The rise of the machines

A review of energy using products in the home from the 1970s to today

energy saving trust®

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Energy Saving Trust

The Energy Saving Trust is one of the UK's leading organisations tackling climate change. Funded by Government and the private sector, we are a private limited company with offices in England, Scotland, Wales and Northern Ireland. Our purpose is to help reduce carbon dioxide (CO_2) emissions through energy efficiency and renewable sources of energy in the home, on the road and in communities. In the last 10 years, our initiatives and grant programmes have resulted in lifetime savings of more than 44 million tonnes of CO_2 and our national network of Energy Efficiency Advice Centres reaches around a million customers a year.

We are perhaps best known for our energy saving recommended mark – currently used on over 1,800 products across more than 140 manufacturers and retailers. The mark identifies the most energy efficient appliances, heating, insulation, glazing and lighting products. We have recently expanded its scope to include consumer electronics.

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Market Transformation Programme

The Market Transformation Programme (MTP) supports the development and implementation of UK Government policy on sustainable products. MTP seeks to reduce the environmental impact of products across the product life cycle by:

- **Collecting information.** Stock, sales, usage and resource consumption data is gathered on household and industrial products, such as televisions, fridges and electrical motors.
- **Building evidence.** The information gathered is used to model how products will evolve in the market place and to estimate future environmental impacts.
- **Working with industry and other stakeholders.** A common understanding is reached on how these impacts can be mitigated; action plans are agreed and the measures implemented.

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MARKET TRANSFORMATION PROGRAMME
Supporting UK Government policy on sustainable products

Written by Paula Owen
Produced by Huma Humayun

All energy consumption projections included in this report are from the MTP's 'What If' tool and other documents, unless otherwise referenced. All numbers and statistics were correct at date of publishing, however as many product areas are evolving, the numbers and projections are subject to continual review.

This is an Energy Saving Trust publication supported by information supplied by MTP. All views expressed in this report are those of the Energy Saving Trust and are not intended to represent the views of Government.

Domestic energy usage on household products has doubled in the last 30 years.

By 2010 consumer electronics will become the biggest single sector of consumer electricity consumption.

Contents

A review of energy using products in the **home**

Introduction

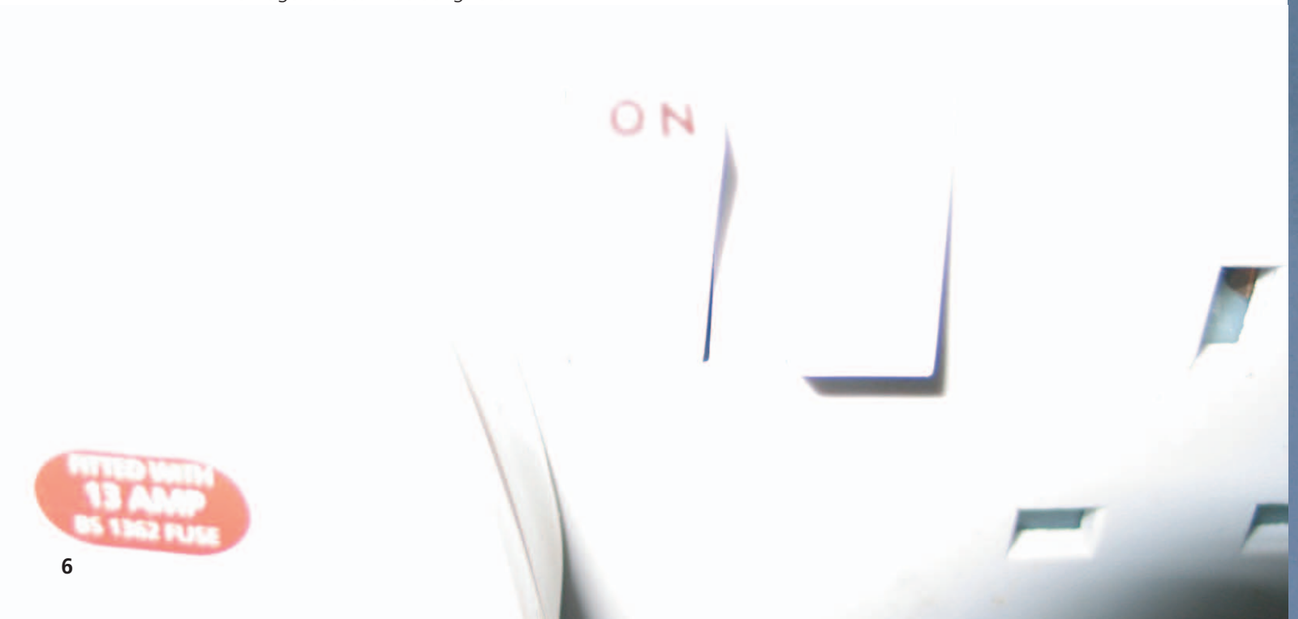
Climate change has become one of the most talked about social issues of our time and makes the news headlines on a daily basis, but few people make the link between our changing climate and the energy that we use at home. Yet household energy use accounts for more than a quarter of the UK's total carbon dioxide (CO_2) emissions - a large contributor to man made climate change.

Although the energy efficiency of our homes, and the products we use within them, has improved by around 2% year on year since 1970, our insatiable appetite for energy has far outstripped this improvement. The increase in the number of energy using products - particularly consumer electronics - to be found in the average home, has made a major contribution to the rise in domestic energy consumption.

In fact, **between 1972 and 2002, electricity consumed by household domestic appliances in the UK[1] doubled and is anticipated to rise by a further 12% by 2010.** The potential impact this will have on our environment is huge and cannot be ignored.

This review is therefore timely and is the first of its kind. It examines not only the growth of these products over the last three decades but also looks at future trends and the related policies currently in place. It offers potential solutions in the shape of the policy measures that could have the most impact in reducing energy consumption in the domestic sector.

We hope that it will help to simulate discussion and encourage action so that we can continue to encourage technological developments without further compromising our environment.



1 DTI table 3.10 Total electricity consumption by household domestic appliance 1970 – 2002 www.dti.gov.uk/energy/inform/energy_consumption/ecuk3_10.xls

Part 1

1.1 Past and present
The rise of the machines

The past three decades have seen an extraordinary growth in the number and choice of consumer durable[2] products. One of the biggest areas of growth has been in energy-using products and, in particular, labour saving devices and personal/home entertainment systems. There are not only the environmental implications of production and waste to consider, but also the energy consumption through the useful lifetime of these products. A continuing upward trend in domestic electricity consumption is deeply worrying.

Compare the average 1970s house (Box 1)[3] with a typical household today (Box 2)[4], which would have many of the featured products in the home.

Despite resembling a stock-take in an electrical store, only the most low-tech, alternative or low income households would not contain many of the products listed.

The implication of mass ownership of these products on energy consumption is enormous. While the energy efficiency of some products has greatly increased over the past few decades (e.g. between 1990 and 2001 the average consumption of a 140 litre refrigerator dropped by 29%[5]), the sheer quantity and choice of products available has swamped any savings made through rises in energy efficiency. Between 1972 and 2002, use of electricity by household domestic appliances in the UK[6] doubled from 44TWh to 89TWh. Consumption is anticipated to rise by a further 12% by 2010[7] to over 100TWh.

2 Refers to goods which are intended for mass markets that are not consumed immediately, but have a lasting life, e.g. washing machines, radios, cars, furniture, books, CDs etc.

3 This is has been derived from figures for 1975 from the following DTI table: "Percentage of households owning household domestic appliances": www.dti.gov.uk/files/file17829.xls - any item that is owned by approximately 50% of the population is included.

4 This list has been compiled using the DTI table noted above, using the 2002 figures. It has been supplemented with items identified by random local surveys by the author and, as such, should not be thought of as statistically robust, but more for illustrative purposes.

5 Boardman, B 2004 Achieving energy efficiency through product policy: the UK experience Environmental Science and Policy 7(3), 165-176

6 DTI table 3.10 Total electricity consumption by household domestic appliance 1970 – 2002 www.dti.gov.uk/files/file17826.xls

7 Taken from MTP publication: Sustainable Products 2005: Policy Analysis and Projections December 2005 Table 2.1 www.mtprog.com/ReferenceLibrary/MTP_Sustainable_Products_2005_FINAL.pdf

1970s

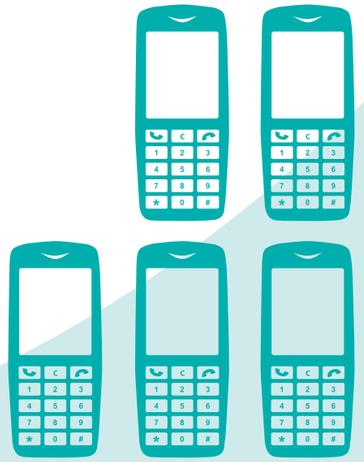
Typical energy using products in the home 30 years ago (Box 1)

- Television
- Vacuum cleaner
- Electric bar heaters
- Hi-fi music system
- Hairdryer
- Electric kettle
- Washing machine
- Iron
- Electric blanket
- Radio
- Sewing machine
- Cooker
- Cassette player
- Fridge
- DIY appliance
- Toaster
- Occasional lamps

2000s

Typical energy using products in the home today (Box 2)

- Televisions
- Video players
- DVD player/recorder
- Portable music players
- Mobile phones
- Hairdryers
- Hair irons
- Electric toothbrushes
- Wireless telephone/answering machine
- Slave portable phone handsets
- Electric kettle
- Smoothie maker
- Magimix
- Ice-cream maker
- Digital radio
- Mini hi-fi systems
- Washing machine
- Tumble dryer
- Dishwasher
- PlayStation/games console
- Cappuccino maker
- Digital clock/radios
- Electric lawnmower
- Strimmer
- Microwave
- Electric oven
- Electric hob
- Extractor fan
- Large fridge/freezer
- Drinks cooler
- Portable fan
- Vacuum cleaner
- PC computer
- Monitor
- Printer
- Scanner/fax
- Digital camera
- Set-top box
- Electric shaver
- Steam iron
- Juicer
- Home security system
- Broadband connection
- Halogen bulb light fittings
- Personal care products
- Power tools
- Electric blanket



In addition, the use of energy by these products is not limited to when they are physically switched on and in use; the remote control has removed the need, in some manufacturers' eyes, of a manual on/off switch. The result is that many household products are never completely switched off, but continually consume energy in a 'passive' stand-by mode.

The exponential rise in popularity of rechargeable products such as the mobile phone, MP3 player and digital camera can in some way be seen as a positive development as it reduces the need for disposable batteries. However, the method of recharging can result in constant energy demand if the recharging unit is left plugged in and switched on at the socket.

If one mobile charger per household is left on standby, the energy wasted is enough to provide the electricity needs of 66,000 homes for one year.

For example, a significant proportion of the population leave their mobile phone charger plugged in and wasting energy all of the time whilst believing it to be inactive.[8] Although the stand-by power consumption of a single mobile phone charger only averages 1 watt[9], the combined stand-by usage of approximately 25 million[10] of these items adds up very quickly to 25 megawatts (MW). This adds up to 219 GWh consumed per annum[11], enough energy to power the electricity needs of 66,000 homes for one year.

Inevitably, changing trends in household size and composition will have an impact on these issues. Projected population growth is less important than the average number of occupants per household and, in particular, the number of single-occupancy dwellings. Evidence suggests that the more people there are in a household, the more energy efficient per capita that household becomes.

Overall, there has been a decrease in the number of people per household over the last few decades such that the current average is 2.3 people per household (compared with 2.9 in 1971), with only 7% of households containing more than four people in 2002, compared to 14% in 1971.

If we assume that the current average of 2.3 people per household remains the same until 2020[12], and the total population rises to nearly 64 million[13], the number of households will rise to approximately 28 million (compared to 26 million today). That represents an extra two million households to equip with all the modern appliances considered essential nowadays. Almost 70% of the expected rise in household numbers in England between 1996 and 2016 is attributable to single person households[14].

8 Meaning that there is not a mobile device attached to charger and actively charging, but the charger is switched on at the wall

9 MTP Briefing note: BNXS36: Estimated UK standby Electricity consumption in 2004

10 A conservative estimate of approximately one active phone per household

11 Assuming the phone chargers are plugged in for 24 hours a day, 365 days per year, with only a small proportion of this time actively charging a phone

12 MTP Briefing note: BNX25 UK Household and population figures 1970 - 2020

13 Population Trends, 118, Winter 2004, National Statistics

14 Holman A 2001 Housing demand and need in England 1996 – 2016. Town and Country Planning Association.

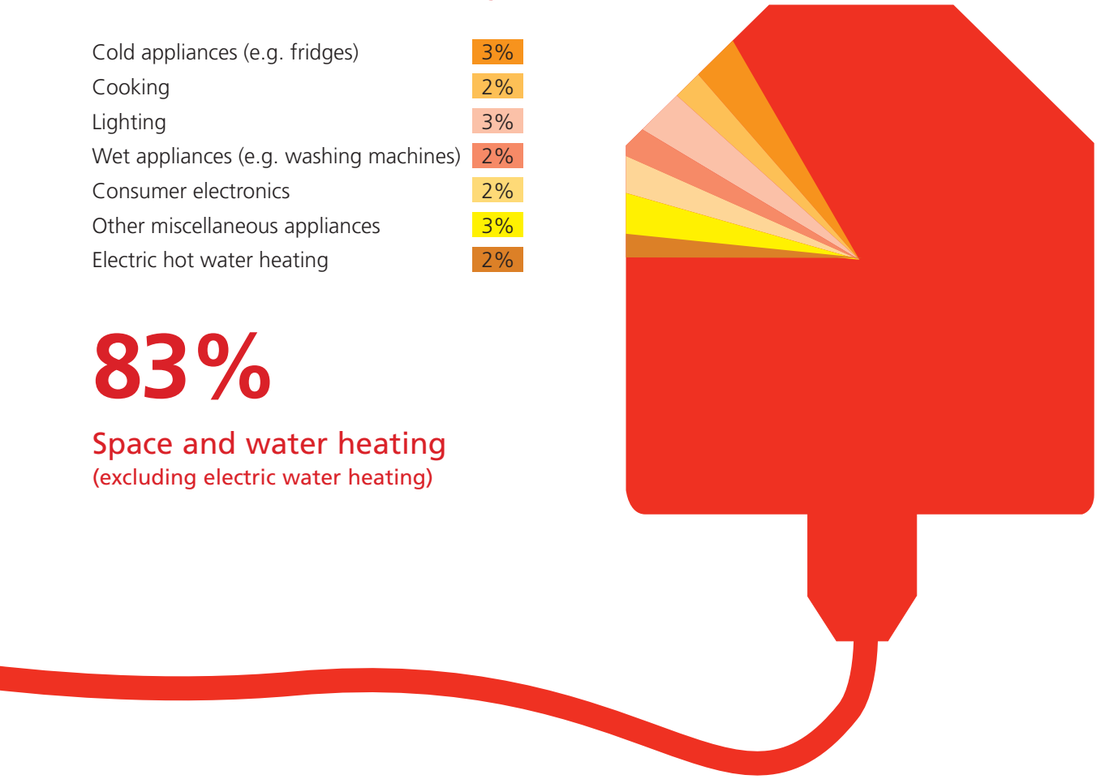
By 2020 there will be an extra two million households to equip with energy using products

1.2 Overview of the **sectors**

By dividing energy-using products in the home into different sectors according to their function, much is revealed about their impact on energy usage. It can be seen from the graph below that focusing on space and water heating has the greatest potential for energy savings. Promotion of energy efficient measures in this sector has therefore been high profile – for example, encouraging the installation of loft and cavity wall insulation and the introduction of condensing boilers. However, other sectors reveal significant opportunities to reduce energy consumption.

Graph 1

A graph of total energy usage in the home in 2000 broken down by sector



83%

Space and water heating
(excluding electric water heating)

1.2.1 Domestic cold appliances

The sector is made up of fridges, freezers and fridge/freezer combinations. An EU energy label is mandatory on all domestic cold appliances.

Penetration of domestic cold products as follows [15]:
Refrigerator: 43%
Fridge-freezer: 64%
Chest freezer: 17%
Upright freezer: 27%

This sector accounts for 18%[16] of total domestic electricity consumption. Estimated energy consumption of cold appliances in 2004 was 15.1 TWh; this is projected to fall to 11.4 TWh by 2020.

UK households spend £1.2 billion of electricity every year on cooling and freezing food and drink.

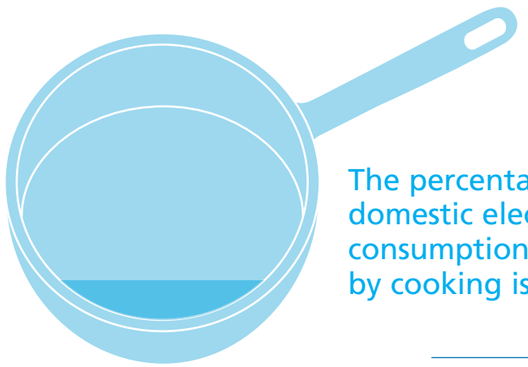
An efficient new fridge-freezer consumes only half of the electricity of an inefficient older model.

1.2.2 Domestic cooking

This sector covers all domestic cooking appliances ranging from ovens, hobs, kettles, toasters and the new worktop-style low-fat grills. This sector is relatively immature in terms of research carried out into energy efficiency. The introduction of the EU label on 1 January 2003 for domestic electric ovens has provided a focus on how activity will progress.

Penetration of domestic cooking appliances is as follows[17]:
Cooker hoods: 18%
Kettle: 97%
Deep fat fryers: 34%
Sandwich toasters: 33%
Electric hob: 46%
Microwave: 83%
Electric oven: 59%
Toasters: 80%
Slow cookers: 20%

The percentage of total domestic electricity consumption taken up by cooking is 15%. Ovens and hobs together account for 54% of this sector's total electricity consumption, with kettles accounting for a further 27%.

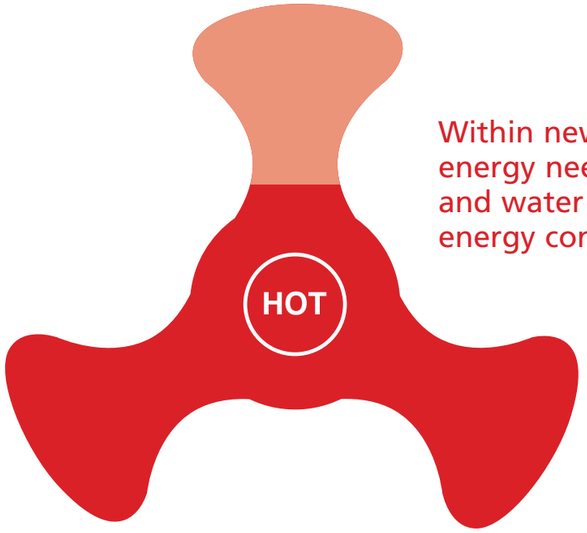


The percentage of total domestic electricity consumption taken up by cooking is 15%.

15 All figures relate to 2002 figures and are taken from the DTI table "Percentage of households owning domestic appliances, 1970 - 2002". The link is noted in footnote 3

16 Taken from MTP Policy Brief: energy consumption of cold appliances

17 See footnote 15



Within new houses, the energy needed to heat air and water is 72% of total energy consumed.

1.2.3 Domestic heating

The domestic heating and hot water market is dominated by individual wet central heating systems with boilers and radiators, which usually provide both space and water heating. These systems account for 74% of the total market.

There are many other types of systems, notably warm air systems, under floor systems, community heating systems including combined heat and power, room heating appliances, storage heating, heat pumps, solar aided systems and, more recently, micro combined heat and power systems for smaller buildings. Fuels include natural gas, liquid petroleum gas, oil, and solid fuel. The sun (passive solar, solar hot water and photovoltaics [PV]) and electricity and/or gas are usually used in combination. System design, installation and controls are all important to the efficiency of the system.

For the housing stock as a whole, with an average SAP[18] rating of 42, heating and hot water accounts for 83% (59% heating; 24% hot water) of total domestic energy. This represents approx 24% of total UK energy consumption. A newly built house, with good standards of insulation providing a SAP of 80, can reduce heating requirements by about 75%. However, water heating requirements remain the same. Within new houses, the energy needed to heat air and water is 72% of total energy consumed.[19]

1.2.4 Domestic lighting

Products covered include lamps (bulbs) and luminaires, as well as their controls, for the housing sector. However, the emphasis is put on lamps and luminaires since lighting controls appear to have a limited impact on domestic energy consumption. Domestic internal lighting accounts for approximately 18 TWh electricity consumption at present and is projected to increase by about 17% to 21 TWh by 2020. This is due largely to increasing household numbers and an increase in the number of lights in each household. On average, each household has 23 light bulbs in use; this is expected to increase to just over 26 bulbs by 2020. Over the same period the average number of fittings per household is expected to rise from 16.5 to 18.9[20].

Currently, internal domestic lighting accounts for 16% of total domestic electricity.[21] However, this figure only represents fixed lighting. Less permanent light fittings such as movable lamps are not included so the contribution of lighting to the total is higher in reality.

The ‘heat replacement effect’ must also be taken into consideration in this sector[22].

If every UK home installed three compact fluorescent lights (CFLs) it would save enough energy to pay for all street lighting in the UK.

18 Standard Assessment Rating: The Government’s preferred method for measuring the energy performance of a dwelling based on an estimate of annual energy consumption for space and water heating on a scale of 1-100.

19 Facts taken from BNDH12: ‘Explanatory notes for policy brief on domestic heating sector: heat generation’

20 Facts taken from BNDL01: ‘Assumptions for domestic lighting sector scenarios’

21 2002 figures taken from Policy Brief: ‘UK consumption of domestic lighting’

22 As CFLs, and other more efficient light sources, replace traditional GLS type bulbs, the heat generated through the more inefficient bulbs will need to be replaced by other sources. Usually the main heating system does this automatically through its thermostatic controls. Therefore, savings from more efficient lights may have been overstated, as extra energy is used from other sources to compensate for the reduction in heating.

An energy efficient light bulb uses only one quarter of the electricity of an inefficient incandescent bulb and lasts up to twelve times longer.

WASHING CLOTHES AT 40C° INSTEAD OF 60C° USES A THIRD LESS ELECTRICITY.

UK households consume £1 billion worth of electricity every year using washing machines, tumble-dryers and dishwashers.

1.2.5 Domestic Wet Appliances

The wet sector covers all domestic laundry and dishwashing appliances.

The penetration of the wet sector is as follows:
Dishwashers: 25%
Tumble dryers: 40%
Washing machines: 79%
Electric showers[23]: 35%
Washer dryers: 15%

These consume 14%[24] of total domestic electricity consumption: Of this, 57% is washing machines; 25% tumble dryers; 18% dishwashers.

Currently, over 90% (GfK - Growth from Knowledge - sales data, 2005/06) of all new washing machine sales are A rated while the majority of tumble dryers remain energy class C.

For dishwashers, the full sized variety (12 settings) is more likely to be A rated (92%, GfK 2005/06). In the slim models (7-8 settings), the A class also dominates with 76% of the market. The compact, or table top, models (6 settings) are dominated by C class models with 52% of the market. Overall, the whole dishwasher market is dominated by A rated models, at 83% of all sales.

1.2.6 Consumer electronics

The consumer electronics sector is one of the largest users of domestic electricity. Products in this sector include: televisions, video recorders, external power supply units (for items such digital TV adapters).

Televisions consume the largest proportion of energy within this sector (at around 40%). TV energy consumption is expected to surge with the increased use of digital TV adapters unless action is taken. Therefore, although there are key policies tackling consumption in all of the products listed above, the present focus of Government's activity is to seek to implement measures that will limit the impact of digital TV adapters.

Penetration of consumer electronics in the domestic sector[25]:
Cassette players/radios: 95%
Hi-fis: 94%
TV: 98%
VCR: 87%

Total electricity use in the consumer electronics sector was estimated to be 17.3 TWh in 2004. This equates to over 16% of total domestic electricity consumption. This is predicted to continue to rise and become one of the largest domestic energy consuming sectors, overtaking, for example, the cold appliances sector where efficiencies will reduce total demand. In 2010, the total energy consumption of the sector is estimated to be over 30 TWh[26], dwarfing all other sectors except for heating.

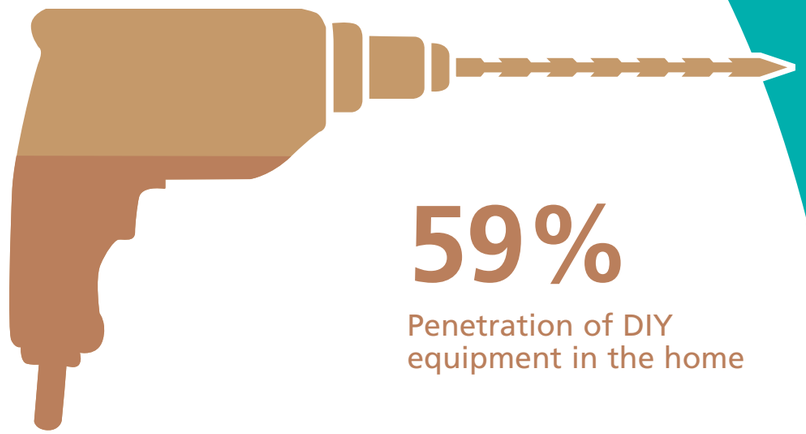
23 Traditionally, electric showers have not been classed with 'domestic wet' appliances. However, since penetration of this products is high (0 - 35% in 30 years) it was thought prudent, by the author, to include them here.

24 This figure does not include electric shower energy consumption.

25 Please note that these figures come from the 2002 DTI 'Households owning domestic appliances' table. There is no mention of DVDs, MP3s and video recorders. These figures are hence a very limited view of what is a rapidly increasing and expanding sector.

26 Taken from: 'Sustainable products 2005: policy analysis and projections MTP Dec 2005'

27 The percentages, where shown, are taken from DTI table 'Percentage of households owning household domestic appliances, 1970-2002'. All figures are for 2002.



UK households spend £1.3 billion every year on powering consumer electronics.

59%

Penetration of DIY equipment in the home

With technologies evolving at such a rapid rate, it is difficult to keep up with developments in consumer electronics. However, it is clear that the switch to digital will have a significant impact in the next three to seven years. Much effort is being directed at ensuring it will not drastically increase energy consumption within the home.

1.2.7 Other miscellaneous appliances

Modern living has brought a whole host of new, energy-hungry appliances into the home that do not fit into the traditional sector areas. Their impact on energy use is considerable and their consumption is growing. A great many of these products are either always left switched on, or in either 'passive' or 'active' stand-by mode.

This category includes, referring back to the 21st century home gadget list (page 9), the following types of appliance, with stated penetration levels of each, where known[27]:

Computers (45%)
Personal care products (94% for hair care)
Monitors (45%)
DIY equipment (59%)
Printers (32%)
Mobile phones (81%)
Fax/scanners (11% for faxes)
Home security systems
Vacuum cleaners
Telephones/answering machines
Garden equipment – including outside
Heaters (80%)
Portable fans
Laptop computers

Set-top boxes for the reception of digital TV are currently being sold very cheaply. However, by 2010 they could be costing UK households £780 million each year in electricity consumption, or £30 per household.

Part 2

2. Current knowledge and policy **measures**

There is a wide variance in the quality of information available on which to base both present and future energy consumption. We have therefore attempted to review the current information base for each of the product areas and also to explain both recent and forthcoming policy measures for improving energy efficiency, the success of which will have a significant impact on our energy use going forward.

2.1 Knowledge base

2.1.1 Domestic cold appliances

This sector is relatively well researched and much data is held regarding the efficiency of products, market penetration and turnover/lifetime. There has been debate on whether the performance under test conditions (on which the energy label is based) reflects actual use by consumers. Other concerns lie with the tolerances allowed in terms of testing and labelling the product with an energy label. An allowable tolerance of up to 15% is seen as high and can be used to uplift a product from one category to the next highest.

The market for wet appliances (split by make/model) is well covered through available data. The Energy Saving Trust also manages and promotes the 'energy saving recommended'[28] label to certify the best of the current market selection (i.e. A+ and A++ appliances since 2005). This provides the consumer with additional help in making the right energy choice, as well as acting as a stimulus for manufacturers and retailers.

MTP has done much research on consumption trends, energy labels, test methods, sales projections, technical advances, real use consumption, efficiency performance indicators and, most recently, the state of the market for A+ and A++ appliances. These are all available (as for all sectors described here) from the MTP site: www.mtprog.com

2.1.2 Domestic cooking

The data on current consumer cooking habits and future trends is limited and patchy, hence any modelling and projections must be viewed with more caution than, for example, projections in the cold appliances sector. Both the Energy Saving Trust and MTP receive regular sales data for gas and electric cooking appliances.

MTP has undertaken modelling based on sales data and trends in ownership. However, it admits that assumptions and calculations are based on data that may not adequately reflect the true energy consumption, number of uses, or the lifespan of hobs and ovens. Even less is known about the use of kettles, although they make up approximately 30% of total energy use in the domestic cooking sector[29].

Unlike the cold appliances sector where, once an appliance has been purchased, consumer behaviour has little impact on the energy consumption of the product, the cooking habits of consumers will have a great deal of influence on how efficient the appliances are over their lifetimes.

2.1.3 Domestic heating and hot water

The domestic heating sector is the subject of much research and data collection by parties other than the Energy Saving Trust and MTP because of its potential for large energy savings. Information on technical aspects of the most common (wet) domestic heating and hot water is well documented. Indeed, SEDBUK, the database of boiler efficiencies maintained by Defra, is an invaluable resource on the best products available.

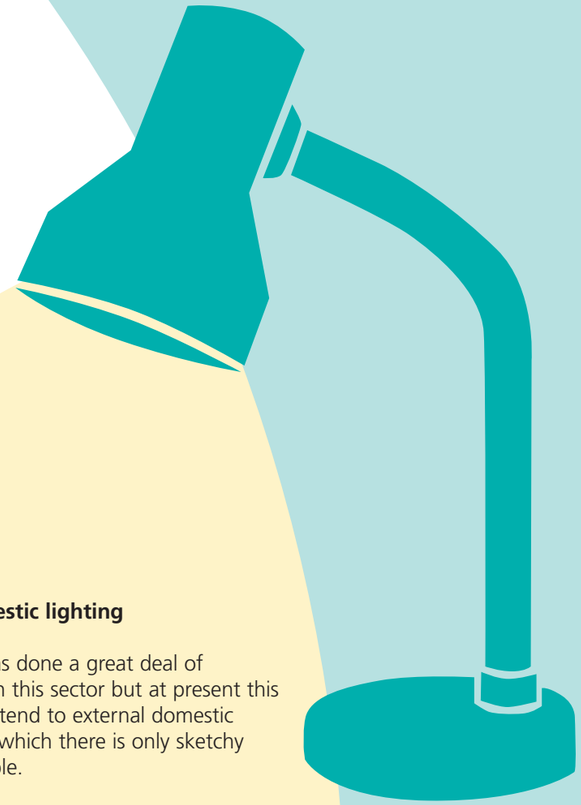
Where data and information is lacking is in the alternative systems that can be used to heat space and water. Gas and oil (wet) heating systems are installed in 74% of all UK homes; this leaves more than 25% of homes heated by alternative systems. Typically these include warm air systems, under floor heating, community heating systems, storage heating, heat pumps, solar systems and micro combined heat and power systems. Much more research is needed on these.

The efficiency of domestic heating is strongly affected by the dwelling fabric and other insulation products, such as cavity wall and loft insulation.

Much of the potential efficiencies are dependent on how householders use their heating systems. Unfortunately there have been no major user trials in which the typical behaviours of householders are explored. Indeed, it is widely considered that more needs to be done to enable householders to gain a better understanding of how to use their heating systems more effectively. If used incorrectly, there can be dramatic consequences for the theoretical savings attributed to these measures.

Much recent research has focused on the heat replacement effect, i.e. the extra energy demand from the heating system to substitute for the absence of waste heat from the introduction of more energy efficient appliances around the house. Consequently, the amount of extra heat required from the main heating system is now factored into future savings models.

A very recent phenomenon is the trend for outside heating, mainly in the form of patio heaters. While data exists on sales, neither the Energy Saving Trust nor the MTP currently receive regular data on these products. There is no hard evidence on regularity of use and amount of fuel consumed. However, recent communication with industry indicates that current use of these products may be as much as a factor of 20 lower than the previous MTP estimate[30].



2.1.4 Domestic lighting

The MTP has done a great deal of modelling in this sector but at present this does not extend to external domestic lighting on which there is only sketchy data available.

The MTP model is based on three essential variables:-

- Lamp[31] stock/ownership figures
- Average power demand of lighting appliances
- Energy consumption by lamp type

These variables give a generally accurate figure of energy consumption. The figure is then validated by a number of studies that assess energy consumption for lighting.

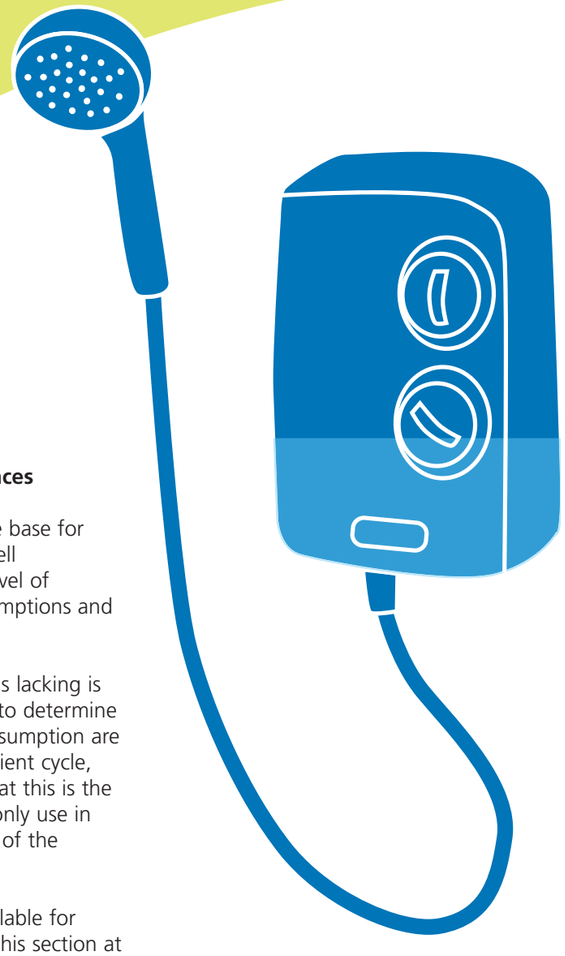
Two areas of uncertainty are sales data for lamps and whether the lifespan of lamps (in hours/lamp) in the home matches the technical predictions.

28 Formerly the Energy Efficiency Recommended label. Online register of products: www.est.org.uk/recommended

29 Taken from MTP Policy Brief: 'UK energy consumption of domestic cooking appliances'

30 MTP briefing note: 'Outdoor heating for comfort: patio heaters'

31 Please note in the term 'lamp' here is taken to denote the bulb rather than a lamp base.



2.1.5 Domestic wet appliances

The information and evidence base for domestic wet appliances is well established. There is a high level of consensus regarding the assumptions and predictions for this sector.

Where information and data is lacking is in consumer behaviour. Tests to determine energy ratings and water consumption are based on a standard eco-efficient cycle, but there is scant evidence that this is the cycle consumers most commonly use in practice as it tends to be one of the longest cycles.

There is very limited data available for electric showers (included in this section at the author's discretion) other than ownership data – 35% penetration in 2002. The popularity of electric showers, over the gravity fed variety, increases water and energy consumption as the models become more advanced and even more power-hungry features are added. Consumer usage therefore needs to be investigated.

2.1.6 Consumer electronics

This is a fast moving sector that is now attracting a lot of attention. The knowledge base is immature for some products as they are relatively new. Sales figures are collected for the main products including TVs, VCRs and DVDs. However, accuracy may not be high as these appliances can be purchased from a wide variety of retailers including supermarkets.

One thing that we can be sure of is that digital adapters will see the greatest rise in ownership out of all the consumer electronic products over the next five to six years. The rapid uptake of this relatively new product could have significant implications for energy consumption if policy interventions are not made soon.

35% penetration of electric showers in 2002

Much work has focused on the stand-by power consumption of consumer electronics as they are in this mode for most of their lives. Historically, manufacturers have not focused on ensuring energy consumption is minimised. However, the MTP has recently produced data on stand-by consumption for a wide range of consumer electronics[32]. Using this data, the Energy Saving Trust will produce a calculation tool for consumers to establish how much of their annual electricity bill they are wasting. The calculator will be available in Autumn 2006.

More research needs to be carried out on consumer use of these products. The only user research available was carried out in 2001 on 32 homes, where it was estimated that between 6-10% of annual electricity demand was from stand-by. Current estimates used in the models are more conservative but real-life trials may reveal much greater energy wastage.

Current data on TV technologies is based on miscellaneous industry projections previously agreed by stakeholders. It is acknowledged that they will need revising in the light of market changes.

To conclude, consumer electronics is the most under-represented sector in terms of data and information held. It is also the fastest moving sector which makes it very difficult to monitor and forecast. Priority should be given to improving the evidence and knowledge base, especially on consumer behaviour.

2.1.7 Other miscellaneous appliances

The products in this section include 'grey/silver goods', i.e. computers; laptops, monitors, printers and scanners. They are relatively well understood in terms of stock and penetration levels. Indeed, these products are beginning to merge with consumer electronic devices as, for example, the media capabilities of PCs improve, and wireless networking becomes an option for the home. Office-based products such as printers are also increasing because of the rise in home workers and the reduction in prices. The desktop PC is now almost ubiquitous, with 24 million units in the UK.

Other products, such as personal care appliances (such as electric toothbrushes), vacuum cleaners, telephones/answering machines, home security systems and gardening equipment, are much less well understood. In some cases there is not even reliable information on stock levels.

Whether the various products in this sector will have a large impact on electricity consumption is highly dependent on how consumers use them. Currently little is known about consumer behaviour.

32 BNXS36: 'Estimated UK standby electricity consumption in 2004'

2.2 Policy measures

2.2.1 Domestic cold appliances

Policy measures in this area have been led by the EU energy label which has been in existence for cold appliances for 10 years. This label, acting together with other measures, has helped transform the UK market from 2% of cold appliance sales being A-rated in 1999, to more than 65% being A-rated or above in 2005/06 (GfK data).

The success of the label has led to the development of new A+ and A++ categories for these appliances which have also been taken up by the Energy Saving Trust's energy saving recommended label.

Since 1999, only cold appliances in EU energy label classes A, B and C have been allowed to be sold as new on the European market (except for D and E labels on chest freezers which are still permitted). However there is a voluntary European Committee of Domestic Equipment Manufacturers (CECED) agreement which aims to remove C rated models from the market, and make the A rated model the average, by 2010.

Other policy measures that have contributed to the change in the market include the Energy Efficiency Commitment[33] (EEC) which has allowed subsidies for the most energy efficient appliances, making it cheaper to buy an A rated fridge than one with a B or C rating.

2.2.2 Domestic cooking

Unlike the cold sector, energy labelling for cooking appliances is in its infancy. It was only in 2003 that the EU passed the energy label regulation requiring electric ovens to carry an energy rating. These have not had time to make a substantial impact yet. However, there are concerns that the energy rating thresholds have been devised at too low a level to provide much differentiation of the market. In 2005/06, out of all sales of electric ovens, 23% were A rated and 68% were B rated although the full A-G rating scale was available. This suggests that the label will not progress the most efficient technologies and that a revision of the energy ratings will be required soon.

Likewise, there is no energy saving recommended criteria for electric ovens at present. In fact, the idea of an energy saving recommended label, based on the EU energy label, was rejected by the energy saving recommended Label Endorsement Panel on the grounds that the EU energy label does not take into account the stand-by power of these appliances. CECED is currently looking into these issues.

An energy label for gas ovens has been proposed, but is unlikely to be available in the short term due to the absence of an agreed test protocol. Its absence may encourage consumers to choose electric ovens rather than gas, even though gas ovens are much more energy efficient in terms of carbon reduction.

There is also no consumer label information on hobs, microwaves or kettles even though kettles account for 30% of total cooking energy consumption. However, some kettles received subsidies through the EEC scheme 2002–2005. Under the current EEC scheme, kettles demonstrating significantly greater energy efficiency are eligible for an innovative uplift subsidy[34].

2.2.3 Domestic heating and hot water

Policy interventions in this sector are numerous and well developed, mainly taking their brief from the Building Regulations (England and Wales). It is not within the scope of this report to discuss these policy measures in detail. Instead the most important recent policy developments will be touched upon.

The most influential and far-reaching policy measure in recent years has been the review of the Building Regulations (England and Wales). For example, changes to Part L of the Building Regulations, which came into force in April 2005, impose a minimum efficiency standard for new and replacement gas boilers (oil boilers count as exceptions until April 2007) which effectively means only condensing boilers now meet the standards required. This has had an enormous effect in the first six months of implementation, with 75% of the boiler market now being dominated by condensers[35]. Although there was much consternation and questioning about the reliability of these appliances by installers and others, these concerns seem to be unfounded and the technology changeover has progressed with minimal problems.

EEC scheme funding has also had a large impact on the promotion and sales of more efficient boilers since 2001.

Energy saving recommended endorsement has focused on promoting the best achievers in the SEDBUK database for the past five years. Only boilers with SEDBUK ratings of A or B were allowed to display the energy saving recommended logo. This has contributed to the transformation of the market for A and B boilers from less than 10% in 2000/01 to more than 80% in 2005/06, although it must be stated that the building regulation changes in April 2005 were the major contributing factor in this. The new regulations will ensure that it has become impossible to buy a boiler with an efficiency rating of less than A or B. Hence energy saving recommended criteria has changed to ensure that a boiler will have to have a SEDBUK rating of A to be awarded the label.

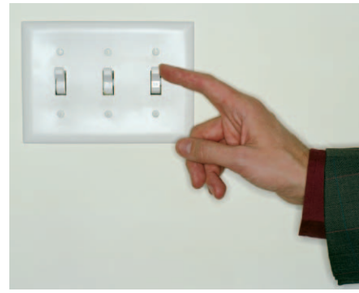
2.2.4 Domestic lighting

The Energy Efficiency Commitment (EEC) has had a dramatic impact on the price of energy efficient lighting in the UK. The promotion of CFLs through subsidies, starting in 1994 under the first Standards of Performance scheme, has reduced prices from approximately £5-£6 per light bulb to about £2-£3.50. They have even been given out at no cost by some energy suppliers. It is estimated that between 2000 and 2004, an extra 39.7 million CFLs were brought onto the market through EEC schemes. Some parties maintain that the continued large subsidy of CFLs in this way is not sustainable, arguing that if the subsidy is removed or reduced, consumers will return to the much cheaper GLS bulbs[36] unless alternative policies which increase the price of the GLS bulbs to better represent their environmental costs are introduced.

Energy saving recommended has also been promoting the most efficient CFLs for over 10 years. Light bulbs have carried an EU energy label for the past six years.

Part L of the Building Regulations (England and Wales) has been a key policy instrument as it requires a minimum number of CFLs to be installed in newly built homes[37]. A minimum of three integrated ballast luminaire fittings are also required in new-build homes. However, the choice of lampshades that fit these inflexible fittings is small and there is incidental evidence to show that homeowners replace them with normal fittings shortly after moving in. This is being addressed in the forthcoming changes to Part L (England and Wales) which seek to tighten the requirement for dedicated luminaries and make the replacement of them more difficult.

Energy Saving Trust ideas for future policies in this area have included an inefficiency charge or tax on GLS bulbs of at least 50 pence and reducing VAT on CFLs and other low energy light bulbs to 5%. However, the Government has confirmed that it is unable to change VAT rates for this purpose. There is already a precedent for inefficiency charges on GLS bulbs in Denmark where a tax of 3.75 DKK (35 pence) is applied to all incandescent lamps, with low energy fluorescent bulbs and other low-energy bulbs being exempt.



It is estimated that between 2000 and 2004, nearly 40 million extra CFLs were brought onto the market through EEC schemes.

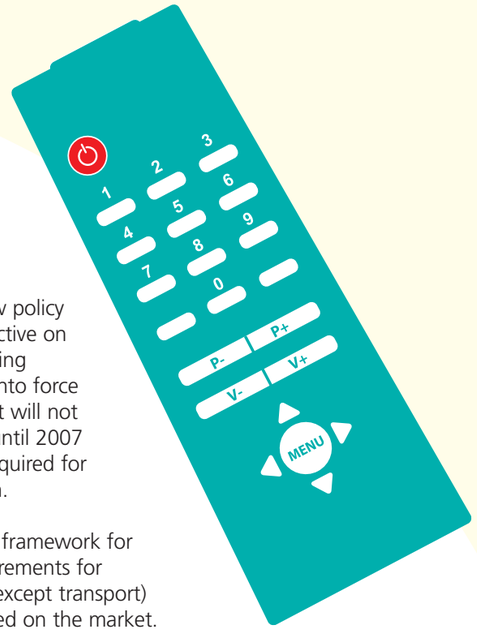
33 Formerly Energy Efficiency Standards of Performance (EESOP). A levy of energy suppliers to ensure they invest in energy saving measures to help their customers become more energy efficient

34 The EEC innovative action uplift subsidy is an incentive for energy suppliers to implement measures that can provide enhanced energy savings over the more traditional energy saving measures.

35 Total market sales Apr – Aug 2005, and 64% of these were A rated

36 Although recent sales data for January 2006 have shown a surprising 40% increase in CFL sales compared to January 2005, It is unclear exactly what has contributed to this sudden rise, but a hypothesis may be that the recent extensive energy price rises have made a significant impact on consumer attitudes.

37 Similar measures will be required in Northern Ireland when the changes to its Building Regulations come into effect in November 2006.



The 1-watt initiative aims to limit the standby power wattage to just one watt or below.

2.2.5 Domestic wet appliances

EU energy labelling for wet appliances is very well established. There has been an energy label on washing machines and washer dryers since 1996/98, on tumble dryers since 1996 and on dishwashers since 1999.

Washing machines
Washing machines have reached near saturation of A rated models in the marketplace. A revision of the label is required but is unlikely to take place before 2008. In the meantime, the EU Energy Label Regulatory Committee voted against an extension of the label to A+. However, the CECED[38] industry commitment includes the identification of a level of performance for washing machines at the level of the proposed A+ rating[39]. Although this is not officially recognised, some manufacturers are advertising their models with an A+ energy rating. In addition to this, the energy saving recommended label has upped its criteria so that only models with an AAA[40] rating can carry the label.

In 1997, CECED voluntary agreements led to the removal of all washing machines with labels of E, F and G. Those with D followed at the end of 2003.

The general trend for energy consumption in washing machines/washer dryers is downwards. In 2004 energy consumption was 4.8 TWh and this is projected to fall to 4.4 TWh by 2020.

Washer dryers
Washer dryers started carrying the energy label in 1998. The drying capacities of these appliances are usually smaller than those of stand alone tumble dryers. They are owned by 15% of the population (a main reason for purchase is lack of space for two separate appliances). Generally, washer dryers are thought of as a few years behind washing machines in technology terms and the market is currently dominated by B and C rated models. In 2005/6, 14%[41] of sales of washer-dryers were A rated. The most popular washer dryer had an energy rating of B (54% of sales).

Tumble dryers
The tumble dryer market is dominated by C ratings (81% in 2005/06); the energy label has not moved the market on in the same way as it has for washing machines. The energy saving recommended criteria are set at A or B rated appliances (and C rated where the product also has an automatic 'switch off when dry' function), but these only made up less than 1% of total sales in 2005/06. The technology in this sector is mature so not many new innovations are expected. About 40% of the population own tumble dryers and this is expected to remain constant to 2020. Energy consumption is expected to rise from 3.4 TWh in 2004 to 4TWh in 2020.

Data indicates that tumble dryers are used for approximately 50% of the total number of washes performed. The variation is probably seasonal, with more use in the winter months.

Dishwashers
Dishwasher energy consumption is expected to rise from 2.3 TWh in 2004 to 2.8 TWh in 2020. The introduction of the EU label in 1999 showed that there was considerable room for improvement in efficiency terms. Industry commitments in 2000 and 2003 removed the least efficient products from the market and, by 2005/06, over 90% of sales of full-size dishwashers were A rated for energy.

There are three main types of dishwasher: full-size (12+ place settings); slim line (7-9 settings) and compact (6 or less). The full-size and slim line versions have responded well to energy efficiency labelling, but the same is not true of the smallest 'compact' size. In the compact version, class C dominates with sales accounting for just over 50%. The energy saving recommended label can be applied to any model that attains the EU label AAA (for energy, cleaning and drying) plus it must meet or exceed the water consumption criteria as specified by the EU Eco-label[42].

Much of the work on dishwashers has focused on reducing the volume of water used, as most energy is consumed in heating up the water. The test cycle is usually based on the most efficient cycle the dishwasher offers for a normally soiled load. This usually takes a few hours to complete as the water is heated to a lower temperature and hence needs longer to clean to a sufficient degree. Little is known about how popular this particular option is with consumers.

2.2.6 Consumer electronics

Although there are not many existing policy measures that deal with the energy efficiency of consumer electronics, voluntary agreements setting targets for energy consumption are coming into play for consumer electronics manufactured or distributed within Europe. Examples include EU-wide voluntary Codes of Conduct (CoC), relating to digital TV services, passive standby for TVs/VCRs and external power supplies In general, these codes are negotiated between European Manufacturers and Trade Associations on the one hand and Member States and the European Commission on the other. In addition, G8 members agreed to take forward the 1 Watt initiative discussed at the Gleneagles summit in 2005. Perhaps unsurprisingly, the aim of this initiative is to limit standby power to 1 Watt for all appliances.

From 2006, energy saving recommended criteria has been set for integrated digital televisions setting a maximum on power rating of 250 watts and a maximum stand-by power rating of 1.5 watts. In addition, the Budget 2006 announced that the Energy Saving Trust will work closely with manufacturers in the area of consumer electronic products, to ensure that the better performing products are purchased by consumers.
The most important new policy development is the Directive on Eco-design of Energy-using Products[43] which came into force in July 2005. However, it will not become law in the UK until 2007 due to the timescales required for national implementation.

The Directive provides a framework for setting eco-design requirements for energy using products (except transport) before they can be placed on the market. There are no immediate obligations placed on manufacturers but, over time, detailed measures will be established for specific products[44]. Compliance will normally be based on the manufacturer's declaration, using the CE marking on products as a basis for claims.

The European Commission intends to engage industry on specific issues and encourage proactive commitments in order to pre-empt mandatory approaches, for example developing specific standards regarding TV on-mode. Within two years the Commission, in consultation with stakeholders via a consultation forum (required by the Directive), intends to establish a three-year work plan to ensure new products are designed to minimise energy consumption in use.

2.2.7 Other miscellaneous appliances

There are few policy interventions in this product area. The most significant ones are the Energy Star label for personal computers and other home office equipment which has historically acted, in effect, as a minimum standard criterion for stand-by power[45], and the Code of Conduct for electronic products that are powered by external powers supplies (discussed in section 2.2.6).

An energy label for vacuum cleaners is also under discussion.

38 CECED – European Committee of Domestic Equipment Manufacturers
39 Models that are 10% more efficient than the EU energy label boundary between A and B class rating
40 This requires an A rating for energy: A for wash performance and A for spin efficiency
41 2005/06 total sales: A = 14%; B = 54%; C = 26%; D= 6%
42 That being the product's water consumption must be less than 0.625s + 9.25 (where 's' is the number of place settings).
43 MTP BNX503: 'Framework Directive for Eco-design of Energy Using Products'
44 The product must: (a) have a sales volume of more than 200,000 units a year within the EU; (b) have a significant environmental impact within the EU; (c) present significant potential for reduction in environmental impact without entailing excessive costs; and (d) have a wide disparity in the environmental performance of energy-using products available on the market with equivalent functionality.
45 This applies only within Europe. In the USA the Energy Star label is more widely used for public procurement and for a wider range of equipment.

Part 3

5 Future trends and issues

3 Future trends and issues

Consumers are affected by numerous influences. Many are obvious, such as advertising of products, but other influences can be invisible. For example, if energy efficient models are not stocked by retailers, consumers are generally unaware of them. Similarly, energy consumption ratings are sometimes distorted by technicalities so the consumer cannot see the total energy consumption of the product. Subsidies can also be distorting, as markets can fall away when the subsidies are removed. Lastly, consumers are not generally aware that electricity can be more carbon intensive than gas because it will have already been converted from another primary fuel[46].

3.1 Domestic cold appliances

There are five main issues in the cold appliances market:

3.1.1. Availability of A+, and above, appliances in the UK marketplace

A-labelled models now dominate the cold appliance market. Approximately 60% of all cold appliances sold in the first half of 2005[47] were A rated. Although A+ and A++ have been on the market in the UK for over a year, they have failed to make much impact so far; sales for A+/A++ models in 2005/06 only averaged 2.7%.

A+ and A++ models have the potential for large energy savings over the A models. For example, A+ saves 23 % more energy than a standard A model (when you trade in an old fridge); and A++ saves nearly 50% of a corresponding A model[48]. As the lifetime of cold appliances averages 10 years, choosing to purchase an A+ or A++ model has the potential for contributing to large carbon savings over a decade. Increasing market penetration of A+ models to 50% by 2010 would save 41,000 tonnes of carbon emissions.

There are three possible reasons for the lack of market penetration of the more efficient A+ models:

- Lack of availability in UK retailers and online stores.
- The increasing popularity of frost free fridge-freezers (and the lack of availability of frost free A+/A++ models). These models consume more energy than their non-frost free counterparts so it is more of a technological challenge for manufacturers to produce models with a rating above A. Consumers who want a frost free version are given little choice but to purchase an A rated model (rather than the more efficient A+ and A++).
- A distorted price differential between A and A+ models. In 2005, A models were on average 50% cheaper than their A+ equivalent[49]. This was largely due to the EEC subsidy on A rated appliances. In late 2005, it was decided that A+ fridges would be eligible for a subsidy under EEC2. This should result in A and A+ models being in the same price bracket.

3.1.2. Review of the energy label

The energy label for cold appliances has existed since 1994. It was extended in 2004 to take account of the A+/A++ models. It is proposed that the label be comprehensively reviewed in 2008 as revision is well overdue. The market is now dominated by A and B class products that render the C-G ratings worthless.

Over the coming two to three years, the EU Committee will need to consider how they can clarify the scope of products covered by the label to ensure that 'chiller' or 'cooler' appliances for drinks etc. are labelled by all manufacturers. Tougher standards should be applied to the top end of the market to provide adequate differentiation and more incentive to manufacturers to improve refrigeration technologies. Test methods also need to be revisited to consider what the right approach is for measuring ambient temperatures, internal volume and the allowances taken into account for the size of the appliance.

Permitted tolerances are another area of concern; currently the label allows for up to a 15% tolerance in energy use measurements so, for example, if a fridge is tested and shows an energy rating approximately 14% below the threshold for an A rated appliance, it can be considered to be an A rated appliance by virtue of the measurement tolerance. Revision of the label should address this issue[50].

3.1.3. Trend for larger, more energy hungry appliances

Over the last five or so years, larger sized American style fridge freezers have moved from being a small volume niche product to a more mass market consumer appliance. They not only cool or freeze food and drinks, they also produce ice on demand through an external port, contain integrated liquid crystal display (LCD) style TVs, and create different temperature zones for different types of foodstuffs and wine.

The main issue is the overall energy they consume. A typical American-style (A rated) fridge-freezer consumes on average 150 KWh per annum more than the typical average sized A rated appliance[51], although both will legitimately receive an A class energy rating[52]. Over the lifetime of an American-style fridge-freezer, an extra 1800 KWh will be consumed. This equates to the total electricity an average household consumes in almost six months[53].

In addition to receiving an A rating these appliances, if they conform to the new energy saving recommended criteria (A+ or above), are eligible to display the energy saving recommended label - in spite of their large energy consumption.

3.1.4. Proliferation of chillers and coolers

Another recent trend is the popularity of small drink cooler appliances - for example, wine coolers and beer chillers - for use in the bedroom, living room, car and picnic. These tend to be glass fronted and very energy inefficient. In addition, they are plugged in and forgotten, even when there are no drinks in them, so the unit can be cooling air, and little else, for most of its lifetime. In fact, these appliances can use 50% more electricity than the equivalent under-the-counter larder type A-rated fridge[54].

Currently, it is not clear whether these appliances are required to display an energy label. Review of the energy label should clarify this ambiguity.

3.1.5. New refrigeration technologies

Refrigeration technology has changed little for many years. There are, however, new technologies that could improve the efficiency of domestic refrigeration. Unfortunately the current costs of research and development are holding them back.

The most promising new technology is 'vacuum insulated panels' (VIPs). These are used in other applications, e.g. medical transportation, and are more efficient than current technology. Barriers to market are mainly the cost involved and the weakness of the insulation at the edges of the appliance – it is vital that the VIP stays intact for the system to function. However, fridge-freezers with VIPs are available in some European countries so it is possible that we could see them entering the UK market.

A small drinks chiller can use 50% more electricity than an under-the-counter A-rated fridge.

46 If this primary fuel is a fossil fuel this will increase the carbon intensity of the electricity supply. This would not be the case from electricity created from nuclear or renewable sources.

47 GfK data for UK market Jan-July 2005

48 MTP BNC14: 'Availability of A+ and A++ refrigeration appliances'

49 MTP BN14 Table 6: 'Price of A and A+ rated appliance in Q2 2005'

50 See MTP BNXS40 'Reducing the impact of tolerances within the current EU energy labelling scheme'

51 Taken, for illustration, from comparison of two Whirlpool appliances: large American style fridge: 500 KWh per annum; typical normal sized Whirlpool fridge freezer: 339 KWh per annum

52 The reason for this discrepancy is that the energy rating is awarded by the energy use per volume – the larger the volume, the more energy an appliance will be allowed to consume whilst still attaining an A class energy rating.

53 A medium usage household consumes 3300 KwH of electricity per annum.

54 Taken from MTP BNC15 'Other small refrigerated appliances on the UK market'

3.2 Domestic cooking

There are four issues with regard to domestic cooking:

3.2.1. Consumer choice in cooking appliances

There is a general consumer trend towards purchasing electric ovens rather than gas. Domestic electric oven ownership is predicted to rise from 59% in 1999 to 69% in 2020. Conversely, ownership of gas ovens is expected to fall from 41% in 1999 to 31% in 2020. On the face of it, identical cooking activity in both an electric and gas oven shows a gas oven uses more energy. However, gas is primary energy and hence produces lower carbon emissions than its electric equivalent. Overall, gas ovens are more efficient than electric ovens in terms of primary energy and carbon as electricity will have already been converted from another primary fuel.

The choice between electric and gas ovens tends to be made on more than energy ratings. Consumers have a strong preference for electric ovens because it is strongly contended they cook better and more evenly. Some households, of course, have no choice in their cooker fuel options because they are not on the gas grid.

Microwaves are almost universal in UK households. In 2004, 85% of households owned one; this is expected to rise to 90% by 2007 and remain stable thereafter. Microwave cooking offers substantial energy savings over traditional ovens, especially electric ovens. However, consumers tend to use microwaves for defrosting and reheating drinks and prepared meals. They are not usually used to cook a whole meal. Electronic microwaves (i.e. those with digital timer/clock displays), as opposed to the more simple manual variety, use increased energy when left on in stand-by mode. In 2002, 70% of microwaves were electronic; this trend is assumed to level out at 80% from 2005.

Gas hobs are preferred by consumers. In 2002, 54% of households owned them and this is expected to rise to 57% by 2020. However, electric hob technologies have improved and, for example, induction hobs can match the efficiency of gas hobs. Price differential is the main barrier to greater market penetration (5% of built-in hob sales were induction in 2004). However, the price of this technology has begun to fall as popularity and availability rises.

3.2.2. Future trends in cooking habits

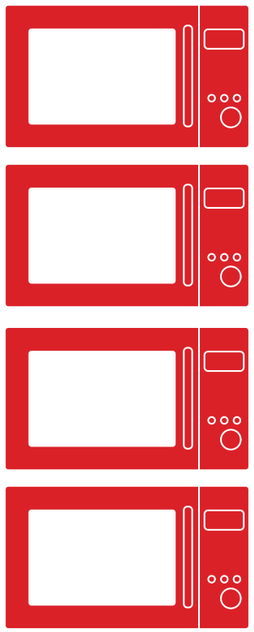
Consumer cooking habits are likely to have the greatest effect on how the domestic cooking sector contributes to total domestic energy consumption in the future. Unlike the cold appliances sector - where the most important consumer action in terms of energy efficiency is the purchase - it is arguable that buying an efficient cooking appliance is less important than the frequency and method of use.

Current trends suggest a decrease in the use of ovens. The estimated total energy consumption for domestic electric and gas ovens and hobs in 2004 was 18.1 TWh. This is projected to fall to 17.6 TWh by 2020, even after accounting for the rise in household numbers.

In contrast, energy consumption by kettles is expected to rise over the next 15-20 years. In 2004, the energy consumption was 4.3 TWh; it is projected to rise to 4.8 TWh by 2020 - mostly due to the projected increase in household numbers.

Energy consumption of microwave ovens will also increase over the next decade; in 2004, it was 2.4 TWh, and it is predicted to rise to 3 TWh in 2020 due to increased ownership, and increased household numbers. Part of the energy rise will result from more electronic models which use stand-by power.

It is difficult to purchase an electric oven, hob or microwave that does not have an inbuilt digital clock that is always on.



3.2.3. Future of energy labelling schemes

Energy labelling schemes are in their infancy in the cooking sector. The relatively low starting threshold for electric ovens has meant the market has not seen a concerted drive to more efficient models. Also the lack of a label on gas cookers may skew the market in favour of electric ovens. If the label is extended to gas ovens, it will be important to make clear that although gas ovens use more energy at the point of cooking, they actually use less energy overall because gas is a 'primary energy' that has not been converted from fossil fuels. Gas ovens provide a greater carbon saving than their electric equivalents. This is a difficult message to get across to consumers.

Kettles account for nearly 30% of all domestic cooking energy consumption and are predicted to make a modest rise in the next 10-15 years. It would be useful to have some type of labelling on kettles to help consumers. For example, most consumers are unaware that some cordless jug kettles consume energy constantly through their base (this is the case where there is an indicator light function included); or that light emitting diode (LED) water level indicators also need a constant (if small) energy supply. More information would help consumers make a more energy efficient choice.

Electric hobs would also benefit from an energy label. This could help increase market penetration of the super efficient induction hobs that are currently owned by very few consumers because of their novelty and price differential. A good energy rating could encourage the EEC to endorse and subsidise these products. However, there are great difficulties to overcome in getting representative, repeatable and reliable test procedures.

Kettles account for nearly 30% of all domestic cooking energy consumption.

3.2.4. Stand-by power on cooking appliances

A great number of household cooking appliances have a constant energy demand ranging from a one watt stand-by, to up to five watts for some less advanced models. It is difficult to purchase an electric oven, hob or microwave that does not have an inbuilt digital clock that is always on. Top of the market electric hobs are always powered to sense when the user is ready to use the appliance. Electric kettles are often cordless with a light on the base to signify they are ready to use; some also have a 'keep warm' function constantly ensuring the water maintains at a high temperature.

Currently, the energy label for electric ovens does not take into consideration stand-by power consumption. This should be reviewed when the label is next revised. Proposals to produce labels for other domestic cooking products should include stand-by energy use.

Compared with standard boilers, the energy saving from condensing boilers is 37%.

3.3 Domestic heating and hot water

Given the changes to the Building Regulations (England and Wales) and the general trend to heat dwellings with gas rather than electricity, consumption in this sector is predicted to slightly increase in the short term and then fall back. Total consumption in 2004 was 368 TWh of delivered energy. This is predicted to rise slightly before falling back to about 370 TWh in 2010. These predictions take into account the rise in household numbers. There are four issues of importance in this area:

3.3.1. Level of turnover of appliances

Regulation changes requiring condensing boilers will not make more of an immediate impact because the lifetime of standard boilers is normally 15-20 years and market turnover is only 5% annually. However, the new build sector will benefit from the double effect of higher standards of insulation and the automatic installation of condensing boilers.

With regard to older stock, excluding any interventions that may speed up replacement, approximately 75% of existing boilers will be replaced by 2020[55]. Compared with standard boilers, the energy saving from condensing boilers is 37%.

Incidental evidence from installers indicates that condensing boilers may have shorter life spans than non-condensing varieties due to the increasing complexity of the systems and potential corrosion resulting from the acidic condensate they create. Although it is too early to put any robust figure on this, it is considered that the lifetimes of these new boilers could be below 10 years.

3.3.2. Combination boilers and impact on other products

The growing popularity of combination boilers, which do away with the need for a hot water tank, has had unforeseen consequences on solar heating which would otherwise have had a substantial part to play in reducing energy demand. Solar heating can reduce water-heating bills by approximately £50 per annum. However, solar heating is not compatible with combination systems because of the lack of hot water tank.

Advice given to consumers about the advantages of a combination system over boilers with water tanks may need to be reviewed.

3.3.3. Use of heating controls

Substantial savings can be made through effective use of heating controls. However, anecdotal evidence suggests that householders do not fully understand how to operate controls effectively. Some owners either ignore them or use them erroneously. One cause may be that the house has changed ownership and no instructions have been left.

There is a need for easier, more intuitive heating control designs, as well as better explanation by installers to the householder.

3.3.4. Electricity in non-electrical heating systems

Electricity used in non-electrical heating systems is estimated to be 6% of the total domestic electricity consumption. The use of fans, pumps, valves, controls, etc. has not been studied, nor policies developed to limit this impact. As systems grow in sophistication, electricity demand in servicing these systems may also grow. A review of energy saving recommended labels for boilers should take this into account.

3.4 Domestic lighting

There are a number of aspects of the future of domestic lighting that are worth consideration:

3.4.1. Trends in lighting types and quantity

Trends in domestic lighting have evolved rapidly over the last decade. Gone are the days of having one central light fitting and maybe two alcove/wall lights with dimmers. Today, the trend is for mood lighting and recessed multiple halogen spotlights. A room can have as many as a dozen different lighting options.

The great popularity of halogen lights in functional rooms such as the kitchen and bathroom can increase energy demand considerably. Even though, on average, halogen lamps tend to be more efficient than GLS bulbs (the most popular halogen is 30 watts, compared to 60 watts for GLS) they are almost always used in multiples, so any gain in efficiency is cancelled out. In addition, halogens also come in large wattages - 50 watts and 100 watts are not unusual.

Manufacturers are turning their attention to producing more energy efficient halogen bulbs. For example, there is now a 35 watt halogen designed to replace the 50 watt version. However, more could be done.

It is estimated that over 50%[56] of all light fittings/shades will not fit a CFL lamp because, for example, the fitting has a dimmer switch attached[57], is for multiple halogen bulbs or the light shade does not fit properly with a CFL. Fortunately, over the past few years there has been an increase in the variety of shapes and sizes of CFLs available, designed to fit a wider range of lamp styles. Another negative feature of CFLs, unpopular with consumers, has been their slow warm up on initial switch-on. Also, there are fears that manufacturers are now producing CFLs with reduced lifetimes;

instead of 10,000 hours, CFLs are sometimes only lasting for 5,000 or even 2,000 hours - proving to be less economical, although still an improvement on the equivalent GLS.

On average, halogen lamps tend to be more efficient than GLS bulbs (the most popular halogen is 30 watts, compared to 60 watts for GLS) but they are almost always used in multiples, so any gain in efficiency is cancelled out.

55 Based on a 5% year on year turnover of boilers

56 Taken from BNDL01: 'Data sources and assumptions for energy scenarios in the domestic lighting sector'

57 Currently CFLs do not work with dimmers, although manufacturers are working on models that are compatible and they should be on the market in the next few years.

Considerable technical advances are underway and it is thought that LEDs could be developed which produce three times more light per unit energy than CFLs.

3.4.2. Currency and accuracy of underlying assumptions

The research that forms the basis of MTP briefing notes dates back to the 1990s. For example, assumptions on lamp ownership per household and the splits between lamp type ownership is based primarily on work carried out in 1997[58] and does not include halogens. Information regarding the 50% of fittings that cannot take CFL lamps comes from 1998[59].

Given the changes in the marketplace, it seems imperative that new research is commissioned to ensure assumptions on models and forecasts are accurate.

3.4.3. Future lighting technologies

A great hope for future efficient lighting technologies lies with LEDs. These are solid-state semiconductor devices that convert electrical energy directly into light. They can achieve high efficiencies because most of the energy radiates in the visible spectrum, hence they could produce more light and less heat. However, currently LEDs produce a lot of heat as well as light and are considered to be both less efficient and more expensive than CFLs.

Considerable technical advances are underway and it is thought that LEDs could be developed which produce three times more light per unit of energy than CFLs. They can also have long lifetimes; up to 100,000 hours which is 10 times greater than CFLs.

LEDs are already being used in some commercial applications - for example, in UK traffic lights and exit signs. However, they would present a significant design challenge for most applications in the home and the estimated time to market for the domestic sector ranges widely from 5 to 20 years[60].

3.4.4. Future subsidies

Subsidies under EEC1 have helped to increase the market for CFLs by 39.7 million over four years, although this still only represents just over one CFL bulb per household! For this to continue, and the prediction of 3.2 CFLs per household by 2020 to be realised, the price of CFLs has to stay at its subsidised level or, ideally, fall further.

However, the lighting sector has suffered from the heat replacement effect whereby the reduction of heat from more efficient light fittings must be compensated by adding heat from another source. Because of the heat replacement effect, the amount of energy savings that can be claimed for lighting measures has fallen significantly from EEC1 to EEC2, which may mean that energy suppliers are less likely to promote CFLs so widely, and discount them so heavily. This could have a marked result on future sales of CFLs. One area that may be positive however is the new 35-watt eco-efficiency halogen lamp.

Lighting products that are not included in current energy efficiency schemes, but which can offer good savings over the conventional lamps they are used in place of, e.g. energy saving versions of halogen dichroic lamps, do not currently qualify for innovative uplift subsidy under EEC2.

A great hope for future efficient lighting technologies lies with Light Emitting Diodes (LEDs).

58 Electricity Association (1997) 'Domestic Lighting in the UK: Customer survey'

59 DELight (1998)

60 For further information see MTP: 'Lighting the way ahead. Innovation roadmap for LEDs'

There is incidental evidence that consumers opt for faster, more power hungry cycles that can use double the energy than the cycle on which the energy rating is based.

3.5 Domestic wet appliances

Future issues in the domestic wet sector can be grouped as shown below:

3.5.1. Consumer behaviour

Working assumptions regarding ownership and consumer habits are based on studies that are now nearly 10 years old, therefore forecasting and modelling may not reflect modern consumer usage patterns.

The test cycles required to be used to determine the energy rating for wet appliances are usually the most energy efficient cycle for each appliance. These programmes tend to take a long time to complete. There is increasing evidence that consumers opt for faster, more power hungry cycles that can use double the energy than the cycle on which the energy rating is based.

In addition, the test cycle is based on a full load of washing. In the eyes of most users this amount of washing would be considered to be overloading the appliance. It is unlikely that consumers use their washing machines in the same way. A common perception is that clothes should have room to move freely for the machine to clean effectively. Test methods should relate to the reality of consumer behaviour to reflect real energy consumption, for example 40°C and half load.

3.5.2. Future purchasing decisions

As the number of households increases over the next 10-15 years and decrease in size, we are likely to see increased purchases of smaller sized or combination appliances - driven mainly by single occupancy households and lack of space. As washer dryers and the smaller dishwashers are generally less energy efficient, we may see an increase in energy consumption predicted for this sector. More work should focus on improving the performance of these appliances.

3.5.3. Stand-by power consumption

Stand-by power consumption is also becoming more important in this sector as wet appliances become more sophisticated. Currently stand-by consumption is not included in the energy label test so there is little incentive for manufacturers to improve performance. It would be useful to include stand-by consumption in the tests or introduce other policy measures to encourage improvements.

3.5.4. Tumble dryer technology

Conventional electric tumble dryer technology is unlikely to improve such that large numbers of appliances can achieve an energy label rating of above C. Alternatives such as gas fuelled tumble dryers or heat pump tumble dryers could help improve this situation, but both have significant barriers in that gas fuelled appliances require professional fitting and have safety issues and heat pump dryers are more expensive.

3.6 Consumer electronics

There are main four issues in this sector:

3.6.1. Exponential rise in the popularity of products

The domestic consumer electronics sector is diverse and exceedingly fast moving. Total energy consumption by these products in 2004 is estimated at around 18 TWh and is forecast to grow to 32 TWh in 2010[61], i.e. almost doubling in just over five years. If this predicted rise is accurate, consumer electronics will become the biggest single sector of consumer electricity consumption by a wide margin.

The reason for the rise is twofold: the sheer rise in the number of gadgets in homes and the fact that these products spend more and more of their useful lives in some type of energy consuming mode – even when the consumer believes that they are inactive.

In 2004, on average, UK households owned: 2.4 televisions, 1.9 video recorders, 0.5 digital adapters and 5.2 external power supply units. Ownership of all these appliances, and particularly of digital adapters, is expected to rise substantially by 2010.

The quantity of products in the home is not an issue that the MTP or Energy Saving Trust can influence. However, as part of its role, the Energy Saving Trust should ensure consumers understand the effect these products have on their ever-increasing electricity bills and encourage then to buy the most efficient models through energy saving recommended labelling.

3.6.2. Stand-by power consumption

We can say with some confidence that, at present, most consumer electronic appliances will always be either in active mode or some type of stand-by mode. The status and consumption in stand-by mode varies greatly between appliances and even models made by the same manufacturer. However, some makes and models have stand-by and semi-active modes that consume the same level of energy as the product's on-mode consumption.

Manufacturers recommend never turning off some appliances – particularly equipment to receive digital TV services because they need to receive downloads of software at various intervals. Appeals to the consumer to switch off these appliances will not work; instead it is imperative that policy intervention persuades manufacturers to ensure the inactive stand-by mode is as energy efficient as possible. This has been achieved with the box manufacturer BSkyB, which is ensuring that stand-by consumption is three watts. It is vital this standard is replicated across the digibox market quickly to ensure digiboxes do not result in a large increase of energy consumption.

3.6.3. Potential rise in on-power consumption

The increases in on-power energy consumption can be seen most clearly in televisions. New technologies have made larger TVs a 'must-have' product. In particular, the rise in popularity of the large plasma screens has contributed greatly to the energy consumption of households as their on-mode consumption can be anything up to four times that of a normal sized cathode ray tube TV[62].

3.6.4. Use of external power supply units

In 2000, the electricity used by external power supply units accounted for 18% of the total energy used by domestic electronic appliances. As stated earlier, the average household now owns over five of these items each. Most people leave these items plugged in and drawing current when not in use – a condition known as 'no-load power consumption'. As mentioned before, a common misconception is that the unit is not drawing current whilst no active charging is taking place – if in doubt touch the unit to feel how hot it gets.

Recent CoC have committed signatories to ensure that these no-load power consumption levels are minimised. Many mobile phone manufacturers and power tool makers have to a large extent fulfiled the requirements of the CoC. However, cordless phones, MP3 players, small kitchen appliances, digital radios and, more recently, broadband equipment are proving a problem.

A major effort to provide consumer education and to promote the CoC is required to ensure the energy demand of power supply units is minimised in the future.

3.7 Other miscellaneous appliances

This area is the most uncertain in terms of longer-term issues and impacts. Any product that is powered by an external power supply will have the issue of the efficiency of that power supply.

Otherwise, energy consumption depends very much on ownership and use of these appliances, including whether they are used regularly.

New technologies have made larger TVs a 'must-have' product. In particular, the rise in popularity of the large plasma screens has contributed greatly to the energy consumption of households as their on-mode consumption can be anything up to four times that of a normal sized cathode ray tube TV.

61 Taken from: MTP Report of Evidence Base 2004-5, September 2005

62 Average power supply for a CRT is 90watts and average power supply for a plasma screen is 400 watts. Taken from: BNCE1: 'List of assumptions for MTP consumer electronics sector'

Part 4

Conclusions

Many recommendations have been made throughout this review so this section simply highlights a number of areas of importance where the Energy Saving Trust considers that further attention and effort is required. A more in-depth discussion of general energy efficiency recommendations can be found in the Energy Efficiency Innovation Review's report to Government[63].

4.1. Study of consumer behaviour

A large number of assumptions regarding consumer behaviour are made when estimating the energy using impact of a product. Sometimes these assumptions are based on user studies, but much of the time they have been based on estimates and informed opinion. In some areas, the user studies that have been carried out are now very dated.

There is a strong argument for a number of the stakeholders to collaborate on a large-scale, longitudinal field study on the behaviour of consumers with energy using products. Ideally the study would select representatives of all major lifestyles and follow their user habits for up to one year.

While this type of study is likely to be expensive, it would prove invaluable to organisations in the energy efficiency field and also inform the forthcoming Environment Direct service for consumers, which will provide information about the effect that different consumption choices can have.

4.2. Data availability

Apart from research on consumer behaviour, there is a pressing need to fill the following gaps in data and information:

- Development of the consumer electronics market
- Sales data from lamp purchase
- Electricity use in non-electric heating systems
- Potential future energy wastage from stand-by modes

4.3. Policy actions

The Energy Saving Trust believes that there is considerable scope to reverse the rising trend in energy consumption and reduce total carbon emissions through a strong and progressive products policy. Below is an illustrative list of the types of measures that have worked effectively already (whether in the UK, EU or elsewhere) and which could form part of a future UK products policy:

- **Accelerated and sustained tightening of product standards.** EU standards for white goods have already banned some of the least efficient products. The UK Government could press for a long term EU-wide approach where the least efficient (e.g. bottom 25%) of the market is removed on a regular basis (e.g. every 3-5 years, depending on product). A sustained policy over a 15-20 year timescale would provide the necessary forward signals for manufacturers to innovate and improve their products.
- **Minimum standards for standby power consumption.** For products which spend a significant time in standby mode, the IEA's 1W standard should be adopted as mandatory as soon as practicable. Wherever possible, full OFF function should be made available and easy for users to apply.
- **Tax on inefficient products.** For products which cannot readily be addressed through tightening of standards, an inefficiency tax could be considered. Two categories might be:
- Where products are grossly inefficient compared to others on the market, e.g. GLS light bulbs compared to CFLs. Incandescent bulbs could be taxed at a rate of at least 50 pence per unit.
- Where 'luxury' products are deemed to have a disproportionately high environmental impact in relation to their utility (e.g. outdoor patio heaters).
- **Outright bans of products.** This has already proved successful, e.g. for inefficient refrigerators. There is no reason why this cannot be extended to other products. An example might be incandescent light bulbs of less than 100W. However it is recognised that this would have to be at EU level.
- **Voluntary agreements with retailers.** For example, for consumer electronics.
- **Expanded use of energy saving recommended labelling.** The EU has already established a Code of Conduct for a range of consumer electronic products that currently requires maximum standby consumption in the range 2-3 W (depending on product type), but this is not proving very effective. Extending the energy saving recommended scheme to consumer electronics would add pressure to the retailers to sign up to the Code and can build upon the recent extension of energy saving recommended to integrated digital televisions (IDTV) to also cover set top boxes and external power supplies (EPS). Subject to receiving the required funding, the Energy Saving Trust has committed to doing this by November 2006.

- **Binding agreements with retailers/ service providers.** Placing obligations on retailers and/or service providers.
- **Greater Research, Development and Demonstration (R,D&D) and accelerated technology deployment for energy efficient products.** For example, the technology of vacuum packs to enhance the insulation performance of cold appliances has been in existence for many years but they have hardly been used at all in domestic appliances. Greater priority should be given to R,D&D activity in this area as discussed earlier in this report.
- **Mandatory product standards in new build homes.** Requirements on housing developers to only install the most efficient appliances (where the home is sold with appliances) and dedicated CFL fittings.

Given the political impetus to make headway in reducing the potentially devastating effects of climate change, and considering the large negative contribution that homes make to the overall 'carbon loading' of our atmosphere, inaction in this area is not a possibility. The Government's ambitious target to cut CO_2 emissions by 20% by 2010, already in doubt, will be totally impossible to achieve without a concerted effort by each and every one of us.

There are many quick and cost effective 'wins' available in the domestic sector but only with the correct policy actions and the right signals to industry. The Energy Saving Trust urges all players in the domestic energy efficiency sector to rise to the challenge of seriously addressing the problem of our ever increasing energy consumption in the home.

63 Weblink to report: http://www.est.org.uk/aboutest/publications/eeirsummary/

Glossary

CECED	European Committee of Domestic Equipment Manufacturers
CFL	Compact Fluorescent Light
CoC	Codes of Conduct
CRT	Cathode Ray Tube (TV)
Defra	Department for Environment, Food and Rural Affairs
EEC	Energy Efficiency Commitment (requiring gas and electricity suppliers to promote improvements in domestic energy efficiency)
GLS	General Lighting Standard (bulb)
GW	Gigawatt (1 GW = 1,000 MW)
GWh	Gigawatt-hour (1 GWh = one hour of electricity consumed at a constant rate of 1 GW)
LCD	Liquid Crystal Display
LED	Light Emitting Diode
MTP	Market Transformation Programme (run by the Department for Environment Food and Rural Affairs)
MW	Megawatt (1 MW = equals 1,000 kilowatts)
MWh	Megawatt-hour (1 MWh = one hour of electricity consumed at a constant rate of 1 MW)
PV	Photovoltaics (photovoltaic solar cells directly convert sunlight into electricity)
SEDBUK	Seasonal Efficiency of Domestic Boilers in the UK (www.sedbuk.com)
TW	Terrawatt (1 TW = 1,000 GW)
TWh	Terrawatt-hour (1 TWh = one hour of electricity consumed at a constant rate of 1 TW)
VIP	Vacuum Insulated Panel