BNCK01: Assumptions underlying the energy projections of cooking appliances

Version 3.2

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

1 Summary

Cooking appliances (ovens, hobs, microwave ovens and kettles) are calculated to account for 20.8 TWh of delivered energy in 2007.

Only electric ovens are currently covered by energy labelling legislation.

The markets for other appliances in this sector have no major policy activities to create incentives to bring forward more efficient models. However, energy savings could be achieved through policies to promote the most efficient technologies already available (eg induction hobs), and by reducing standby power consumption.

The assumptions presented in this Briefing Note provide information on the expected energy consumption and associated consumer habits used in the MTP modelling to 2020.

2 Scope

This Briefing Note sets out the information, rationales and assumptions made in the Market Transformation Programme (MTP) Policy Brief for Cooking Appliances. Unless otherwise stated, the projections in this Briefing Note have been produced based on Oxford University Environmental Change Institute's DECADE policy impact assessment model[1], plus information extracted from the Save II project report, *Efficient Domestic Ovens*, 2000[2] .

This sector includes electric and gas hobs and ovens, microwave ovens and kettles.

[1] Much of the research and reference material used originates from a range of projects undertaken by the Environmental Change Institute (ECI) with funding from the European Commission through the SAVE (Specific Action for Vigorous Energy Efficiency) and DECADE (Domestic Equipment and Carbon Dioxide Emissions) programmes. References are provided where possible.

[2] *Efficient Domestic Ovens,* Save II Project (4.1031/D/97-047), ISBN 951-788-304-8 (2000). http://www.ceecap.org/img_assets/File/Ovens_st.pdf

3 MTP assumptions for domestic cooking appliances

3.1 Unit energy consumption

Projections are based on the use of a 'unit energy consumption' (UEC): energy used per appliance.

The mean UEC shows a decrease. Trends towards ready meals, microwave oven use and eating out or takeaway meals are the main reasons behind a drop in the usage of hobs and ovens.

Microwave oven UEC has increased only marginally and almost levelled off. The increase is due to standby power consumption as electronic control models become more popular.

Owing to the lack of data on kettles, it is assumed that the UEC has remained constant.

Further decline or levelling off is expected for all other major cooking appliances.

3.2 Reference case scenario (Ref)

The Reference case projects energy consumption into the future and the expected effects of existing policies or market activities (eg. voluntary agreements).

For the cooking sector, it assumes an increase in the electricity consumption of all cooking appliances and kettles. This increase is a result of the rising number of households[3] and ownership levels.

3.3 Earliest Best Practice scenario (EBP)

The EBP scenario assumes that best economic and technologically feasible appliances are purchased.

This scenario excludes additional changes in user behaviour beyond those assumed for the Reference case.

3.4 Policy scenario (Policy)

The Policy scenario projections show the likely effects of possible policies or other market-changing options that have yet to be adopted or implemented.

Possible main policies affecting this appliance sector include:

- CECED [4] (European Committee of Domestic Equipment Manufacturers) Voluntary Agreement - nothing proposed (owing to lack of comparable electric and gas oven energy labelling).
- Energy Saving Recommended (ESR) - Energy Saving Trust[5] scheme to highlight products that demonstrate best practice in terms of energy efficiency, thus allowing consumers to more easily identify products. The scheme is open to all manufacturers. Products meeting set criteria are able to display the ESR logo at point of sale and in promotional material. The scheme aims to review the criteria

[3] MTP Briefing Note BNXS25: *UK household and population figures 1970 - 2020*. http://www.mtprog.com/ApprovedBriefingNotes/pdf.aspx?intBriefingNoteID=325
[4] CECED = Conseil Européen de la Construction d'appareils Domestiques
[5] Energy Saving Trust: http://www.energysavingtrust.org.uk/energy_saving_products

as the efficiency of appliances improves, to maintain recognition of best practice for recommended appliances.
- European Energy Label for gas ovens - the test method for the energy labelling of gas ovens is being established but there are still discussions about the methodology.
- The European Commission's Eco-Design of Energy-using Products (EuP), relating to the standby power consumption of ovens.

There are currently no proposals for energy efficiency policies for other appliances such as hobs, kettles or microwave ovens.

4 Electric ovens

Although gas ovens are up to three times more efficient in primary energy terms, consumer preference is for electric ovens (and gas hobs). Electric ovens are perceived to heat more evenly and not all consumers have a choice of fuels, even in non-remote locations[6].

Energy and carbon savings can be achieved through fuel switching as well as efficiency improvements. An EBP scenario which sees an increased take-up of gas (ie fuel switched from electric ovens) would involve higher delivered energy consumption from gas ovens. This increase would reflect a decrease in the EBP line for electric ovens due to fuel switching.

4.1 Reference scenario

4.1.1 Current policies

European Energy Label for electric ovens - 1st July 2003.

The Statutory Instrument implementing the energy label directive into UK law can be viewed at the Office of Public Sector Information[7].

4.1.2 Ownership

The percentage of households owning an electric oven is given in Table 1 below. This level of ownership is derived from data found in different sources because there is no single reliable set of data on ownership[8].

[6] In 1998, 81% of UK households were connected to the natural gas network - expected to reach 85% by 2020.
[7] http://www.opsi.gov.uk/si/si2003/20030751.htm
[8] DECADE model produced as part of the EC SAVE programme.

Table 1: Percentage of households owning electric ovens

Year	% households
2000	57.70
2001	58.22
2002	58.75
2003	59.28
2004	59.82
2005	60.37
2006	60.92
2007	61.48
2008	62.04
2009	62.60
2010	63.17

Year	% households
2011	63.75
2012	64.32
2013	64.90
2014	65.48
2015	66.06
2016	66.65
2017	67.24
2018	67.82
2019	68.41
2020	69.00

Details of the number of households can be found in MTP Briefing Note BNXS25 concerning households and populations[9]

4.1.3 Appliance lifespan

The average lifespan of an oven is assumed to be 18.65 years in the MTP modelling. This figure is calculated from the trend in sales necessary to maintain the appropriate level of stock in people's homes.

Future reviews of the modelling will consider a possible shortening of this replacement period as replacement cycles are decreasing owing to trends in kitchen and product designs[10].

4.1.4 Consumer habits

Oven usage is likely to continue to decline owing to changing lifestyles and habits.

It is assumed that ovens are used 135.1 times per year (2007), and this frequency is reduced by 2.4 times per year over time (giving 103.4 times per year in 2020).[11]

4.1.5 Oven efficiency

Table 2 details the assumed energy consumption per use for electric ovens.

Prior to the introduction of the Energy Label, different levels of performance were not specified for the different specifications of ovens, and the figure for 'other' was used in the modelling (years before 2003).

Table 2 Energy consumption per use for different oven efficiencies

Level of performance (Energy class)	A	B	C	D	E	F	G	Other
kWh per use	0.96	1.16	1.36	1.56	-	-	2.16	1.2

[9] MTP Briefing Note BNXS25: *UK household and population figures 1970 - 2020*. http://www.mtprog.com/ApprovedBriefingNotes/pdf.aspx?intBriefingNoteID=325
[10] The Business Book 2003, Independent Electrical Retailer.
[11] Assumptions made in the DECADE modelling as part of the SAVE programme.

Levels of performance are taken as an average for each energy class - no differentiation is made for different oven sizes or systems (fan vs convection).

Consumption per use data come from the SAVE II study, which presented a market average of around 1.24 kWh per cycle for the brick test and 1.56 kWh per use when testing with real dishes. A linear adjustment has been used in line with the Energy Label Energy Index (EI).

There is very limited information on the efficiency of electric ovens, both for the old existing appliances currently used in different households (stock) or from sales data.

Self-cleaning cycles are not included in the modelling, but range from between 2.4 and 6 kWh/cycle[12].

Table 3 gives percentage sales of all electric ovens by Energy Label class for 2003 to 2005.

Table 3 Sales according to energy efficiency class

	A	B	C	D	E	F	G
2003	7.7%	90.6%	1.2%	0%	0%	0%	0.5%
2004	15.2%	81.5%	2.7%	0.3%	0%	0%	0.3%
2005	22.7%	68.5%	8%	0.5%	0.3%	0%	0%

The Reference scenario model currently assumes a shift to greater sales of more efficient new appliances in 2006 and 2007 (39% class A, 59% class B), but no further improvements after 2007 owing to a lack of any further agreed policy activities.

4.1.6 Standby power consumption

Standby power consumption is assumed to be an average of 5 W, and is found on around 61% of ovens[13].

The modelling assumes that the standby power consumption will remain at 5 W, but will increase in frequency and be found on 62% of all ovens from 2010.

4.2 Policy scenario

An increase in the sales of more efficient ovens is reflected in the Policy scenario, with a target of 100% of sales being energy efficiency class A by 2010.

Drivers for this are expected to include the Energy Saving Trust's Energy Saving Recommended (ESR) scheme and a revision of the EC Energy Label.

Savings from reducing standby power consumption would be achieved from a reduction to 2.5 W by 2010 and to 1 W by 2015.

Further information on the policies can be found in the Domestic Cooking Policy Brief (2007).

[12] SAVE II Efficient domestic ovens working report, Task 2, page 16. http://www.ceecap.org/img_assets/File/Ovens_st.pdf
[13] Measured on a limited sample for MTP energy label compliance testing, March 2004.

4.3 EBP scenario

The EBP scenario assumes that only the most efficient models (efficiency class A) will be purchased from 2007 and that standby power consumption will be found in the same percentage of appliances as in the other scenarios, but the consumption will be 1 W per oven.

5 Gas ovens

The average gas oven uses more delivered energy than an equivalent electric oven, but uses less primary energy and results in lower carbon emissions.

5.1 Reference scenario

The appliance lifespan and number of uses are assumed to be the same as for electric ovens (see above).

5.1.1 Ownership

The assumptions regarding the percentage of households owning a gas oven are given in Table 4[14].

Table 4 Percentage of households owning gas ovens

Year	% households
2000	40.44
2001	39.98
2002	39.52
2003	39.06
2004	38.58
2005	38.11
2006	37.62
2007	37.14
2008	36.64
2009	36.15
2010	35.65

Year	% households
2011	35.14
2012	34.63
2013	34.12
2014	33.61
2015	33.10
2016	32.58
2017	32.06
2018	31.54
2019	31.02
2020	30.50

5.1.2 Energy consumption and efficiency

Gas ovens are assumed to consume, on average, 1.52 kWh/use[15] and this level of performance is not expected to change under the Reference scenario.

5.1.3 Standby power consumption

Standby power consumption is assumed to be the same as that for electric ovens (5 W on about 61% of new models).

[14] This is based on the assumption that all households own and use an oven, and those that do not have an electric model use a gas one.
[15] Brick test data for gas ovens as part of the SAVE II *Efficient Domestic Ovens* study (para 7.4.1.2, page 77). http://www.ceecap.org/img_assets/File/Ovens_st.pdf

5.2 Policy scenario

The only current Policy option proposed is an energy label for gas ovens. There has been some initial development work on this, but further work (and funding) is necessary. An additional barrier is how the label will relate to the current label on electric ovens and whether they will be comparable. It is assumed that improvements in the efficiency of new models will begin to be seen from 2009 in preparation for labelling in 2011. As the energy class levels of performance are not yet defined, it is difficult to model an improvement in the efficiency of the ovens sold on the basis of percentage of different energy classes sold. The assumption is therefore made that the average efficiency of gas ovens will improve by 5% per year starting in 2009.

Further information can be found in the Domestic Cooking Policy Brief (2007).

5.3 EBP scenario

The EBP scenario assumes that all models purchased would have an energy consumption of 1 kWh per use, and standby power consumption of 1 W from 2007.

6 Electric hobs

6.1 Reference scenario

6.1.1 Ownership

The current assumptions regarding the percentage of households owning an electric hob are given below in Table 5. This includes built-in hobs and hobs on free-standing cookers.

Table 5 Percentage of households owning electric hobs

Year	% households	Year	% households
2000	46.1	2011	44.9
2001	46.1	2012	44.6
2002	46.1	2013	44.4
2003	46.1	2014	44.2
2004	46.0	2015	43.9
2005	45.9	2016	43.6
2006	45.8	2017	43.3
2007	45.6	2018	43.1
2008	45.5	2019	42.8
2009	45.3	2020	42.5
2010	45.1		

Although this assumption shows a decline in the number of electric hobs, with consumers preferring to switch to gas hobs, the speed and flexibility of ceramic and induction hobs could see a reversal of this trend[16].

Electric hobs are assumed to have a lifespan of 19.83 years.

[16] Independent Electrical Retailer - November 2003 article.

6.1.2 Energy consumption

Energy consumption is based on an average appliance using 0.71 kWh per use (2007).[17] This value assumes that around 3% of sales are induction hobs. Induction hobs are assumed to use around 30% less energy than the average of other hob types.

The number of uses per year is assumed to be 424[18] and is not expected to change over the years.

6.2 Policy scenario

The Policy scenario aims to deliver 80% of new sales in 2020 being induction hobs, from a level of 20% in 2010. This would reduce the average kWh/use.

Further information can be found in the Domestic Cooking Policy Brief (2007).

6.3 EBP scenario

The EBP scenario is based on the Reference scenario, but assumes that all sales will be of the most efficient hob utilising induction technology and consuming 0.504 kWh per use, from 2007.

7 Gas hobs

The usage patterns for gas hobs are assumed to be the same as for electric hobs (given above).

7.1 Reference scenario

7.1.1 Ownership

The current assumptions regarding the percentage of households owning a gas hob are given below in Table 6[19]. This includes built-in hobs and hobs on free-standing cookers.

Table 6 Percentage of households owning gas hobs

Year	% households
2000	53.6
2001	53.6
2002	53.6
2003	53.7
2004	53.7
2005	53.8
2006	53.9
2007	54.1
2008	54.3
2009	54.4
2010	54.6

Year	% households
2011	54.9
2012	55.1
2013	55.3
2014	55.6
2015	55.8
2016	56.1
2017	56.4
2018	56.7
2019	56.9
2020	57.2

[17] DECADE model produced as part of the EC SAVE programme.
[18] DECADE model produced as part of the EC SAVE programme.
[19] DECADE model produced as part of the EC SAVE programme.

Gas hobs are assumed to have a lifespan of 18.6 years.

7.1.2 Energy consumption

Energy consumption is based on a measurement of 0.9 kWh per use.

Usage patterns are assumed to be the same as for electric hobs.

A standby power consumption of 5 W is assumed to be present on around 3% of gas hobs.

7.2 Policy scenario

There are currently no Policy measures or market activities that provide an improvement on the Reference scenario.

For standby power consumption, a reduction to 1 W by 2010 on the small number of new models expected to have standby is included in the modelling of this scenario.

7.3 EBP scenario

No information on the efficiency potential of gas hobs is available to suggest any improvements. Efficiencies are more likely to be achieved through changes in consumer behaviour (eg. use of different types or sizes of saucepan and use of lids etc), but are not currently modelled.

Standby power consumption is modelled as being at a lower level of 1 W from 2007 for this scenario.

8 Kettles

8.1 Reference scenario

For the Reference scenario, it is assumed that kettles are owned by 96.3% of households (2007), and this figure is likely to fall by only a couple of percent to 95% by 2020[20].

For calculation purposes, electricity consumption is considered to be 0.11 kWh per use based on heating 1 litre of water (90% efficient)[21].

The number of uses per year is assumed to be 1,542.

The average life of a kettle is assumed to be just over 4.4 years.

No account is currently taken of the use of kettles that maintain hot water or have lights or indicators that consume electricity (kettles with special features could have standby power consumption of around 1.5 W). Further research on consumer habits is necessary to determine the effect of such features and how consumer habits may have changed.

Shortly after a revision of the current modelling, the Energy Saving Trust announced that certain kettles (saving 20% over standard models) were suitable

[20] DECADE model produced as part of the EC SAVE programme.
[21] DECADE model produced as part of the EC SAVE programme (not apparent if this is a combination of traditional and jug kettles and if habits have changed with more use of jug kettles with gauges, reducing consumption per boil).

for Energy Saving Recommended endorsement. Any effect from this has not yet been modelled for the Reference (or previously for Policy) scenario.

8.2 Policy scenario

There are no Policy measures or market activities to provide a Policy scenario.

8.3 EBP scenario

The EBP scenario models a situation where all kettles are used more efficiently (from 2007) owing to the use of kettles that encourage the user to boil only as much water as is necessary (eg. the Eco Kettle). The assumption is made that, in this situation, only 0.08 kWh of electricity is consumed per use.

9 Microwave ovens

9.1 Reference scenario

9.1.1 Ownership

For the Reference scenario, it is assumed that microwave ovens are owned by 85% of UK households (2007). The MTP modelling assumes that this level of ownership will not change[22].

The lifespan of a microwave oven is assumed to be eight years.

9.1.2 Energy consumption

Microwave ovens are mainly used for defrosting and reheating. They are not generally used for the full cooking of family meals. Grill and combination functions are rarely used by those who have them[23].

Energy consumption per use is assumed to be 0.945 kWh[24] based on actual measurements of 1.39 kWh for full power function and 0.5 kWh for defrosting.

Usage is considered to be an average of 96 times per year[25].

No differentiation is made between solo microwave ovens and those offering grills or combination functions, as consumers rarely use these.

9.1.3 Standby power consumption

For all electronic models, standby power consumption is assumed to stay at 3.6 W[26]. For 2007, 65% of sales are assumed to be electronic models. It is expected that electronic models will become more popular and account for 85% of sales by 2020.

[22] The Business Book 2003, Independent Electrical Retailer (between 85% and 95%, Mintel suggests there are 10% of consumers who are not interested in owning one).
[23] According to a 1998 survey from 1,496 respondents conducted by *Which?* Magazine. The main tasks were reheating drinks and meals, defrosting and cooking ready meals.
[24] DECADE model produced as part of the EC SAVE programme - this is an average figure based on an equal proportion of reheating and defrosting uses.
[25] DECADE model produced as part of the EC SAVE programme.
[26] DECADE model produced as part of the EC SAVE programme. Research in 2004 on a small sample of electronic models showed an average of 3.4 W.

9.2 Policy scenario

Energy consumption for microwave oven use is assumed to be the same as that modelled for the Reference scenario.

Standby power consumption is also assumed to be the same.

A reduction in standby power consumption to 1 W on the 70-80%[27] of new models that are assumed to have standby is assumed by 2015.

9.3 EBP scenario

Energy consumption for microwave oven use is assumed to be the same as that modelled for the Reference scenario.

The EBP scenario models a standby power consumption of 1 W for all new models purchased from 2007.

10 Behavioural potential

The following actions could offer savings, but such changes in habits are not currently incorporated into any of the scenarios:

- Keeping lids on saucepans during cooking.
- Using pressure cookers.
- Using a microwave oven for 40% of oven tasks in those households which currently own a microwave oven. (Further savings could be made using combination microwave ovens with a halogen light (eg LG SolarDom, BSH Quantum) instead of a main oven.)
- Switching off microwave ovens with a display at the mains between uses. However, some microwave ovens require resetting when switched back on and so consumers are not expected to adopt this practice for all microwave ovens.

Additional savings could be made in cooking behaviour by:

- Pre-boiling cooking water using a kettle (instead of heating from cold on an electric hob).
- Cooking more than one meal at a time and freezing some for later use.
- Removing kettle limescale at regular intervals.
- Turning off the oven around 10 minutes before the end of the cooking time and allowing residual heat to finish the cooking (this will not work for some fan-assisted ovens).

10.1 Barriers to the uptake of more efficient products

The barriers to increased ownership of more efficient cooking appliances include:

- High costs of better technology (eg induction hobs start at around £500, compared to £170 for standard ceramic hobs).

[27] Information recorded by the Intertek RPT test laboratory in 2002 during energy label compliance testing.

- Inertia - some consumers are likely to change their oven and hob only when the kitchen is given a 'make-over'.
- Lack of fuel choice. Gas appliances are considered to be up to three times more efficient in primary energy terms than an electric equivalent, but there are still many homes not connected to mains gas. Liquid petroleum gas (LPG) is an option but there are initial installation costs to set up LPG storage.

11 Issues

11.1 Ownership and use behaviour

The information used for the current modelling has not been updated for some time. More up-to-date data on ownership, replacement cycles and usage patterns would help to ensure appropriate modelling and energy use projections.

11.2 Other cooking appliances

The cooking sector modelling is currently limited to the main energy-using appliances. However, other forms of cooking such as using grills and small domestic appliances are not included owing to a lack of information on ownership and use. A limited review of these types of appliance would confirm that the main energy-using appliances and cooking methods are being considered.

11.3 Electric vs gas

There are savings to be made in terms of carbon emissions by using gas appliances instead of electric. A fuel-switching scenario is not currently available, and little is known about incentives that might change consumer behaviour to switch to gas. The potential from consumer acceptance needs to be considered before any policy scenarios are built or options presented.

Related MTP information

Briefing Note BNCK02: Energy label for domestic ovens
http://www.mtprog.com/ApprovedBriefingNotes/pdf.aspx?intBriefingNoteID=84

Briefing Note BNCK03: Energy test methodologies for domestic electric ovens
http://www.mtprog.com/ApprovedBriefingNotes/pdf.aspx?intBriefingNoteID=312

Briefing Note BNCK05: Historical microwave oven use and options to increase usage in the future
http://www.mtprog.com/ApprovedBriefingNotes/pdf.aspx?intBriefingNoteID=417

Briefing Note BNCK06: Trends in kettle type and usage and possible impact on energy consumption
http://www.mtprog.com/ApprovedBriefingNotes/pdf.aspx?intBriefingNoteID=416

Changes from version 3.1

Minor editorial changes.

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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