BNM C02: Circulators Government Standards Evidence Base 2009: Reference Scenario

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
EEI	Energy Efficiency Index

1 Introduction

- The Reference Scenario is a projection of what is likely to happen to energy consumption of each product if no new policies are implemented. All agreed and formally signed-off policies are included in the reference scenario.

- For cross-cutting policies such as CERT and Building Regulations, which are agreed but where the likely impact for specific products is unknown, assumptions are made about the impact per product, and detailed in the following sections. Where possible, separate projections of the reference scenario are made with and without such policies.

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 Scenario outputs

- The graph below shows the energy consumption for all circulator stock under the three scenarios from 2009 to 2030.

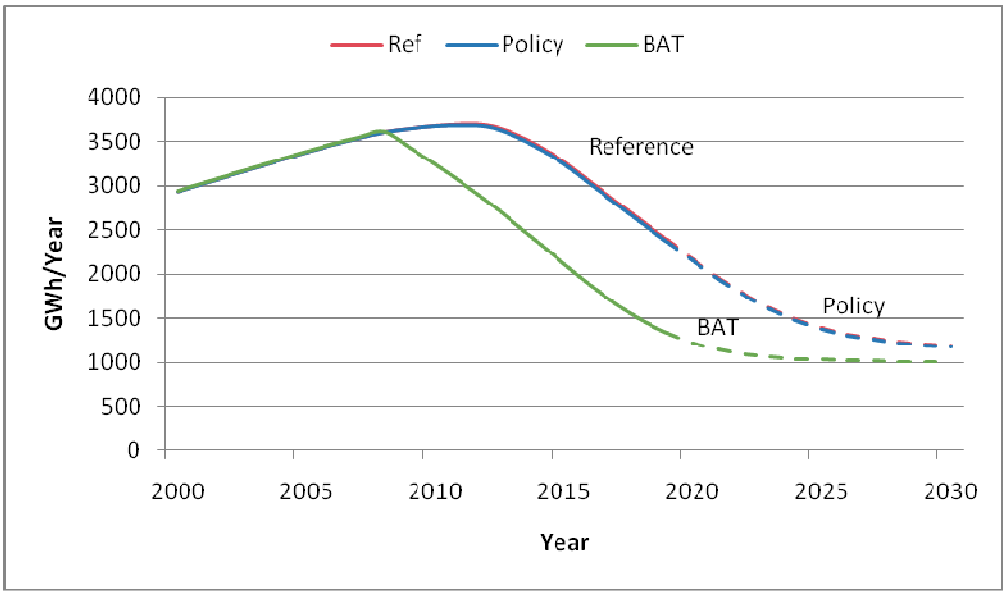

Figure 1 Comparison of scenarios for domestic circulators

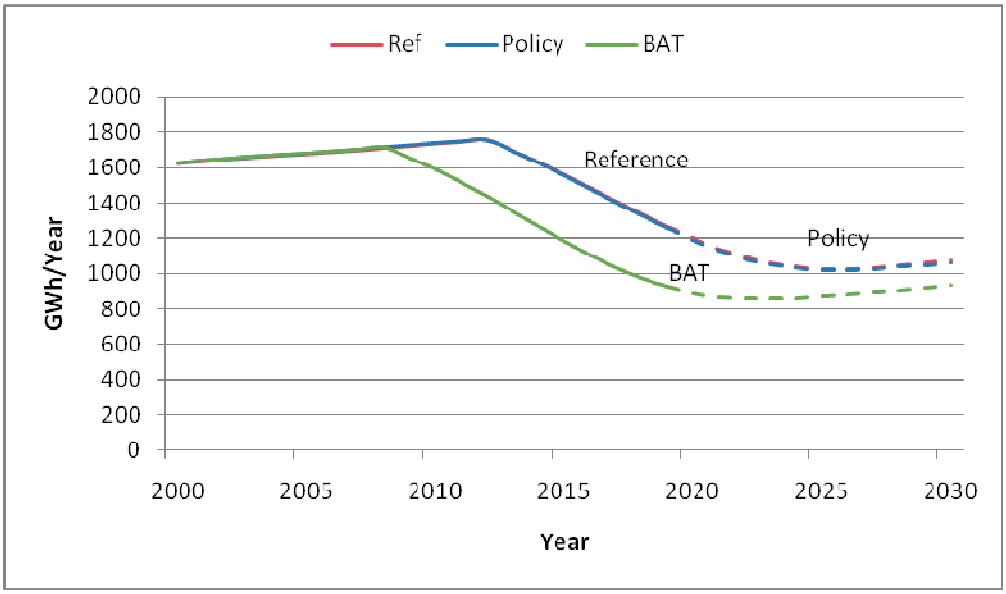

Figure 2 Comparison of scenarios for non-domestic circulators[1]

Table 1 Summary of scenario outputs

Energy Consumption (GWh)	2009	2020	2030
Boiler Integrated	1720	1340	800
Small	1930	820	390
Large	1730	1200	1070
TOTAL	5380	3360	2260
CO_2 Emissions ($MtCO_2$)			
Boiler Integrated	0.74	0.58	0.34
Small	0.83	0.35	0.17
Large	0.74	0.52	0.46

[1] Energy consumption figures for the non-domestic sector in the 2009/2010 Product policy analysis and projections document 'Saving energy through better products and appliances' were scaled down to match DECC projections for overall energy demand (www.decc.gov.uk/en/content/cms/statistics/publications/dukes/dukes.aspx).

MTP data represents the best currently available information based on a bottom-up modelling approach. MTP's data is the basis for detailed energy calculations in the 2009/2010 Product policy analysis and projections document. However, DECC projections indicate that overall energy demand in the non-domestic sector is lower than projected by MTP's detailed models. MTP has assumed that the differences between the DECC overall projections and its detailed bottom-up projections are due to incomplete data on the following inputs for some of its non-domestic products:

- existing product stock;
- existing product efficiency;
- product usage.

The energy consumption figures in these GSBNs have **not** been scaled down, in order to enable constructive stakeholder comment on the MTP input data, and therefore differ from the ones presented in the 2009/2010 Product policy analysis and projections document.

TOTAL	2.31	1.45	0.97

3 Current policy & measures

Table 2 Current policies & measures, Reference Scenario

Model	Policy name	Period in force	Description	Impact
Small, BI, Large	Energy related Products directive	2010-2030	Minimum performance standards agreed: • Jan 2013: EEI < 0.27 for standalone circulators (small and large) • Aug 2015: EEI < 0.23 for all circulators No assumptions have been made for future revisions of ErP	At least 95% of the market affected, the remainder are outside of the scope of the measures (solar systems, drinking water, etc.)
Small, Large	Circulator Labelling Scheme (voluntary)	Jan 2005-ongoing	Existing voluntary labelling scheme which categorises circulators in terms of efficiency from A-G. The A class is roughly equivalent to an energy-efficiency index of 0.27.	The scheme has no major impact on high efficiency circulator sales as the end-user generally does not directly purchase the product. Thus, zero impact assumed in model
Small, BI, Large	Building Regulations; Part L (in England and Wales and equivalent in Scotland and Northern Ireland)	Part L revision 2006. Next revision expected in 2010	Part L suggests standalone circulators should be labelled A-G, with A rated being the most energy efficient. BI circulators are not included in part L.	It is assumed that the Building Regulations are not ambitious enough to have any real impact on circulator sales. Thus, zero impact assumed in the model
Small, BI	CERT (Carbon Emissions Reduction Target)	2008-2011	At present certain models of Imp Standard and Std PM standalone circulators are included under CERT.	25% of Improved circulator sales and 1% of Standard PM circulator sales per annum (2008-2011) attributed to CERT.

- There are no test standards for circulators.

3.1 Policy timeline

- The following policy timeline identifies when policies come into effect, including future revisions that are formally signed off. Future revisions and new policies that

are not yet formally signed off are included in the policy scenario (see Policy Scenario GSBN).

Table 3 Policy Timeline for Reference Scenario

Model	Policy name	Current specification in force	2009	2010	2011	2012	2013	2014	2015-2020
Small, BI, Large	Energy related Products directive	2010					EEI=0.27 for Small and Large		EEI=0.23 for all circulators
Small, Large	Circulator Labelling Scheme	January 2005							
Small, BI, Large	Building Regulations	2006							
Small, BI	CERT (Carbon Emissions Reduction Target)	2008-2011							

4 Efficiency

4.1 Summary

- Circulator efficiency is defined as the ratio of the hydraulic power (flow and pressure) delivered by the circulator to the electrical power consumed by the circulator; it is presented as an energy efficiency index (EEI), which is a rating system based on the total annual energy consumed by the circulator (kWh) when operating to a predetermined load pattern and number of running hours per annum.

- EEI varies with the heating mode (On/Off or thermostatic radiator valve, TRV) in which a circulator is used. Domestic circulators operate in On/Off or TRV mode, whereas non-domestic circulators only operate in TRV mode.

- The standard definition of EEI is based on the TRV mode of operation, which is highlighted in Table 4.

- The benchmark indicates the best available technology on the market using improved permanent magnet technology.

Table 4 Efficiency metric for circulators

		Benchmark	Imp PM	Std PM	IM VS	Imp	Std
Small	**EEI (TRV)**	0.2	0.23	0.27	N/A	0.87	1.16
	EEI (on/off)	0.36	0.43	0.47	N/A	0.93	1.21
BI	**EEI (TRV)**	0.2	0.23	0.27	N/A	1.26	1.68
	EEI (on/off)	0.52	0.63	0.68	N/A	1.34	1.75
Large	**EEI (TRV)**	0.2	0.23	0.27	0.44	0.45	0.54

Table 5 Small standalone circulator sales % split

	Sales weighted average power (W)	Std %	Imp %	Std PM %	Imp PM %	Benchmark %
2009	105.7	50	42	8	0	0
2010	104.2	47	44	9	0	0
2011	102.2	44	45	10	1	0
2012	87.9	28	44	27	1	0
2013	40.1	0.5	0.5	97	2	0
2014	38.9	0.5	0.5	69	30	0
2015	36.5	0	0	30	70	0
2016	35.2	0	0	0	100	0
2017	35.2	0	0	0	100	0
2018	35.2	0	0	0	100	0
2019	35.2	0	0	0	100	0
2020	35.2	0	0	0	100	0
2021	35.2	0	0	0	100	0
2022	35.2	0	0	0	100	0
2023	35.2	0	0	0	100	0
2024	35.2	0	0	0	100	0
2025	35.2	0	0	0	100	0
2026	35.2	0	0	0	100	0
2027	35.2	0	0	0	100	0
2028	35.2	0	0	0	100	0
2029	35.2	0	0	0	100	0
2030	35.2	0	0	0	100	0

Table 6 Boiler integrated circulator sales % split

	Sales weighted average power (W)	Std %	Imp %	Std PM %	Imp PM %	Benchmark %
2009	153.3	50	42	8	0	0
2010	151.9	47	45	8	0	0
2011	150.6	44	48	8	0	0
2012	147.6	39	52	9	0	0
2013	147.2	38	53	9	0	0
2014	106.1	25	25	12	38	0
2015	88.3	17	17	6	60	0
2016	61.9	5	5	0	90	0
2017	61.9	5	5	0	90	0
2018	61.9	5	5	0	90	0
2019	61.9	5	5	0	90	0
2020	51.0	0	0	0	100	0
2021	51.0	0	0	0	100	0
2022	51.0	0	0	0	100	0
2023	51.0	0	0	0	100	0
2024	51.0	0	0	0	100	0
2025	51.0	0	0	0	100	0
2026	51.0	0	0	0	100	0
2027	51.0	0	0	0	100	0
2028	51.0	0	0	0	100	0
2029	51.0	0	0	0	100	0
2030	51.0	0	0	0	100	0

Table 7 Non-domestic circulator sales % split

	Sales weighted average power (W)	Std %	Imp %	IM VS %	Std PM %	Imp PM %	Benchmark %
2009	345.5	48	31	15	6	0	0
2010	341.6	44	34	15	7	0	0
2011	337.7	40	37	15	8	0	0
2012	333.8	36	40	15	9	0	0
2013	192.6	0	0	0	95	5	0
2014	185.3	0	0	0	70	30	0
2015	174.3	0	0	0	33	67	0
2016	164.6	0	0	0	0	100	0
2017	164.6	0	0	0	0	100	0

	Sales weighted average power (W)	Std %	Imp %	IM VS %	Std PM %	Imp PM %	Benchmark %
2018	164.6	0	0	0	0	100	0
2019	164.6	0	0	0	0	100	0
2020	164.6	0	0	0	0	100	0
2021	164.6	0	0	0	0	100	0
2022	164.6	0	0	0	0	100	0
2023	164.6	0	0	0	0	100	0
2024	164.6	0	0	0	0	100	0
2025	164.6	0	0	0	0	100	0
2026	164.6	0	0	0	0	100	0
2027	164.6	0	0	0	0	100	0
2028	164.6	0	0	0	0	100	0
2029	164.6	0	0	0	0	100	0
2030	164.6	0	0	0	0	100	0

4.2 Data sources – efficiency & sales-weighting

Table 8 Efficiency & sales-weighting data sources

Model	Year	Reference	Reference date	Author	Justification	Confidence in sources (High/Low)
Small, BI, Large	2009-2030	Expert opinion	February 2010	MTP Technical Expert	Expert opinion of how sales in the market will spread themselves over different efficiency classes over time	High
Small, BI, Large	2008	ErP Preparatory Study	April 2008	AEA Energy and Environment	Peer reviewed document, defines the load profile used in the MTP model (the 'Blue Angel' distribution)	High

Model	Year	Reference	Reference date	Author	Justification	Confidence in sources (High/Low)
Small, Large	2008	"Results of Circulator Labelling Revision"	Dec 2008	University of Darmstadt (Dr. Gerhard Ludwig, Dr. Miriam Roth)	Amendments to EEI levels, explanation and new values provided	High
Small, Large	2008	"Update of EEI levels"	17th Dec 2008	Europump	Explanation of changes to EEI levels, and new calculation methods	High

4.3 Methodology & key assumptions – efficiency & sales-weighting

4.3.1 Historic data

Table 9 Interpolation & background calculations – efficiency & sales-weighting

Model	Year	Methodology & assumptions
Small, BI, Large	1960-2008	The average efficiency (EEI) of new circulators for each circulator type is assumed to remain constant over time, although the percentage of sales assumed for each type will vary (see below), therefore the average efficiency of new sales will change over time.
Small	1960-2008	The percentage of sales assumed, based on expert judgement, for each class of efficiency of small standalone circulators is dominated by Standard technology (100% sales) from 1960 to 1994. Improved circulators are introduced onto the market at that stage and command a 40% share. Std PM circulators are introduced in 1999 with a 1% market share, rising to only 6% by 2007. The low level of deployment of PM circulators is assumed to be due to cost, availability and lack of knowledge by the installers of circulators.
BI	1960-2008	BI circulators are assumed, based on expert judgement, to enter market in 1990 with 100% of BI sales as Standard technology. Improved circulators are introduced onto the market in 1995 and command a 40% share due to improved efficiency without a much larger investment cost. Std PM circulators are introduced in 1999 with a 1% market share, rising to only 6% by 2007. The low level of deployment of PM circulators is due to cost, availability and lack of knowledge by the installers of circulators. Information relating to BI circulators is more difficult to ascertain as the technology is integrated into the boiler during manufacture.
Large	1960-2008	Standard technology dominates the large circulator market (100% sales)

Model	Year	Methodology & assumptions
		until 1991 when IM VS circulators are introduced. IM VS sales are assumed to increase at a rate of 1% per annum until 2008, based on expert judgement. Improved circulators enter the market in 1995 with a 10% market share rising to 30% by 2008.

4.3.2 Future analysis

Table 10 Extrapolation & background calculations – efficiency & sales-weighting

Model	Year	Methodology & assumptions
Small, BI, Large	2009-2030	The average efficiency (EEI) of new circulators for each circulator type is assumed to remain constant over time, although the percentage of sales assumed for each type will vary (see below), therefore the average efficiency of new sales will change over time.
Small	2009-2030	In 2013 ErP Directive is introduced for Std PM circulators. It is assumed that 1% of Standard and Improved circulators which are outside the scope of the measure are sold in the year. The second step of the ErP directive is introduced in August 2015 with 65% of Imp PM circulators sold that year, 5% of Benchmark circulators are also sold as some consumers will want to install the most efficient product available. The latter increases to 10% by 2020 due to S.O.
BI	2009-2030	The ErP IM is not applicable to BI circulators in 2013. Expert judgement suggests that Standard and Improved circulator sales will decrease to 2015 when the ErP measure is introduced for Imp PM circulators and it is assumed that 60% of this type are sold in that year. Between 2015 and 2020, it is estimated that Standard and Improved circulators each have 5% sales as replacement for existing boiler stock is catered for. In 2020 Imp PM circulators sales are 98% and in that year 2% of Benchmark sales are attributed to the Supplier Obligation. Benchmark sales increase by 1% annually to 2030, at the expense of Imp PM circulators.
Large	2009-2030	Expert judgement suggests standard circulator sales will decline to 2013, when the ErP directive is introduced, due to manufacturers ramping down production of Standard technology. Std PM and Imp PM circulators have 90% and 10% of the market respectively in that year. In 2015, the second phase of ErP, this percentage split changes to 31% and 67%

4.4 Data issues – efficiency & sales-weighting

Table 11 Data issues – efficiency & sales-weighting

Model	Issue/risk	Approach taken/rationale
Small, BI, Large	Distortion of EEI calculations which affects small circulators	Consultations with manufactures, experts and Europump have taken place to discuss the distortion. An adjustment factor has been agreed but may need to be revisited. Incorrect factors may lead to small circulators being classed as more efficient then in reality.

4.5 Confidence level – efficiency & sales-weighting

- Although there are minor queries over distortion of the EEI for small circulators, the confidence levels in efficiency of each technology are high.

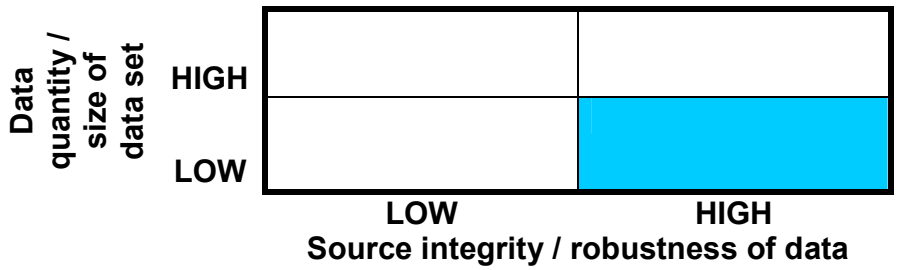

Figure 3 Confidence indicator for efficiency data

Related MTP information

- BNM C01: Circulators Government Standards Evidence Base 2009: Key Inputs
- 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** quoting the document reference, or call the MTP enquiry line on +44 (0) 845 600 8951.

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