

The contribution of reversible air to air heat pumps towards the Renewable Energy Directive

Introduction

Each year, the Department of Business, Energy and Industrial Strategy (BEIS) reports to Eurostat, the statistical division of the European Commission (EC), its progress against the Renewable Energy Directive (RED) target¹; 15 per cent of UK energy consumption is to be sourced from renewables by 2020. Although there is no set target for heat specific consumption, the UK aims to achieve 12 per cent by 2020.

This article provides the high level provisional results from a recent research project into heat consumption from reversible air to air heat pumps (RAAHPs) in order for heat generated by these types of heat pumps to be included in the UK's progress against the RED. The full research paper can be accessed via the following link:

www.gov.uk/government/publications/renewable-energy-from-reversible-air-to-air-heat-pumps

Key Points

- In 2016, 512 thousand tonnes of oil equivalent (ktoe) were generated by RAAHPs
- Total installed capacity of RAAHPs meeting the minimum eligible for reporting progress towards the RED was 20GW in 2016
- Heat generated by all heat pumps increased by a factor of over four
- Renewable heat (as measured on a RED basis) increased from 6.2 per cent (as reported in DUKES 2017) to 7.0 per cent in 2016
- 73 per cent of RAAHPs were used for heating at least some of the time (the remainder were either used only in cooling mode or weren't able to provide heating)
- There were 3.6 million single and split type systems operating in 2016, and 0.3 million variable flow rate systems

Background

Since 2008, the UK has included heat from heat pumps, where evidence for the stock and performance has been readily available. Previously, ground source, air source, and exhaust air heat pumps were included, using industry body sales figures to estimate the stock in addition to Eurostat default assumptions² and the results of a previous heat pump research study³. Typical capacities were estimated using data collected to support the Renewable Heat Incentive (RHI)⁴.

There are three types of systems which can be considered to be RAAHPs⁵;

- Single split air conditioners; systems where a single indoor unit is connected to a single outdoor unit, both ducted and un-ducted
- Multi split air conditioners; systems where multiple indoor units are connected to a single outdoor unit, with all units operating simultaneously
- Variable refrigerant flow (VRF); systems where multiple indoor units that can be in heating and cooling mode simultaneously are connected to one or more outdoor unit

¹ <http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32009L0028>

² In 2013, the EC published a Commission Decision providing guidelines on calculating renewable energy from heat pumps which included default assumptions;;

<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32013D0114>

³ www.gov.uk/government/publications/detailed-analysis-of-data-from-heat-pumps-installed-via-the-renewable-heat-premium-payment-scheme-rhpp

⁴ www.gov.uk/government/collections/renewable-heat-incentive-statistics

⁵ Source; Delta EE research results;

www.gov.uk/government/uploads/system/uploads/attachment_data/file/680534/renewable-energy-reversible-air-to-air-heat-pumps.pdf

Special feature – heat generated by reversible air to air heat pumps

Although market industry data showed that there was a high number of RAAHPs in the UK, it was considered likely that they were mostly used as air conditioning units rather than to provide heat. BEIS considered that even if a modest proportion of RAAHPs were used to provide at least some heating, this could provide a significant boost to renewable heat estimates.

In order to provide a more reflective picture of renewable heat in the UK, BEIS commissioned Delta Energy and Environment (Delta EE) to undertake a detailed survey of small to medium enterprises (SMEs) and energy managers to estimate key variables necessary to calculate the heat generated. These were;

- The proportion of RAAHPs able to provide heating
- Time in operation in heating mode (as opposed to cooling)
- The average capacity (this was not available from RHI data as RAAHPs are not supported by this mechanism)
- The stock of heat pumps exceeding the minimum Seasonal Performance Factor⁶ ((SPF, 2.5 as specified in the heat pump guidelines)

In addition, Delta EE were tasked with estimating other factors to improve the accuracy of the estimates; although the heat pump guidance includes some default assumptions, member states are actively encouraged to produce their own, more reflective estimates. These properties are;

- Average SPF
- Hours of operation
- The proportion exceeding the minimum SPF (100 per cent of heat pumps installed after 2008)

A regional analysis was also required as the EC Commission Decision guidance for reporting requires member states to produce estimates based on warm, average and cold climates as heat pump characteristics vary depending on the ambient temperature. The UK is classified as mostly being a warm climate apart from Scotland and the northernmost counties of England (Northumberland, Tyne and Wear, Tees Valley Cumbria, County Durham, and Cumbria.

Methodology

In order to estimate the quantity of heat generated, how heat pumps are used in situ (as opposed to relying on manufactures' specifications), are required. Delta identified that the majority of installed RAAHPs are within the commercial sector and therefore determined that the following research approaches should be pursued;

- A telephone based survey of 100 SMEs which use RAAHPs for heating
- An online survey of energy managers representing larger groups and companies active in the UK and using RAAHPs at some (or all) of their sites
- Interviews of installers active in the UK air conditioning market
- Desk based research including the analysis of previous scientific work in this area as well as market research of prices and efficiencies
- Review of market data collected by the Building Services Research and Information Association (BSRIA)

More detail on the methodology can be found in section 3.3 (page 9) of Delta EE's report⁷.

⁶ Measure of the efficiency; for example, an SPF of 2.5 means that 2.5kWh of heat is delivered for every 1kWh of electricity it uses;

[Seasonal Performance Factor \(SPF\) | Ofgem](#)

⁷ www.gov.uk/government/uploads/system/uploads/attachment_data/file/680534/renewable-energy-reversible-air-to-air-heat-pumps.pdf

Results

Final results were derived using a combination of the best quality data from each of the survey and research approaches.

Table 1 below shows a summary of the derived assumptions alongside references to the relevant section in Delta’s published report.

Table 1

Description	Assumption	Survey / research method	Section in report
Installed capacity; single & multi VRF	8.18 kW 47.47 kW	BSRIA sales data for cooling capacity plus analysis of relationship between heating and cooling capacities	Page 51, section 7.1.2
RAAHPs used for heating	73 per cent	Mean; EMA SME	Page 28, section 6.1.3 Page 45, section 6.2.3
Located in “average” climate	89 per cent	SME survey	Page 37, figure 30
Exceeding the minimum 2.5 SPF ⁸ ; Single & split VRF	50 per cent 100 per cent	Analysis of BSRIA sales data 2008 and 2017	Page 53, section 7.1.4
Hours of operation; VRF average climate VRF cold climate	738 738	EMA	Page 29, section 6.1.5
Single & multi average climate Single & multi cold climate	646 339	SME	Page 45, section 6.2.3
Proportion non-recovered heat (VRFs only)	39 per cent	SME survey	Page 56, third bullet
Average SPF	2.8	Desk research; Eunomia report ⁹	Page 53, section 7.1.4

The varied approach to the research; surveys combined with desk based research has led to more robust assumptions and has ensured more gaps in existing knowledge have been filled. For example, had the study focussed solely on the Energy Managers Association (EMA) survey, the proportion of recovered heat for VRF systems would not have been established as these systems were not prevalent among the SME sector. For those variables where data were determined using more than one approach, such as the hours of operation, there is an increased level of confidence in the results. The coverage of the study has meant that none of the default values set out by the commission have been implemented.

Table 2 below shows a comparison of the Eurostat default assumptions compared to the results of Delta EE’s research:

⁸ For reporting the UK’s progress against the Renewable Energy Directive, only heat generated by heat pumps exceeding the minimum SPF. For other renewables reporting such as The Digest of UK Energy Statistics (DUKES), all heat pumps are included. This applies to all heat pumps, not just RAAHPs

⁹ “RHI Evidence: Reversible Air to Air Heat Pumps”;
www.eunomia.co.uk/reports-tools/rhi-evidence-report-reversible-air-to-air-heat-pumps/

Table 2

	Hours of operation		Average SPF	
	Average climate	Cold climate	Average climate	Cold climate
Split and multi split	646	339	2.8	2.8
VRF	738	738	2.8	2.8
Apportioned ¹	669	438	2.8	2.8
Eurostat assumption	710	1,970	2.6	2.5

¹ As Delta had produced estimates for the different types of RAAHPs, it was necessary to produce an overall figure. This was done using apportionment depending on the relative installed capacities. As installed capacity for single and multi split systems was much greater than that for VRF systems, the net result was skewed towards single and multi splits.

Where the results of the survey differ most to the default assumptions is in the hours of operation in the colder climate; just 438 compared to 1,970.

The formula used to calculate the useable energy value is provided in the Commission guidance;

Installed capacity X proportion >2.5 SPF X hours of operation

This is then adjusted to allow for the portion of energy used to drive the heat pump;

Useable energy X (1-1/ Average SPF)

Impact on progress against the Directive target

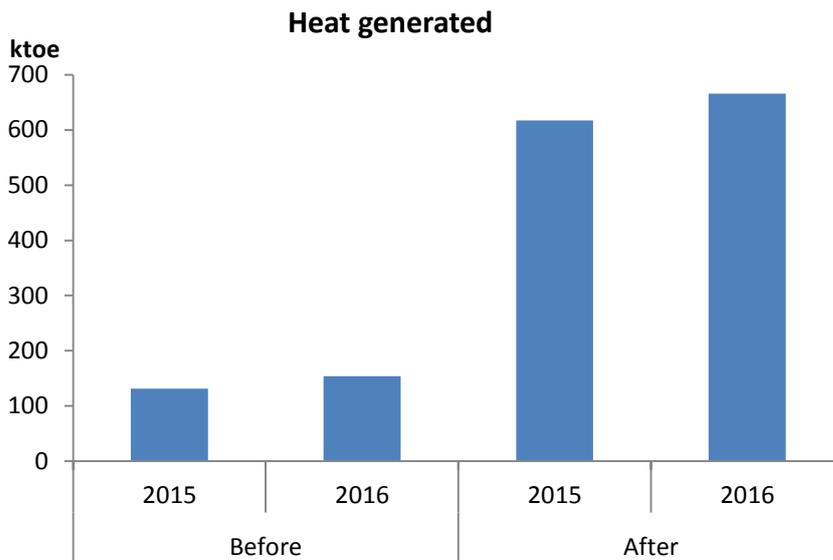
The results have been incorporated into the latest reporting to Eurostat on the UK's progress against the Renewable Energy Directive; filed 31st December 2017 as published on their website at: <http://ec.europa.eu/eurostat/web/energy/data/shares>

The "Detailed Results" link shows the full templates returned for each member state and includes a specific heat pump sheet. This shows the full breakdown by heat pump type and climate zones.

The inclusion of RAAHPs has increased heat generation from heat pumps by a factor of 4. Chart 1 below shows a comparison for the 2015 and 2016 years both before¹⁰ and after inclusion;

¹⁰ As reported in the Digest of UK Energy Statistics (DUKES), published in July 2017. See table 6.1 or 6.6 [Digest of UK Energy Statistics \(DUKES\): renewable sources of energy - GOV.UK](http://www.gov.uk/government/uploads/system/uploads/attachment_data/file/614442/Digest_of_UK_Energy_Statistics_(DUKES)_renewable_sources_of_energy_-_GOV.UK)

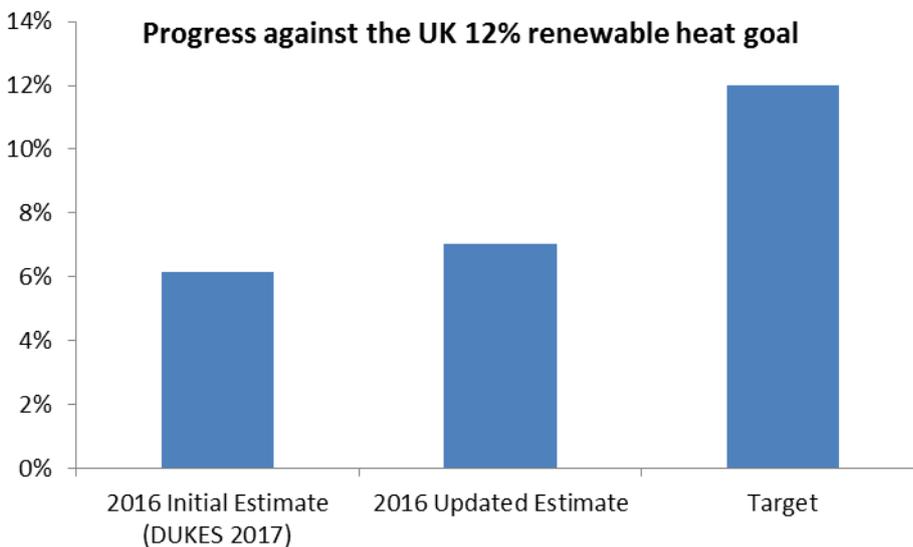
Chart 1



The impact on the percentage of renewable heat was more muted as heat pumps represent a fairly small proportion of overall heat.

Chart 2 below shows the effect against the UK's goal¹¹ of achieving 12 per cent of heat from renewable sources:

Chart 2

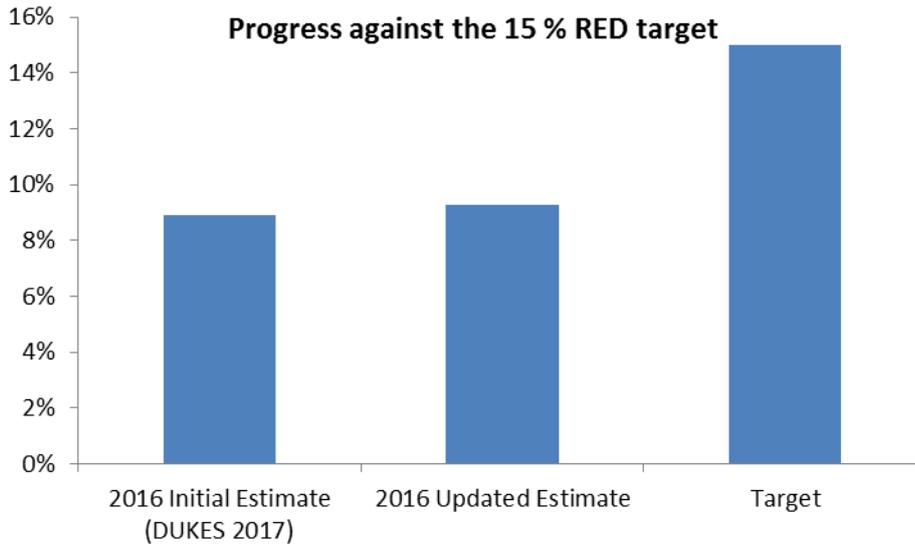


When reported in DUKES 2017, the percentage of renewable heat in 2016 was 6.2 per cent. With the inclusion of RAAHPs, this share grew to 7.0 per cent.

The effect on overall progress against the RED is more muted again as the impact of RAAHPs is further reduced when divided by total energy consumption. Chart 3 shows the impact:

¹¹ There is no specific EU target for renewable heat or electricity but the UK has set a 12 per cent renewable heat goal by 2020

Chart 3



In DUKES 2017, progress against the 15 per cent target was 8.9 per cent. The latest SHARES return showed that this had risen to 9.3 per cent.

Although the impact on the overall proportion of renewable energy is fairly small, the inclusion of RAAHPs provides a more accurate picture of renewable heat sources in the UK.

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