of fuel used for the other two heat categories a similar set of assumptions has been made to those in section 3.2, namely, that the woodfuel used by boilers with a heat capacity of less than 1,000kWth in commercial situations or accredited to the Non-Domestic RHI scheme comprised 73% wood chips and sawmill co-products, 25% comprised pellets and 2% other material.

Likewise, it is assumed that in the case of boilers in the Domestic RHI scheme, the type of woodfuel comprised 90% wood pellets and 10% logs.

Based on survey information and the above assumptions, the total woodfuel used in 2014 by woodfuel category is given in Figure 3 below.

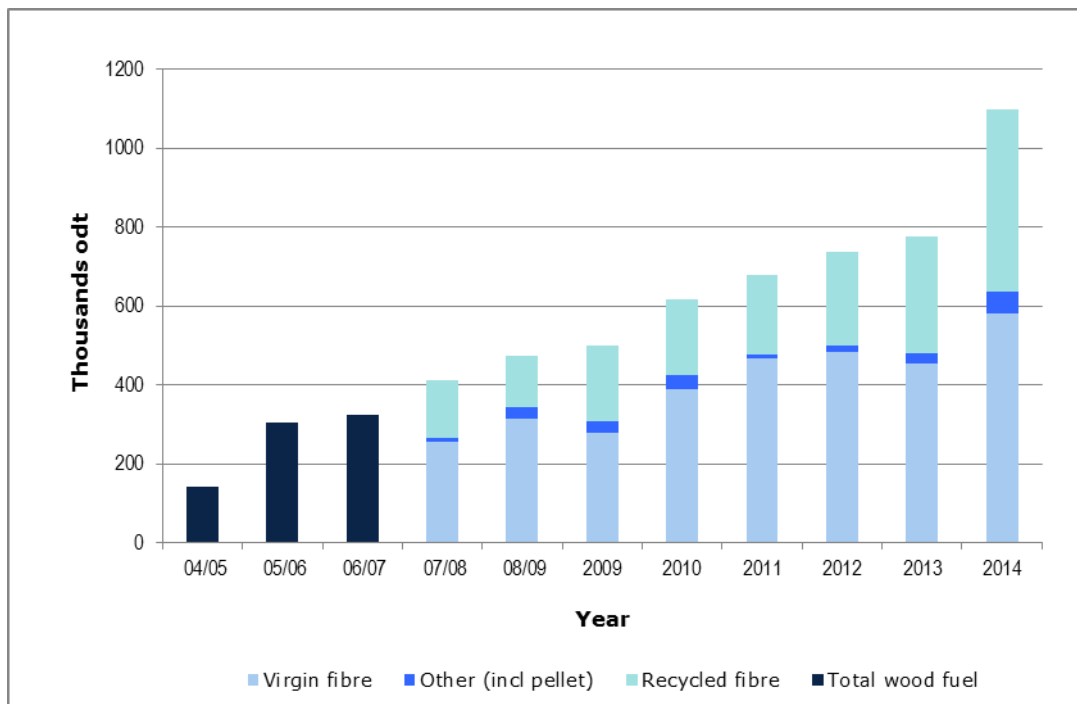
Figure 3: Woodfuel usage by fuel category in 2014



Compared with 2013, there has been a 6% reduction in the percentage split of virgin fibre and process residues used and a corresponding increase in the percentage split of recycled wood used.

Figure 4 shows total woodfuel use since 2004/2005 by major fuel category. In 2014 there has been a significant increase in woodfuel use comparing to previous years.

Figure 4: Total woodfuel use between 2004/05 and 2014 split by major fuel category.



4.3 Pellet plants operating in Scotland

In 2014, no new pellet plants started operating in Scotland so the total remained at 5. Their total intake of logs and sawmill co-products was very slightly higher than in 2013 at 304k odt.

4.4 Contributions towards the Scottish Government’s renewable heat targets

Operational data on the contributions that wood-fuelled boilers made to the Scottish Government’s renewable heat targets in 2014 is not available for all heat categories of boilers, but it is for boilers with a capacity of 1,000kWth or more.

As was the situation in 2013, the heat output obtained operationally from boilers with a heat capacity of less than 1,000kWth is not available, but the numbers of boilers in each heat category and estimates of the average thermal capacity of the boilers have been

obtained, as described in previous sections. As the number of operational hours is not known, these have again been estimated by assuming that the boilers are only used for 6 months of the year (180 days) and they are then only operating 10 hours a day. Using these estimates, the annual operating hours work out at 1,800 which represents an assumed load capacity of 20.5% which is almost identical to the DECC load factor of 20%.

The contribution that woodfuel made towards the Scottish Government's renewable heat targets in 2014 has been estimated and is given in Table 6.

Table 6: Estimated contribution of woodfuel to Scottish Government renewable heat target in 2014

Boiler Heat Category	No of Boilers	Annual Operational hrs	Av Boiler capacity kWth	Heat output MWh
Boilers \geq 1,000kWth	26	Survey data	Survey data	2,151,855 ⁸
Boilers \geq 200 - 999kWth	164	1,800	365	107,748
Non - dom RHI boilers < 200kWth	1,895	1,800	118	402,498
Domestic RHI boilers < 200kWth	1,821	1,800	25	81,945
Total	3,906			2,744,046

The estimated heat contributed to the Scottish Government's renewable heat target by woodfuel in 2014 was 2,744,046 MWh. Comparing this with the estimate in 2013 shows that there has been an increase of nearly 707,000 MWh, or 35%, in the contribution that woodfuel has made to the Scottish Government's renewable heat targets.

4.5 Carbon savings

For commissioned wood-fuelled boilers that have been accredited into the Renewables Obligation scheme, the recorded actual annual production of electricity and heat has again been used to calculate carbon savings rather than the thermal capacity of the boiler on which calculations have been based in previous years.

⁸ Total obtained from survey reduced to account for heat generation for pellet production



The carbon savings achieved as a result of using woodfuel rather than other energy sources can be calculated using conversion factors for different fuel types published annually by DECC⁹. The conversion factors for 2014 are given in Table 7.

Table 7: Conversion factors for greenhouse gas emissions for 2014

Substituted fuel (1kWth)	Conversion factor: net CV kg CO₂e
Electricity	0.5146
Compressed natural gas	0.205526
Burning oil (kerosene)	0.259657
Coal (industrial)	0.332532
LPG	0.230287

For boilers of capacity 1,000kWth or more, it was feasible for most of the plants to record the substituted fuel to which the appropriate conversion factor has been applied. It was not possible to identify what type of fuel was being replaced in most boilers with a thermal capacity of less than 1,000kWth and it has therefore been assumed that it was oil (Burning oil – kerosene). The carbon savings have been calculated using a calorific value of wood of 5,000 kWh per tonne and are shown in Table 8.

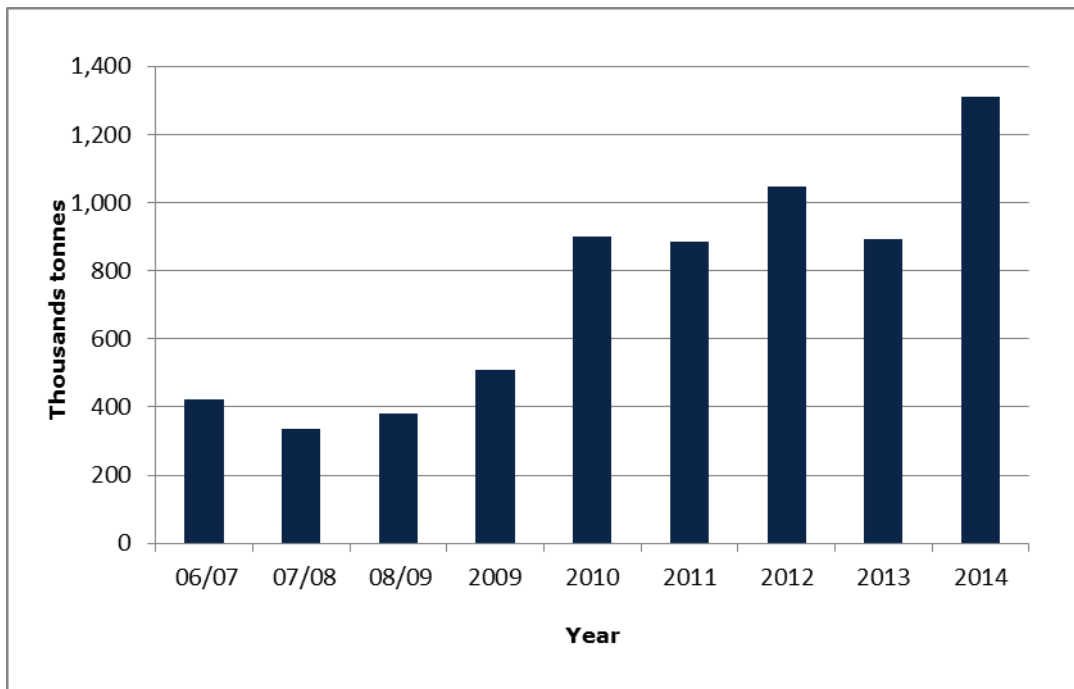
Table 8: Carbon savings from woodfuel projects in Scotland in 2014

Heat category of boiler	Woodfuel use (odt / annum)	Annual CO₂e Savings (tonnes/ annum)
Boilers ≥1,000kWth	921,083	1,079,933
Boilers 200kWth – 999kWth	35,778	46,450
Boilers less than 200kWth per annum	141,014	183,077
Total	1,046,881	1,309,460

⁹ DECC, 2015: Government CHG Conversion Factors for Company Reporting

The woodfuel boilers operating across Scotland are estimated to have saved 1,309,406 tonnes of CO₂ over the course of 2014. This is a 47% increase compared with 2013, when the annual carbon savings have dropped comparing to previous years (see Figure 5) due to changes in reporting methodology. The 2014 increase is explained in large part by a new wood-fuelled CHP plant becoming operational.

Figure 5: Annual CO₂e Savings (thousand tonnes/annum)



5. Projects in progress

The uptake of RHI funding for large biomass installations of 1000 kWth and above was significantly lower than the original programme forecast. In response, the RHI tariff for large projects doubled to 2p/kWh in April 2014. The anticipated result is an increase in the uptake of the scheme for this category of boilers in the long term. However, there are no new woodfuel projects of this scale foreseen in the next 3 years.

DECC has adopted a mechanism for budget management of RHI payments which involves "degression" of tariff rates for technologies that are absorbing more cash from the RHI budget than DECC had envisaged. For the boilers in the small category of less than 200kWth, the eighth degression in the Non-Domestic scheme and the sixth degression in the Domestic scheme come into effect in January 2016, and further degressions in tariffs are possible. In addition, the price of oil has dropped dramatically. At this stage, it is hard to predict what impact these two factors will have, but a reduction in the rate of commissioning of domestic and small non-domestic boilers in the heat category of less than 200 kWth appears very likely (the fastest growing category in the past).

At present there are two commercial projects that are scheduled to become operational in 2016, two new commercial plants (one with a probability factor of $\geq 70\%$ and the other with a factor $\geq 50\%$), and the expansion of another (probability factor of $\geq 100\%$), are planned for 2017 and another new commercial plant is being planned for 2018 (probability factor $\geq 40\%$). Assuming that all these commercial plants proposals proceed as planned they may increase total woodfuel use by some 268,000 odt per year by the end of 2018.

6. Discussion

6.1 Methodological reflections

The methodology used in this report differs from earlier ones in a number of respects:

1. It has been possible to make extensive use of data collected and published by the Department of Energy and Climate Change (DECC) on Renewable Heat Incentive (RHI) accredited boilers. This has provided a number of important benefits in terms of the coverage and comprehensiveness of information on biomass boilers and their use of woodfuel since 2012, but it also resulted in some overlap with survey data collected between 2009 and 2012 which have had to be addressed and resolved.
2. The guidance from DECC on the methodology and conversion factors to use in calculating carbon savings has been changing and the latest have been applied.
3. The actual outputs of electricity and heat from boilers in the Renewables Obligations scheme have been collected and used to calculate carbon savings rather than basing them on boiler capacity and therefore the results should be more accurate.
4. The other major change is that DECC data for small boilers accredited into the Non-Domestic and Domestic RHI schemes have been used for the first time and this provides a degree of detail that would be very hard to pick up through surveys.
5. Although there is now much better information about the number of small wood-fuelled boilers, capacity data for commissioned boilers accepted into the Domestic RHI scheme, and their woodfuel use is not considered very reliable. Operational information in this report for small boilers has been derived from past survey data and DECC data and therefore it is thought to be reasonably reliable, but changes could be taking place that are not picked up. However, any errors are thought to be small and be masked by the impact of the amount of woodfuel used in the larger boilers.

These methodological changes are thought to provide a much more accurate estimate of woodfuel use and the wider benefits of its use than has previously been possible.

6.2 Key findings

The quantity of woodfuel used in Scotland amounted to 1,098k odt in 2014, compared with 775k odt in 2013 and 737k odt in 2012.

The total number of boilers that use woodfuel in Scotland has also continued to increase significantly. In 2013 the total number of boilers using woodfuel was 1,784 and in 2014 the total was 3,906. Part of the increase can be attributed to the inclusion of information on commissioned boilers that have been accredited to the Domestic RHI scheme going back to 2009 based on DECC information available in 2015.

Boilers with a capacity of more than 1,000kWth used 692k odt in 2013 which accounted for 89% of all the woodfuel used. In 2014 the amount of woodfuel these boilers used increased to 921k odt, but the percentage of total woodfuel used by these boilers in Scotland dropped to 84% because of the rapid increase in the number of boilers with a heat capacity of less than 200kWth.

The number of wood-fuelled boilers in the medium heat band category (200kWth-999kWth) was 137 in 2013, and 164 in 2014. The total amount of woodfuel used by this category was the smallest and only amounted to 30k odt in 2013 and 36k odt in 2014.

The fastest growing number of boilers was in the category less than 200kWth. There were 771 antedated and RHI accredited boilers commissioned by the end of 2013 in the Non-Domestic scheme, that are estimated to have used 50,231 odt of woodfuel, and 852 RHI accredited boilers in the Domestic scheme that used 3,408 odt of woodfuel. At the end of 2014 there were 1,895 antedated and RHI accredited boilers in the Non-Domestic scheme, that are estimated to have used 133,730 odt, and 1,821 RHI accredited boilers in the Domestic scheme that used 7,284 odt. In total, there were 3,716 boilers in this heat category using a total of 141k odt, which accounted for 13% of all woodfuel used.

The most widely used type of woodfuel in Scotland in 2013 was virgin wood fibre in the form of chips, sawmill co-products and process residues, and this accounted for 59% of the total woodfuel used. Recycled wood was the next most widely used fuel type and accounted for 38%, with wood pellets being the third most widely used fuel type at 2% of the total. In 2014, virgin fibre, sawmill co-products and process residues accounted for 53% of the total woodfuel used, recycled wood 42% and wood pellets 4%. Recycled wood is a very important fuel type for the largest boilers, more than 1,000kWth, while pellets are the most important fuel type for boilers less than 200kWth in size.

Most wood-fuelled boilers are located in rural areas in Scotland.

There are 5 wood pellet plants operating in Scotland and they used approximately 294,000 odt in 2013 and in 2014 the total rose slightly to 304,000 odt.



Wood-fuelled boilers' contributions towards meeting Scottish Government renewable heat targets and carbon savings continued to grow in 2013 and 2014 as the number of boilers and the quantity of woodfuel used increased.

The rate at which wood-fuelled boilers have been installed is expected to slow over the next few years because of the changes in the way the UK Government encourages and supports the renewables sector and the recent major drop in the price of oil. The present indications are that total use of woodfuel may increase by a further 268,000 odt per year by the end of 2018.