



# BNM C01: Circulators Government Standards Evidence Base 2009: Key Inputs

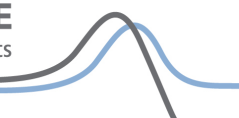
Version 1.1

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.

Document Abbreviations	
Small	Small Standalone Circulators
BI	Boiler Integrated Circulators
Large	Large Circulators
IM	Induction motor
VS	Variable Speed
PM	Permanent Magnet
FS	Fixed Speed
Std	Standard
Imp	Improved
TRV	Thermostatic Radiator Valve
EEl	Energy Efficiency Index

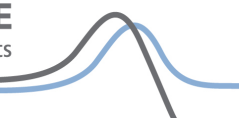
## 1 Introduction

- 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:
  - 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

- Circulators are integrated pump and motor products which are typically used to re-circulate heating or cooling media within a closed circuit and are principally used for central heating systems. A small percentage (<4%) are used for other applications such as solar water heating, or chilling systems. They range in size from 1W-2500W input power.
- Domestic circulators are those used in households and can be divided into two categories: small standalone and boiler integrated (BI). BI circulators are always integrated into the boiler and may also include other boiler control functions within the assembly. Standalone circulators are usually separate from the boiler, although can also be incorporated within the boiler. Unlike BI circulators and components, standalone circulators are available directly to the public, although in most cases it will be the tradesperson who purchases on the customer's behalf.
- Non-domestic circulators are used in central heating systems for industrial and commercial premises and are classed as large standalone circulators.
- Domestic and non-domestic circulators either use a standard induction motor (Standard or Improved circulators and, for non-domestic only, Improved Variable Speed) or a permanent magnet motor (Standard PM or Improved PM circulators).
- PM circulators are the most efficient available technology.

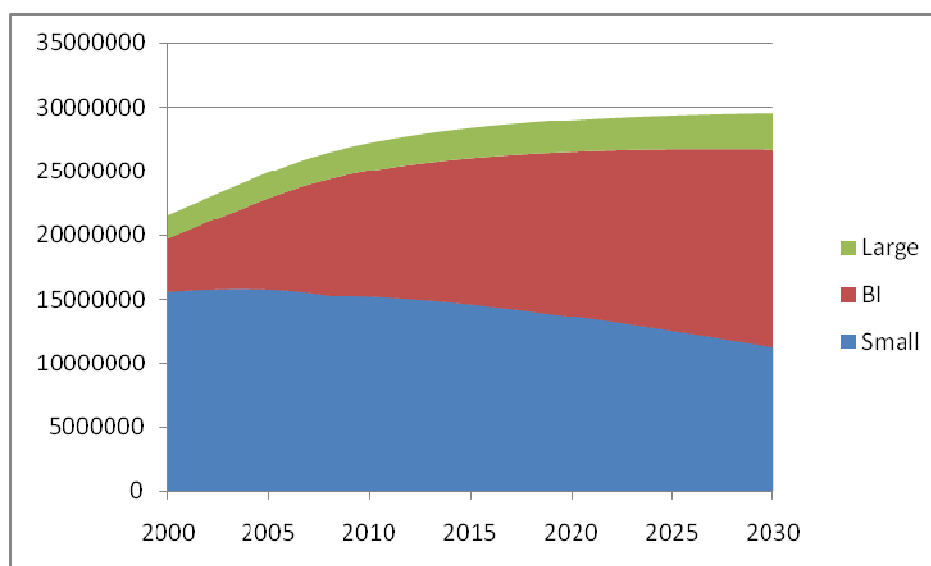


## 2 Stock

### 2.1 Summary

**Table 1 Stock of circulators**

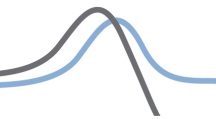
	<b>2010</b>	<b>2020</b>	<b>2030</b>
	(000s)	(000s)	(000s)
Small	15,218	13,658	11,260
Boiler-integrated	9,819	12,854	15,432
Large	2,144	2,464	2,831
<b>TOTAL</b>	<b>27,181</b>	<b>28,976</b>	<b>29,523</b>



**Figure 1 Graph of Circulator stock from 2009 to 2030**

### 2.2 Data sources – stock

- This model is a stock-based model, which calculates sales using the stock projection and the product lifetime. Real sales data are put in as a check only, to help evaluate the output sales calculated from the model. This data series is usually incomplete. The sales shown in the previous charts and tables were to illustrate the full generated output (rather than input) sales data series.



**Table 2 Stock data sources**

Model	Year	Reference	Reference date	Author	Justification	Confidence in sources (High/Low)
Small	1960-2009	MTP Boiler model stock data from BRE 2007 based on English Household Condition Survey (EHCS) data	2009	EHCS/BRE	All hydronic central heating boilers require a circulator, and boiler stock is closely linked to number of households, on which there are good data.	High
BI	1990 - 2009	Expert Judgement	2008	MTP expert opinion	No UK projections available so this is a best estimate.	Low
Large	2005	ErP Preparatory Study <sup>1</sup>	April 2008	AEA Energy and Environment	No UK data available. Data for UK is extrapolated from the ErP study	Medium
Large	2008	Communication from a major UK manufacturer	November 2008	Major UK manufacturer	No official UK data available	High

<sup>1</sup> April 2008, AEA Energy & Environment; "Appendix 7: Lot 11 'Circulators in Buildings'", Report to the European Commission.



## 2.3 Methodology & key assumptions – stock

- The MTP model is a stock-based model, which calculates sales using a stock projection, the product lifetime and a stock churn calculation to account for products purchased in previous years gradually leaving stock. Real sales data are put in as a check only, to help evaluate the output sales from the model. This data series is usually incomplete.

### 2.3.1 Historic data

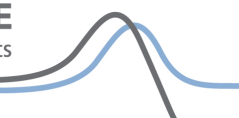
**Table 3 Interpolation & background calculations – stock**

Model	Year	Methodology & assumptions
Small, BI	1960-2008	It was assumed that 5% of boilers have more than one circulator, based on the consensus of ErP stakeholders (no market data available). Thus, circulator stock was calculated as boiler stock plus 5% and a percentage split between small and boiler-integrated types was then applied.
Small, BI	1960-2008	Based on stock and average lifetime of boilers, it was assumed that all circulators pre-1990 were of the standalone type. Since 1990 the stock of boiler integrated circulators has increased from 1% of domestic circulator stock in 1990 to 40% in 2008 at the expense of standalone circulators. This percentage split was then applied to the total circulator stock in order to calculate small and BI circulator stock figures. Boiler integrated circulators are a rapidly growing part of the market and a steady increase in market share over time is seen as a fair assumption. This has not been confirmed by manufacturers of circulators/boilers.
Large	1960-2008	Stock data based on Europump information sourced from the ErP Preparatory Study. The document states that in the EU-25 in 2005 there were 1 million circulator sales with a growth rate of 1.4% per annum. It was assumed the UK market is approximately one fifth of the EU market (based on expert judgement) which leads to a UK sales figure of 200,000 for 2005 and 204,000 in 2008 (slight underestimate compared to UK manufacturer data for 2008). Assumed that stock in 2005 is sales in that year (200,000 circulators) multiplied by the assumed average lifespan (10 years).

### 2.3.2 Future analysis

**Table 4 Extrapolation & background calculations – stock**

Model	Year	Methodology & assumptions
Small, BI	2009-2030	Future stock projections of circulators based on MTP projected boiler stock. Gas and oil boiler stock increases minimally (less than 1%) from 2009 to 2015 where stock then remains relatively static to 2030.
Small, BI	2009-2030	Split by type of circulator shows the number of BI types continuing to grow at the expense of small standalone types. Stock is assumed to grow by 1% annually from 2008 to 2030. Only gas boilers assumed to have BI circulators, other boiler types use standalone circulators.
Large	2009-2030	The ErP Study states that large circulator sales will grow at a rate of 1.4% per annum and the same growth rate has been applied to stock, as no other data are available.



## 2.4 Data issues – stock

**Table 5 Data issues – stock**

Model	Issue/risk	Approach taken/rationale
Small	Some boiler systems use more than one circulator	There is little evidence providing actual figures, but it is known to be small number. Based on expert opinion this has been set at a nominal 5% of boiler stock with more than one circulator.
Small	Eurostat data on sales was not used as results unreliable – these data do not correlate to UK sales or stock (see note in ErP Preparatory study <sup>2</sup> , page 35 that expands on this point)	UK boiler stock data taken from MTP Boiler model were used and considered to be reliable.
BI	No market data available on penetration of boiler integrated circulators on the market.	Based BI numbers on a proportion of the total stock, with an assumed annual growth rate which is expected to reach a limit of c.60% by 2028.
Large	Stock data based on a single sales figure for 2005 multiplied by 10 (circulator lifespan) to give stock figure for 2005 and sales growth rate applied to stock. No historical or future trend data are available.	Given the growing market, this is likely to represent a slight overestimate of the stock.

## 2.5 Confidence level – stock

- The dataset for EU sales is compiled by Europump, and is regarded as robust because >90% of EU sales are from Europump members. However, for large circulators the stock figure is based on the premise that the UK market is one fifth of the EU market, which is a fair assumption but may not be precise. The stock of domestic boilers in UK is regarded as reliable.

<sup>2</sup> April 2008, AEA Energy & Environment; “Appendix 7: Lot 11 ‘Circulators in Buildings’”, Report to the European Commission.

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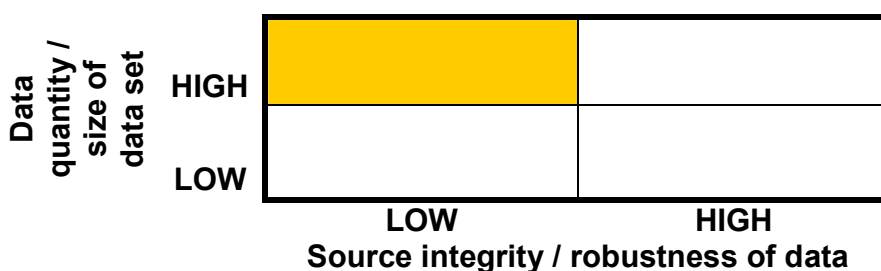


Figure 2 Confidence indicator for stock data

## 3 Sales

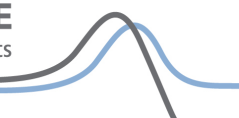
### 3.1 Summary

- The MTP model is a stock-based model, which calculates sales using a stock projection, the product lifetime and a stock churn calculation to account for products purchased in previous years gradually leaving stock. Real sales data are put in as a check only, to help evaluate the output sales from the model. This data series is usually incomplete.

Table 6 Sales of circulators

	2010	2020	2030
	(000s)	(000s)	(000s)
Small	1,484	1,205	946
Boiler-integrated	986	1,344	1,585
Large	217	251	289
<b>TOTAL</b>	<b>2,687</b>	<b>2,800</b>	<b>2,820</b>

- The market for all types of circulators has traditionally used exclusively induction motor driven circulators with poor hydraulics efficiency.
- The introduction of permanent magnet motors and improved hydraulics within the last 10 years has led to much lower energy consumption.
- The 2005 Europump voluntary labelling scheme has coincided with a growth in sales of these improved products.
- It appears that further regulatory action is needed in order for sales to grow at a faster rate.
- Although the UK is an important market for these products, there is less emphasis on efficiency, with competition based more on lowest purchase price.
- It is almost exclusively a European market, with few sales in other countries. Manufacturing is also largely restricted to the European Union: Wilo (Germany) and Grundfos (Denmark) dominate this market.
- Europump data on sales state that of the 14m circulators sold annually in the EU-25, 39% are small standalone, and 54% are boiler integrated. The remainder are large standalone circulations.



## 3.2 Data sources - sales

**Table 7 Sales data sources**

Model	Year	Reference	Reference date	Author	Justification	Confidence in sources (High/Low)
Small, BI	2005	Europump data on annual sales	April 2008	Europump	Only source	High
Large	2005	ErP Preparatory Study	April 2008	AEA Energy and Environment	Reliable source	High
Large	2008	UK Manufacturer	Dec 2008	UK Manufacturer	Reliable source	High

## 3.3 Methodology & key assumptions - sales

### 3.3.1 Historic data

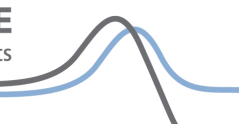
**Table 8 Interpolation & background calculations – sales data**

Model	Year	Methodology & assumptions
Small, BI, Large		The MTP model is a stock-based model, which calculates sales using a stock projection, the product lifetime and a stock churn calculation to account for products purchased in previous years gradually leaving stock. Real sales data are put in as a check only, to help evaluate the output sales from the model. This data series is usually incomplete.
Small, BI, Large	2005	UK sales data were derived from Europump data on annual EU sales (heating circulators) of 5.5 million standalone circulators in 2005, using the assumption that the UK represents one fifth of this market. These were consistent with the large circulator sales estimates from a UK manufacturer. These sales data were used to validate the estimated sales generated by the stock model and were found to be consistent.

### 3.3.2 Future analysis

**Table 9 Extrapolation & background calculations – sales data**

Model	Year	Methodology & assumptions
Small, BI, Large		The MTP model is a stock-based model, which calculates sales using a stock projection, the product lifetime and a stock churn calculation to account for products purchased in previous years gradually leaving stock. Real sales data are put in as a check only, to help evaluate the output sales from the model. This data series is usually incomplete. No extrapolation of actual data is required.



## 3.4 Data issues - sales

Table 10 Data issues - sales

Model	Issue/risk	Approach taken/rationale
Small, BI	Few actual sales data points to validate estimated sales generated by model	As this model uses stock data rather than sales, sales figures are only used for validation. Ideally, the more sales figures for validation the better.

## 3.5 Confidence level

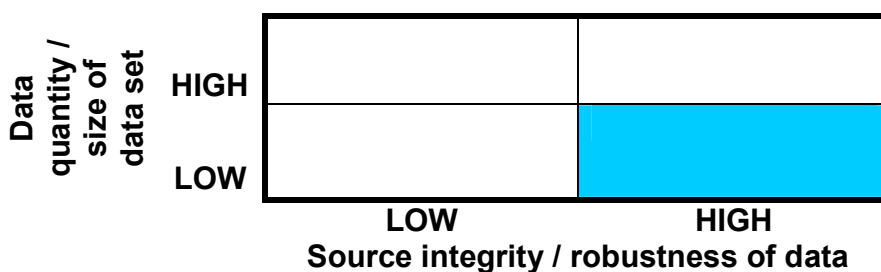


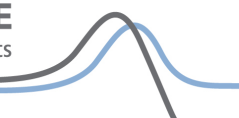
Figure 3 Confidence indicator for sales data

## 4 Usage & lifespan

### 4.1 Summary

Table 11 Lifespan and usage of circulators

	Lifespan (years)	Usage (hours per year)
	2009-2030	2009-2030
Small	10.5	2300
Boiler-integrated	10.5	2300
Large	10.5	2300
<b>TOTAL</b>		



## 4.2 Data sources – usage & lifespan

**Table 12 Usage & lifespan data sources**

Model	Year	Reference	Reference date	Author	Justification	Confidence in sources (High/Low)
Small, BI	2007	ErP Preparatory study	April 2008	AEA Energy and Environment	Based on wide stakeholder consultation	Low
Small, BI, Large	2008	ErP Preparatory Study	April 2008	AEA Energy and Environment	Best data available	Low
Small, BI, Large	2008	ErP Preparatory Study	April 2008	AEA Energy and Environment	'Blue Angel' is a load profile which was used in the ErP study and has been used in the MTP models as it is the only one in existence and enjoys widespread acceptance	Medium/Low
Small, BI, Large	2008	ErP Preparatory Study	April 2008	AEA Energy and Environment	Best source of data on different types of control mode	Low

## 4.3 Methodology & key assumptions – usage & lifespan

### 4.3.1 Historic data

**Table 13 Interpolation & background calculations – usage & lifespan data**

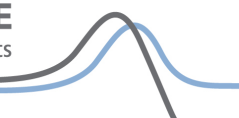
Model	Year	Methodology & assumptions
Small, BI, Large	1960-2009	Lifespan: Assumed to remain constant over time, based on the ErP Preparatory Study which assumed that the average lifespan of a circulator is 10 years on the basis that a boiler has a lifespan of 20 years and each boiler will on average consume two circulators (although an individual circulator will have a lifespan of 13 years).

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		Because boiler lifespan has a major impact on average circulator lifespan, estimates of circulator lifespan are not as critical as estimates of boiler life in determining <u>average</u> circulator lifespan.
Small, BI	Use, 1960-2009	Annual running hours of 2,300 hours pa are assumed in on/off mode, based on the model used in the ErP boiler preparatory study, which assumed average annual running hours of 5000. The reduction to 2300 hours in the UK has been applied to allow for the fact that UK circulators are on/off controlled by the boiler whereas circulators in mainland Europe are run continuously during the heating season therefore resulting in longer running hours.
Small, BI	Use, 1960-2009	Blue Angel load profile adopted for circulators operating with TRV (thermostatic radiator valve) systems as this is representative of UK variable flow systems. The profile specifies a specific power load at various flow percentages, and then total annual energy use is found by multiplying the power load by the percentage of time in operation (also set by Blue Angel) and by the total annual running hours.
Small, BI	Use, 1960-2009	UK manufacturers are slowly moving to variable flow control, which is common in the European case. Many European systems use continuous flow control but the UK market is limited to On/Off or TRV only. The split of operation between these two modes is based on expert judgement.
Large	Use, 1960-2009	All larger circulators work on variable flow control based on the Blue Angel profile. They all run in larger (non domestic) buildings, and so 2300hpa is assumed.

## 4.3.2 Future analysis

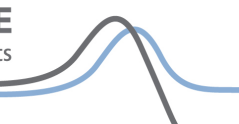
**Table 14 Extrapolation & background calculations – usage & lifespan data**

Model	Year	Methodology & assumptions
Small, BI, Large	2009-2030	Assumed that that lifespan and use remain constant over time.

## 4.4 Data issues – usage & lifespan

**Table 15 Data issues – usage & lifespan**

Model	Issue/risk	Approach taken/rationale
Small, BI, Large	Blue Angel flow profile risk	There are ongoing discussions by building control experts about the accuracy of the assumed “Blue Angel” flow profile. However, the Blue Angel profile is the best estimate currently available and small variations in the profile will not greatly impact the savings potential of improved circulators.
Small, BI, Large	Lack of data on split between control modes	The split by control method, i.e. between On/Off room thermostat control and TRV control has had to be estimated for small and BI, as there is little formal evidence defining this.
Small, BI,	Lifespan	There are various factors that will impact lifespan by a small amount, but they are



Large		<p>conflicting, with no clear indication of the relative magnitudes of these factors:</p> <ul style="list-style-type: none"> <li>• Climate change – reduced heating hours, increased lifespan</li> <li>• Increased insulation – reduced heating hours, increased lifespan.</li> <li>• The reliability of PM circulators is unknown, but increased complexity might lead to slightly reduced lifetime.</li> </ul>
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## 4.5 Confidence level – usage & lifespan

- Data on lifetime of circulators are based on ErP study. There is greater confidence in the known values of annual EU sales and boilers, from which an approximate lifespan can be derived. Improved data on boiler lifetime would improve confidence in the results.
- Circulator usage is based on annual heating hours, which are related to boiler hours. Both EU-derived and UK boiler operating figures give very similar data, giving some confidence in the figures, although actual data are scarce.
- Data on the split of usage between standalone and BI circulators are weak.

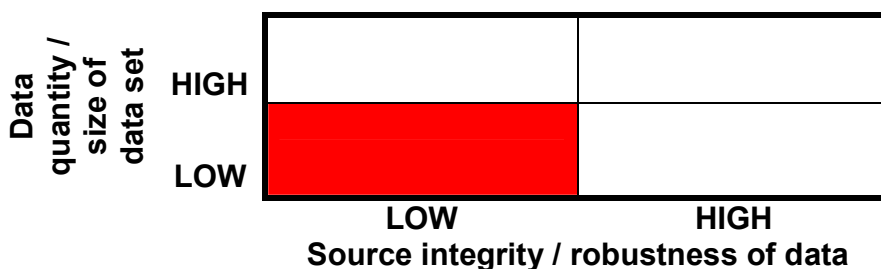
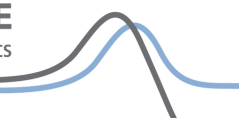


Figure 4 Confidence indicator for usage & lifespan data

### Related MTP information

- BNM C01: Circulators Government Standards Evidence Base 2009: Key Inputs
- BNM C02: Circulators Government Standards Evidence Base 2009: Reference Scenario
- BNM C03: Circulators Government Standards Evidence Base 2009: Policy Scenario
- BNM C04: Circulators Government Standards Evidence Base 2009: Best Available Technology Scenario
- BNM C05: Circulators Government Standards Evidence Base 2009: Key Outputs



- BNDH B01: Domestic Boilers Government Standards Evidence Base 2009: Key Inputs
- BNDH B02: Domestic Boilers Government Standards Evidence Base 2009: Reference Scenario
- BNDH B03: Domestic Boilers Government Standards Evidence Base 2009: Policy Scenario
- BNDH B04: Domestic Boilers Government Standards Evidence Base 2009: Best Available Technology Scenario
- BNDH B05: Domestic Boilers Government Standards Evidence Base 2009: Key Outputs

## Changes from previous version

- Minor changes to the template.

## 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](mailto:info@mtprog.com) quoting the document reference, or call the MTP enquiry line on +44 (0) 845 600 8951.

For further information on related issues visit <http://efficient-products.defra.gov.uk>