BNDH EWH01: Domestic Electric Water Heaters Government Standards Evidence Base 2009: Key Inputs

Version 1.0

This Briefing Note and referenced information is a public consultation document and will be used to inform Government decisions. The information and analysis forms part of the Evidence Base created by Defra's Market Transformation Programme.

1 Introduction

- The aim of this Briefing Note is to provide details and reference sources of the underlying data in the model, along with the key assumptions used in the model.

- There are three main sections to this Briefing Note, corresponding to the main variables of the MTP modelling approach:
  - Ownership & stock
  - Sales
  - Usage & lifespan

  Each section also includes an indication of the overall confidence in the dataset, to provide a sense of the robustness of the model.

1.1 Product definition

- Products covered by this briefing note are **Dedicated Domestic Electric Water Heaters**, which are defined in the ErP[1] Working Document on possible Eco-design Energy labelling and Installation requirements for Water Heaters[2] as a "**product that is connected to a given external supply of drinking water and is equipped to**

[1] The Energy related Products Directive, in this paper referring to the documents for Lot 2, Water heaters.
[2] July 2008 revision, page 5.

generate heat and transfer this drinking water to desired temperature levels and at desired quantities, flow rates and intervals."

- Dedicated domestic water heaters can be distinguished by fuel (gas, electricity, solar, etc.) and functionality (storage and instantaneous). This briefing note covers instantaneous and storage electric water heaters and includes:
    1. Electric storage (kitchen heaters or small showers) water heaters [ES]
    2. Electric instantaneous water heaters and electric boiling water appliances (electronic) [EI]
    3. Electric showers (instantaneous hydraulic) [EIH].

- This brief does not include combination units for space and water heating, which are covered by the Domestic Boilers model described in BNDH B01: Domestic Boilers Government Standards Evidence Base 2009: Key Inputs.

1.1.1 Dedicated Domestic Electric Storage [ES] Water Heaters

- The **Dedicated Domestic Electric Storage [ES] Water Heaters** that have been modelled can be classified as follow:
    1. Single point/non-pressurised with a capacity of less than 15 litres
    2. Multi point/pressurised with a capacity of less than 15 litres
    3. Large vented with a capacity bigger than 15 litres.

- **Single point/non-pressurised:** these are also named "displacement" or "point of use" water heaters (e.g. hand wash appliances) and have an open outlet. To displace the hot water they rely on the opening of a tap or a valve on the inlet side in the heater with incoming cold water. The open outlet ensures that any excess pressure in the heater is vented.[3]

- **Multi point/pressurised:** these are supplied directly from the mains under pressure and can deliver hot water to two or more outlets simultaneously.

- **Large vented:** these have a storage capacity that is above 15 litres and are mainly applied to supply multiple consumer points where supply from a cold-water storage tank is impractical.[4] A vent pipe allows a safe route for excess pressure, air bubbles and steam should the system overheat; it runs from the top of the cylinder back up to the cold-water storage header tank where its open vent is located just above the water level.[5]

1.1.2 Dedicated Domestic Electric Instantaneous Water Heaters

- The instantaneous types of Dedicated Domestic Electric Water heaters are mainly

[3] BSRIA, March 2008, World heating 2007 – United Kingdom Water Heating – Report 50851/17
[4] BSRIA, March 2008, World heating 2007 – United Kingdom Water Heating – Report 50851/17
[5] http://www.plumbingpages.com/featurepages/HWopenvented.cfm

used as point-of-use water heaters and are characterised by a number of elements: flow rate at a particular outlet temperature, flow rate control and water heater pressure.

- For the purpose of this study the **Dedicated Domestic Electric Instantaneous Water Heaters** have been split into groups:

    1. Instantaneous water heating devices with "electronic" flow rate control **[EI],** including non-pressurised single point 'hand-wash' units and pressurised in-line units (12 kW or less) which deliver heated water to multiple taps or showers. These products can maintain a set temperature throughout a range of flow rates and sometimes allow the user to preset temperature and/or flow rate through the electronic control. This group also includes instantaneous electric boiling water appliances[6] which are water heaters designed to produce water up to the boiling point. For example these are used to supply hot water for consumption: tea, soup, etc.

    2. Instantaneous water heating devices with "hydraulic" flow rate control **[EIH]**. This product type includes mainly electric showers and is controlled by a simple heating on/off switch dependant on the water pressure, but with a temperature limit override. Electric showers are fed with cold water only, which is heated instantaneously as the water flows. Flow rates are relatively low at about 4-9 litres per minute, depending on power rating and required temperature rise. These rates can also be affected by low mains pressure at peak times, diminishing performance. Electric showers typically use about 300 kWh per household per year. Running costs and associated CO_2 emissions of electric showers are much higher than mixer showers using water heated by gas.[7]

[6] ErP Preparatory Study on Eco-design of Water Heaters – Task 4 Report Final, VHK, September 2007, p.145 http://www.ecohotwater.org/
[7] Domestic heating and hot water – choice of fuel and system type - Good Practice Guide - GPG 301, Building Research Energy Conservation Support Unit, 2002

Figure 1 Example of a typical Electric Instantaneous Water Heater (Vaillant) and Electric Shower [8]

[8] www.plumword.co.uk

2 Stock

2.1 Summary

- The split of dedicated devices for the production of domestic hot water is about 80% using electric power and 15% gas-fired; the remaining percentage use other forms of water heating such as Agas, stoves, etc.[9]

- Of all domestic electric water heaters, electric showers dominate. This results from a previous regulation that forbade the storage of more than 15 litres of hot water under mains pressure; this regulation was removed in 1989 by the water bylaws (replaced later on by the Water Regulations),

- Electric showers are almost unique to the UK. They are found in small quantities in other European countries, and in some Asian countries such as Singapore and Malaysia. Asia is the primary source of UK imports.[10]

[9] BRG Consult UK-1-25, July 2008, UK Heating 2008 –International market strategy – United Kingdom

[10] BSRIA, March 2008, World heating 2007 – United Kingdom Water Heating – Report 50851/17

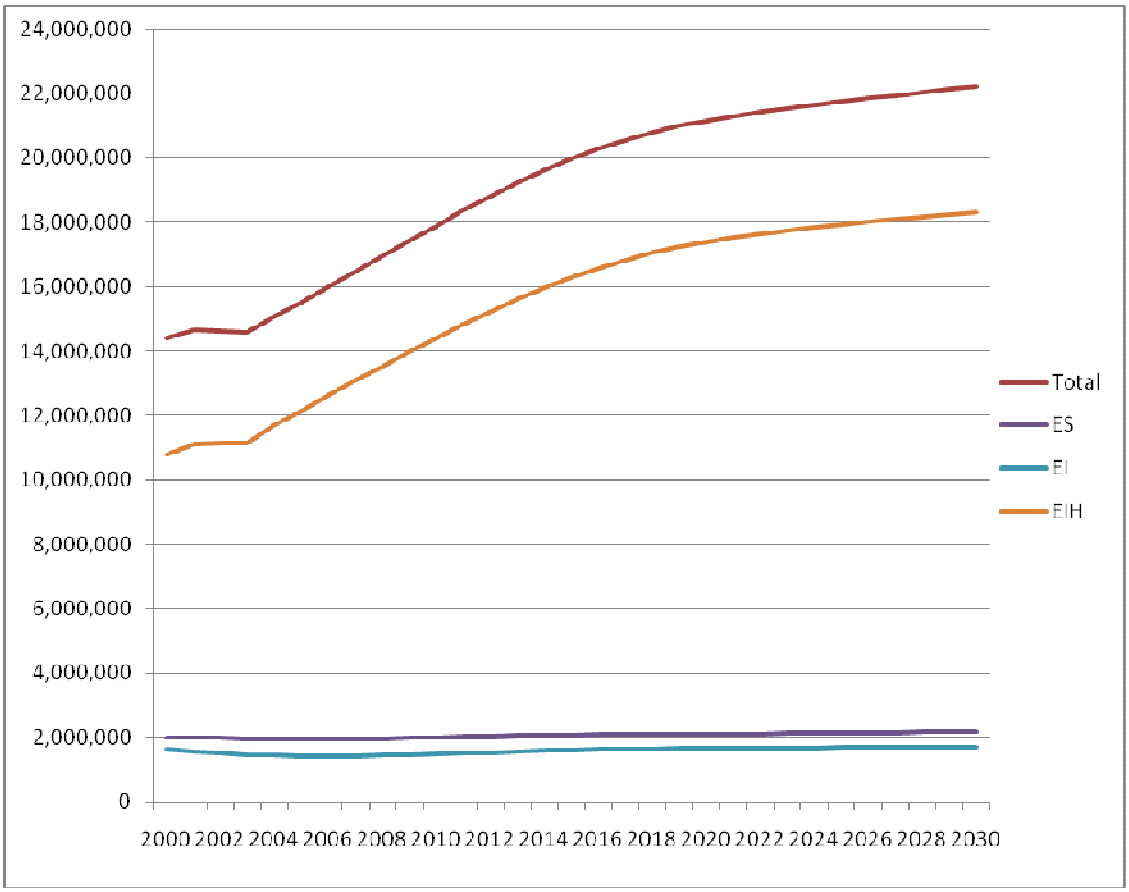

Figure 2 Dedicated Domestic Water Heaters (Electric) - Stock

- Electric showers (EIH) dominate the electric water heater stock with over 80% of the total share. Smaller storage products are removed from the market in the Policy and BAT Scenarios replaced by the more efficient instantaneous products (EI).

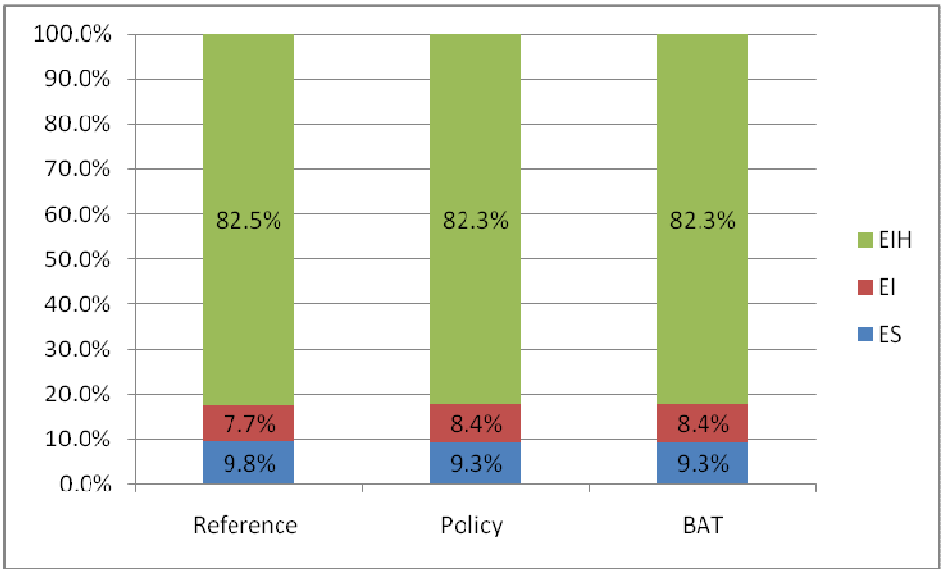

Figure 3 Dedicated Domestic Water Heaters (Electric) – Share of stock by scenario

Table 1 – Summary Stock - Dedicated Domestic Water Heaters (Electric) (unit='000)

Product	2010	2020	2030
ES Water Heaters (Electric Storage)	2,003	2,099	2,174
EI Water Heaters (Electric Instantaneous)	1,492	1,661	1,721
EIH Water Heaters (Electric Showers)	14,398	17,399	18,317
Total	**17,893**	**21,159**	**22,212**

2.2 Data sources – Stock

- This model is sales-based, which calculates stock using the sales projection and the product lifetime. Real stock data were used as a check only. The stock shown in the previous chart and table are the generated output of the model rather than input data.

Table 2 Stock data sources

Year	Reference	Reference date	Author	Justification	Confidence in sources (High/Low)
2004	Preparatory Study on Ecodesign of water Heaters Task 2 report p.15 tab 3-1 Total EU domestic water heater park 2004	September 2007	BRG Consult for Van Holsteijn en Kemna(VHK)	Only informati-on available.	Low

Methodology & key assumptions – Stock

- The domestic heating models are sales-based, which calculate stock using the sales projection and product lifetime. Real stock data are used as a check against the output stock calculated from the model. This data series is usually incomplete. The stock shown in charts and tables are to illustrate the full, generated output (rather than input) stock data series.

Table 3 Extrapolation & background calculations – stock

Year	Methodology & assumptions
1986 -2003	Extrapolated in MTP model from sales data.
2004 -2007	Extrapolated in MTP model from sales data derived from World Heating 2007 UK Water Heating Report 50851/17: Table 2.1
2008 - 2011	Extrapolated in MTP model from sales data derived from World Heating 2007 UK Water Heating Report 50851/17: Table 3.2
2012 - 2030	Extrapolated in MTP model from sales data derived from linear growth of BSRIA data (2005 – 2011)

2.3 Data issues – Stock

- A single stock datum point has been identified for 2004; this is from the BRG Consult report referenced in Table 2. No other data sources have been identified.

- Availability of data is the main issue; however, as sales and lifetime data are from reliable sources, the extrapolation of stock can be considered reliable.

Table 4 Data issues – stock

Issue/risk	Approach taken/rationale
Very little stock data available	Stock numbers calculated using a sales projection, the product lifetime and a sales churn calculation

2.4 Confidence level – Stock

- Confidence level rationale is based on one year of stock data.

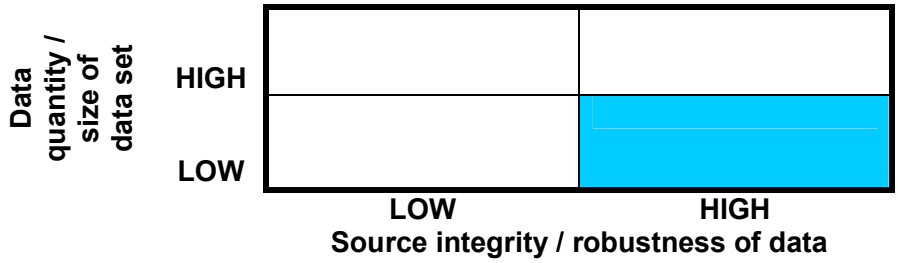

Figure 4 Confidence indicator for stock data

3 Sales

3.1 Summary

3.1.1 Graphs & Summary table (Sales)

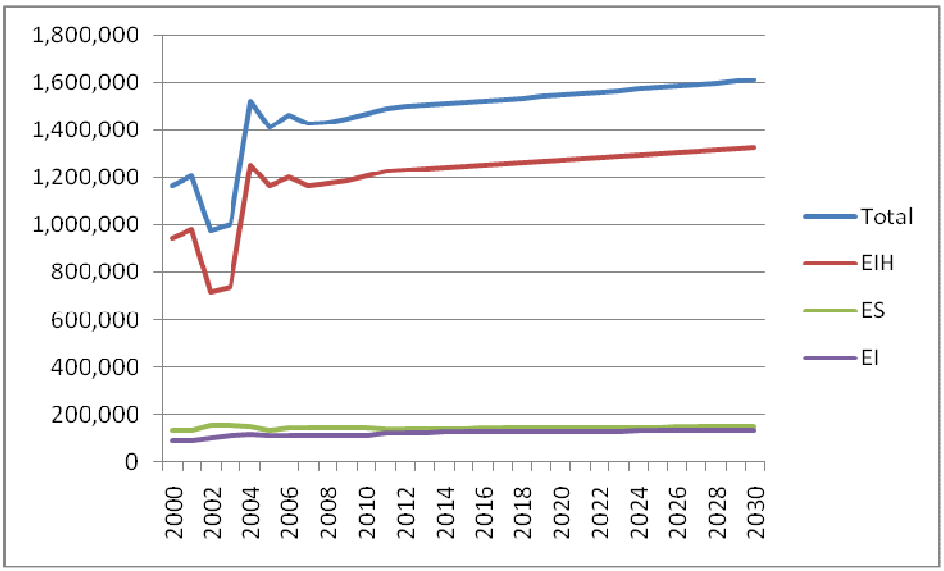

Figure 5 - Dedicated Domestic Water Heaters (Electric) - Sales

3.1.2 Sales data

Table 5 – Summary Sales - Dedicated Domestic Water Heaters (Electric) ('000s)

Product	2010	2020	2030
ES Water Heaters (Electric Storage)	145	151	158
EI Water Heaters (Electric Instantaneous)	116	120	125
EIH Water Heaters (Electric Showers)	1,186	1,276	1,328
Total	**1,447**	**1,547**	**1,611**

3.1.3 Brief overview of market: historic & future trends, key features]

- The total UK **water heater market** is estimated to have experienced slight growth in 2007 (+1.3/1.6%), following a rebound in 2006.
- The market for water heating products linked to the boiler (combi boilers and indirect cylinders) has grown over the last few years, whereas the market for direct water heaters has been flat or falling.[11]
- The **instantaneous electric showers** [EIH] market is mainly driven by the residential replacement market (~70% in 2007) and by house renovations which include an additional bathroom.
- Long-term growth in this market peaked in 2005 and has since been in decline[12].
- The **electric storage water** heater market has seen a continued decline in the sales of vented units (single point). It represents about 7% of dedicated domestic electric water heater sales (2006-2007)[13].
- As the number of homes in the UK grows over the coming years (for projections see BNXS25 UK Household and Population Figures 1970 – 2030), modest growth in all types of water heater is expected.

3.2 Data sources - sales

Table 6 Sales data sources

Year	Reference	Reference date	Author	Justification	Confidence in sources (High/Low)
1986 - 1994	SAVE 1998, Study on water heating - labelling/standards (Task 3 Appliance Market Study) - Final Report; May 2001	May 2001	Environmental Change Institute, University of Oxford: Kevin Lane, Judith Lipp.	Best data available	High
1996-2001	BRG Consult; UK Heating 2008: Section 5 - Fig. III/1 United Kingdom -	July 2008	BRG Consult	Best data available	High
2001 - 2005	World Heating 2007 UK Water Heating Report 50851/17: Table 3.1	March 2008	BSRIA	Best data available	High

[11] BRG Consult UK-5-1, July 2008, UK Heating 2008 –International market strategy – United Kingdom
[12] BRG Consult UK-5-1, July 2008, UK Heating 2008 –International market strategy – United Kingdom
[13] BSRIA, March 2008, World heating 2007 – United Kingdom Water Heating – Report 50851/17

Year	Reference	Reference date	Author	Justification	Confidence in sources (High/Low)
2006 - 2007	World Heating 2007 UK Water Heating Report 50851/17: Table 2.1	March 2008	BSRIA	Best data available	High
2007-2012	World Heating 2007 UK Water Heating Report 50851/17: Table 3.2	March 2008	BSRIA	Best data available	High

3.3 Methodology & key assumptions - sales

3.3.1 Historic data

- The sales data utilised for this study has been sourced mainly from BSRIA - World Heating 2007 UK Water Heating Report 50851/17: Table 3.2-3.1. The other sales information have been extrapolated from the BRG Consult UK Heating 2008 report for the UK and from a study on water heating (SAVE 1998)[14] labelling and standards.

Table 7 Interpolation & background calculations – sales data

Year	Methodology & assumptions
1986 - 1994	The sales data has been taken partly from the SAVE study[15] on water heating - labelling/standards and the sales related to Electric Showers (not included in the SAVE study) have been extrapolated based on linear decline from BISRA/BRGC sales data 1996-2011.
1995	Interpolation from BSRIA[16] 2002/2003/BRGC data assuming linear trend extrapolated from sales data
1996-2001	This set has been taken from BRG C UK Heating 2008 (Section 5 - Fig. 111/1) with the addition of dedicated domestic electric storage water heaters (> 15 litres storage capacity) sales values interpolated applying a linear trend from BSRIA data for 2002-2011.

3.3.2 Future analysis

- The entire domestic dedicated electric water heater market is projected to remain almost static, at an average growth rate of around +0.4% sales growth per annum, reflecting the proportion of new homes built to 2030.

[14] SAVE 1998, Task 3 Appliance Market Study- Final Report May 2001 Kevin Lane, Judith Lipp

[15] SAVE 1998, Task 3 Appliance Market Study- Final Report May 2001 Kevin Lane, Judith Lipp

[16] World Heating 2007 UK Water Heating Report 50851/17 BSRIA

Table 8 Extrapolation & background calculations – sales data

Year	Methodology & assumptions
2012-2030	Projected sales data were available to 2011 from BSRIA report (Table 3.1). It has been assumed that the sales of domestic dedicated electric water heaters will increase by 0.4% year on year.

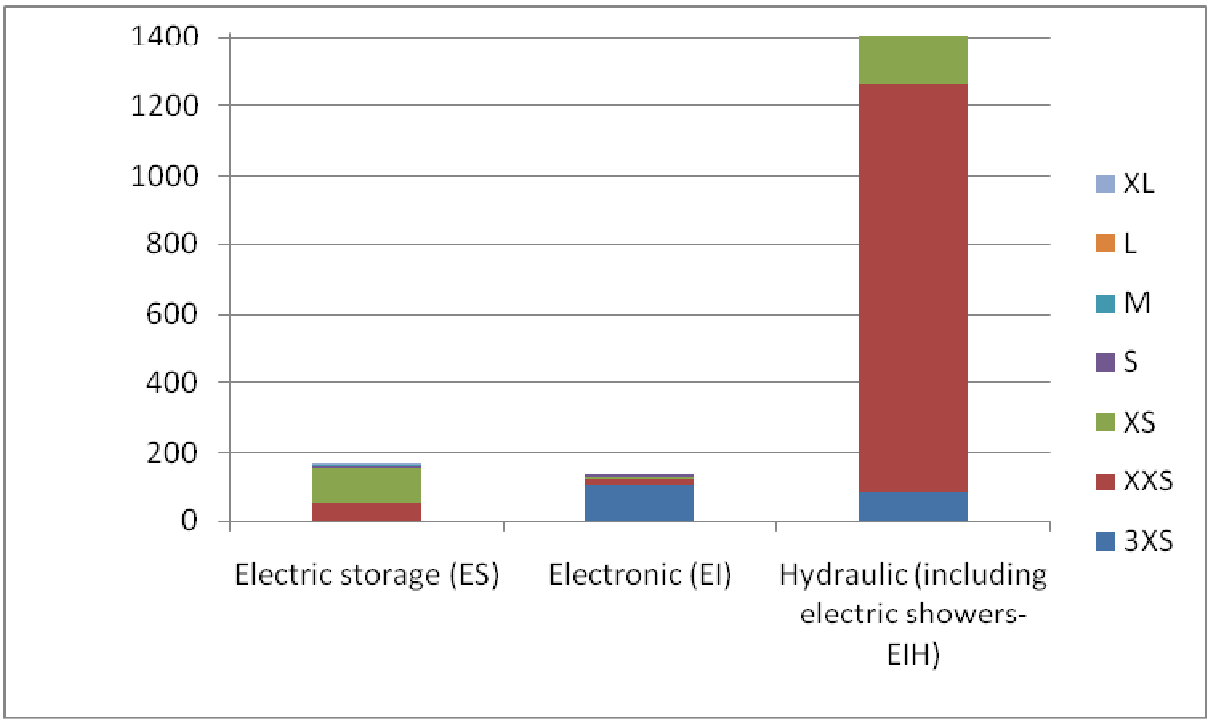

Figure 6 - Dedicated Domestic Water Heaters (Electric) – Sales by class (2011)

- The share of sales in each class is assumed to remain static from 2011
- The entire market is dominated by XXS (6.3 – 12.5 kW) electric showers (EIH)

Table 9 Sales data by product size

	Size	XXS	XS	S	M	L	XL
Electric storage (ES)	Example applications	small sink tap	average sink tap	large sink tap/small shower tap	average shower tap	bath tap	large bath
	Litres	<10	10-15	15-30	80	120	>150
	Sales share	30%	63%	5%	1%	1%	1%

	Size	XXS	XS	S	M	L	XL
Electronic (EI)	Min power (100/80% st.st.effi)[17] kW	6.3	12.5	15.7	18.8/23.3	31.3/39	31.3
	Sales share	90%	4%	4%	3%		
Hydraulic (including electric showers-EIH)	Min power (100/80% st.st.effi) kW	6.3	12.5	15.7	18.8/23.3	31.3/39	31.3
	Sales share	90%	10%				

- The share of each product type is also assumed to remain static from 2011

3.4 Data issues – sales

- Sales are broken down by size according to the classifications used by ErP (i.e. XXS to XL). However the sales data (BSRIA) relied upon are classified by sizes that differ from those used by ErP.

3.5 Confidence level

- The overall confidence in the sales data set (i.e. data points, interpolation and projections) is medium – low as sales data have been applied to size categories which differ from those defined in the original data set. However source data sets are large and were obtained from credible sources.

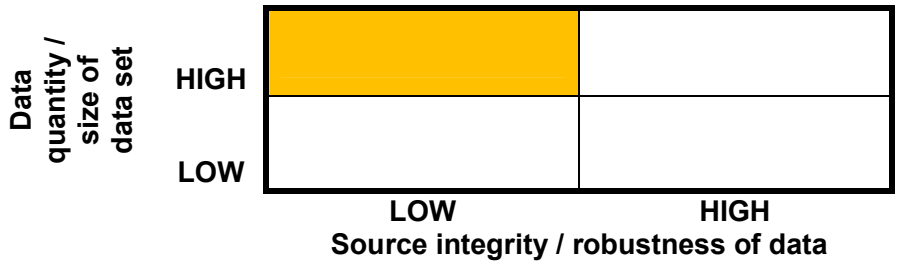

Figure 7 Confidence indicator for sales data

[17] This is the minimum power for the classification of Instant Electric Dedicated Water Heater. The abbreviation (st. st. eff.) can be found in task 5 of the Preparatory study on Eco-design of Water Heaters, although it is not explicitly explained. It is deduced that this is the minimum power, expressed in kW, at a max/min efficiency of 100/80% calculated at steady state.

4 Usage & lifespan

4.1 Summary

4.1.1 Dedicated Domestic Water Heaters (Electric) Lifespan

- Typical lifespan of Dedicated Domestic Electric Water Heaters will vary depending upon type of system but generally is as follow:
  - Electric Storage [ES] = 20 years
  - Electric Instantaneous [EI] = 13 years
  - Electric Showers [EIH] = 13 years
- The weighted average lifespan for dedicated domestic water heaters is listed in the table below.

Table 10 UK Dedicated Domestic Water Heaters (Electric) Lifespan to 2030 (years).

Product	2010	2020	2030
Dedicated Domestic Water Heaters (Electric)	14.2	14.2	14.2

4.1.2 Dedicated Domestic Water Heaters (Electric) Usage

- The usage of a dedicated domestic electric water heater is measured in hours. Typically a storage system runs continuously; therefore 8,760 hours per year. Instant system usage varies.
- The "usage" value utilised in the model for dedicated domestic water heaters (electric) is embedded in the energy consumption of the product, calculated using the "Ecohotwater" model[18]. The use of this model is described more fully in BNDH EWH02: Domestic Electric Water Heaters Government Standards Evidence Base 2009: Reference Scenario.
- Ecohotwater was used to calculate the primary energy used by the products (average kWh/household/year) and this calculation takes into consideration various factors to define its usage, including the dwelling size (therefore number of occupants), location, pipes, insulation, etc.
- The data from the Ecohotwater model used in the MTP model represents the energy consumed by the water heater unit: the product of its annual usage (hours) and its size (kW).

[18] The ErP Preparatory study report, ANNEX IV on Eco-design implementing measures for dedicated water heaters Draft v2 - European Commission - Brussels, (June 2008)

4.2 Data sources – usage & lifespan

Table 11 Usage & lifespan data sources

Year	Reference	Reference date	Author	Justification	Confidence in sources (High/Low)
1986 - 2030	Usage: ErP Preparatory Study on Eco-Design of Water Heaters: Task 2 (Final)	Sept 2007	Van Holsteijn en Kemna (VHK) and BRG Consult	Only available data	Low

4.3 Methodology & key assumptions – Usage & Lifespan

- The average lifespan for each product type (electric storage, instantaneous and showers) has been estimated from the raw data available and then extrapolated/interpolated in proportion to sales percentage for each year.

- The usage calculation for 1986-2030 is embedded within the Ecohotwater model. Even though this tool is utilised to estimate the primary energy consumption of the product (kWh/year), usage it is not one of its outputs.

- However usage, in hours of use, is derived from the average actual energy consumption per unit (kWh) and the unit power (kW), weighted by the number of units installed in the MTP dedicated domestic electric water heaters model: see section 2 “Stock” above.

4.3.1 Historic data

Table 12 Interpolation & background calculations – usage & lifespan data

Year	Methodology & assumptions
1986 - 2007	Lifespan taken from Preparatory Study on Eco-design of Water Heaters: Task 2 and interpolated in proportion to the sales percentage of each product type (electric storage, instantaneous and showers) for each year.

4.3.2 Future analysis

Table 13 Extrapolation & background calculations – usage & lifespan data

Year	Methodology & assumptions
2007 - 2030	Lifespan is taken from the ErP preparatory study: Task 2 pg 14 and weighted by the number of products in each size category.

4.4 Data issues – usage & lifespan

Table 14 Data issues – usage & lifespan

Issue/risk	Approach taken/rationale
It is difficult to make robust predictions of future lifespan levels because of a lack of data, and because customers' needs and behaviour are difficult to predict.	The projection is based on typical, recently estimated lifespan from the reference stated.
Usage patterns are calculated by the Ecohotwater model. This will not represent real usage by any one consumer.	This model has been based on research during the preparation of draft ErP legislation and represents as good an estimate as is available from other sources.

4.5 Confidence level – usage & lifespan

- The confidence level for usage & lifespan is low since the data quantity available is small, and is not considered highly robust.

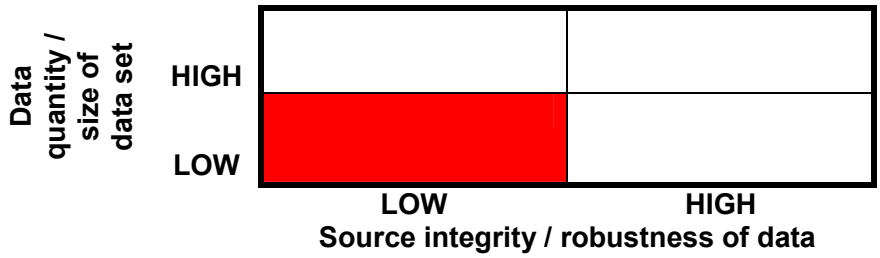

Figure 8 Confidence indicator for usage & lifespan data

Related MTP information

- BNDH EWH02: Domestic Electric Water Heaters Government Standards Evidence Base 2009: Reference Scenario
- BNDH EWH03: Domestic Electric Water Heaters Government Standards Evidence Base 2009: Policy Scenario
- BNDH EWH04: Domestic Electric Water Heaters Government Standards Evidence Base 2009: BAT Scenario
- BNDH KO01: Domestic Central Heating Government Standards Evidence Base 2009: Key outputs

Changes from previous version

- None. This is the first published version

Consultation and further information

Stakeholders are encouraged to review this document and provide suggestions that may improve the quality of information provided, email **info@mtprog.com** quoting the document reference, or call the MTP enquiry line on +44 (0) 845 600 8951.

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