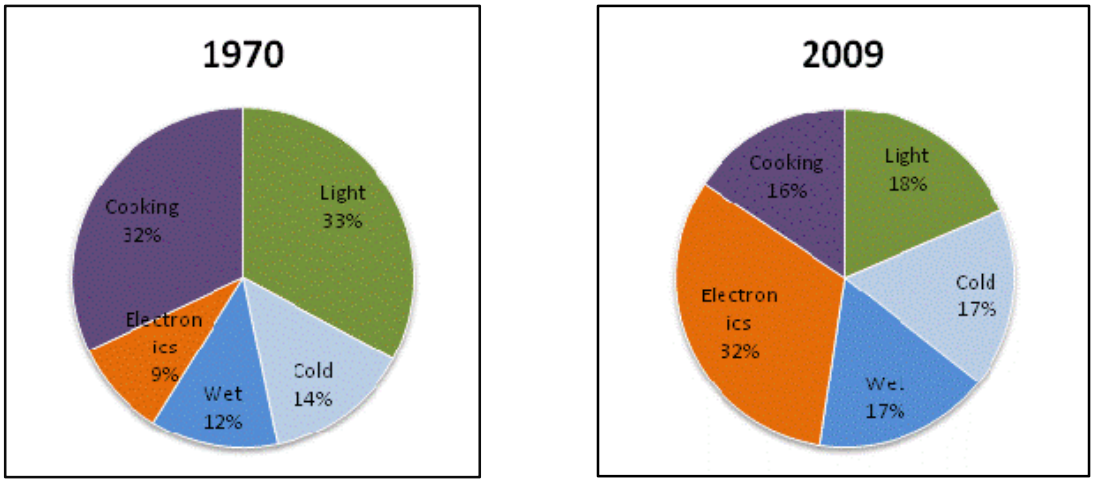

Figure 3 Electricity consumption of household domestic appliances by sector 1970 – 2009 (excluding heating) [16]

The Consumer Electronics sector is now the biggest single user of domestic electricity (Figure 3), overtaking the traditionally high consuming sectors of cold appliances and lighting.

By 2020 the combined CE and ICT sectors are expected to use 49 TWh of electricity, compared with around 110 TWh for domestic appliances as a whole (excluding electric heating). That means that entertainment, computers and gadgets will account for 45 per cent of electricity used in the home[3].

With increased consumption in this sector, comes an increase in wastage and inefficiencies, particularly through standby features. Figures from the Energy Saving Trust suggest the average household wastes £37 each year by leaving on average 12 gadgets left on standby or charging at any one time. This equates to more than £740m of electricity wasted, or in terms of CO_2 emissions, equivalent to 1.4 million long-haul flights[4].

Ethical Consumerism

Despite efforts from bodies such as The Energy Saving Trust and The International Energy Agency, the Market Transformation Programme insists that it would not be practical to introduce legislation in the UK to remove the standby function as it would entail higher prices for unique UK models. Manufacturers claim it is a purely consumer-driven and not a technical issue, with the exception of set-top boxes for example, which need to have power all the time to download and update their electronic programming guides. According to the Market Transformation Programme, 'manufacturers include sleep modes on their products because it is what their customers want it'[4].

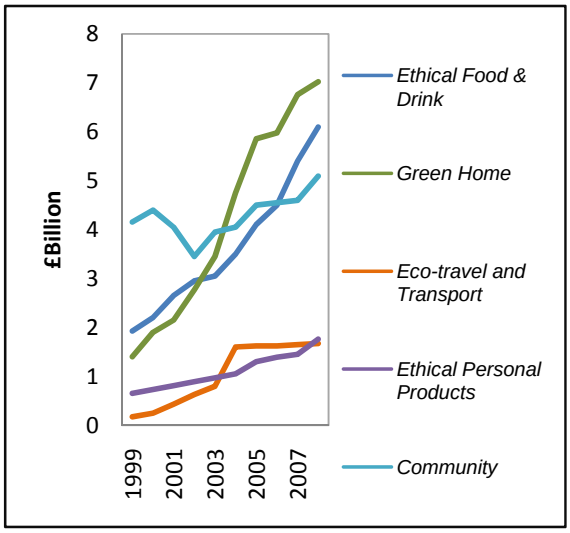

Figure 4 UK Ethical Consumer Market [5]

Yet ethical consumerism is a massively increasing market, with the overall ethical market worth £36 billion in 2008 compared

to £13.5 billion in 1999. Green home expenditure has been one of the most exceptional growth areas in the market, which increased fivefold in the 1999-2008 decade, from £1.4 billion in 1999 to over £7 billion in 2008 (Figure 4).

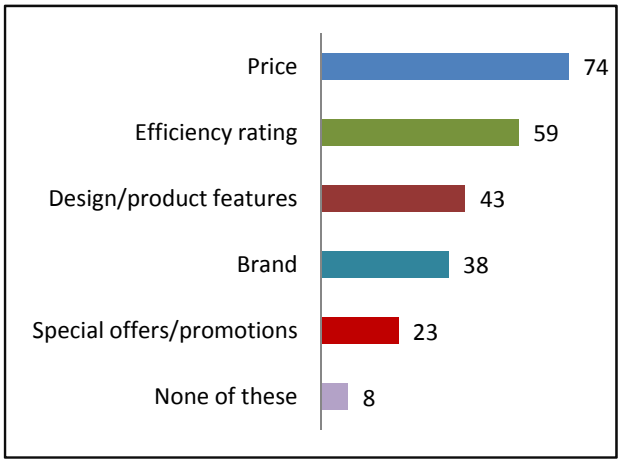

Figure 5 Top reason for purchasing white goods (UK %) [5]

One of the biggest contributors to the increase in the Green Home category is electrical appliances with 1392% growth over the period 1999 - 2008 [5], driven in part by the development of energy efficiency labelling through legislation, and a very high 59% of people surveyed stated energy efficiency as one of their top reasons for purchasing white goods (Figure 5) which suggests that consumers *are* willing to pay a little bit more to achieve higher energy efficiency.

RELATED WORK

The AllSocket concept was designed in response to the issues outlined here, and the subsequent research contributed a large part toward the development of the idea.

AllSocket Power Track System is a domestic electrical distribution system which integrates the electrical wiring into the skirting board. Card-like 'AllPlugs' replace conventional electrical plugs and simply slot into the distribution system anywhere around the perimeter of the room, to accommodate the increasing number of gadgets and appliances without adaptors and extension cables or the expense of chasing in of additional plug points. AllSocket also aims to reduce waste electricity consumption with features that allow users to turn the power off to one or several appliances at a time by either by one wireless wall switch, or automatically by smart plugs which detect standby states.

During the research and development, it became clear that whilst AllSocket could offer an immediate solution to the current issues, impending legislation and existing commitments from manufacturers to tackle the waste issues at product level are likely to render the 'green' features of the AllSocket concept superfluous.

EXAMINING CE AND ICT

KEY POWER CONSUMPTION FACTORS

Breaking down the statistics for the consumer electronics (CE) and Information, communication and technology (ICT) sections (since this is the fastest growing sector) identifies the main causes of the rise (Figure 6). Further examination of each of these product categories looks at what their power needs are, their proliferation in our homes, the way we interact with them, and whether there are more effective

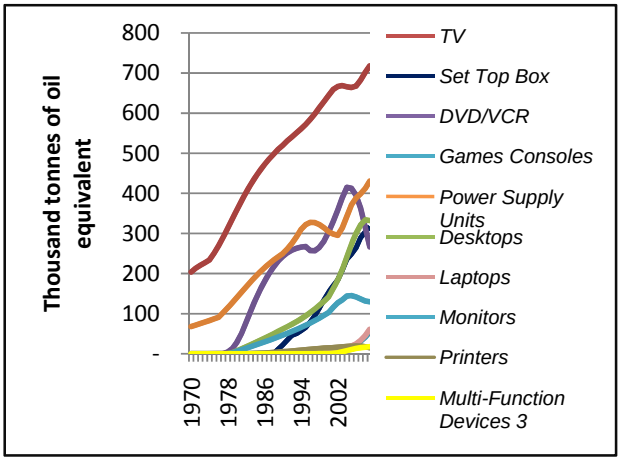

Figure 6 Total Electricity Consumption by Consumer Electronics and Computer Equipment by product category 1970 to 2008 [16]

or alternative ways to supply power to them.

Televisions

Trends are driven by an increase in programme viewing time, use for console games and internet access. Improvements in quality and affordability also drive up numbers, however increases on consumption from larger screens, stock and use is offset somewhat by an expected doubling of efficiency of both LCD and plasma technologies. TVs are getting larger. In fact, some of the largest, high resolution, direct view TVs (versus rear projection products) can use as much electricity each year as a new, conventional refrigerator, or roughly 500 kWh, every year.[6]

Key factors [7]:

- Largest share of energy used – 40% of total CE consumption in 2009
- Stock numbers due to rise 21% by 2020
- Average on-time for main TV expected to rise from 4.9hr/day to 5.1
- Combined energy consumption increase of 17%

Digital Set Top Boxes

The digital switchover has had a significant impact on equipment and energy consumption for TV services. Simple set top boxes (SSTBs) are basic tuners providing the viewing of free-to-air digital channels and are used mostly with older analogue TV sets, and almost never switched off when the TV is not in use. Complex STBs have more features such as subscriber channels and TV recording and consume more energy as a result, and by 2015/16 almost all STBs connected to the primary TV will be CSTBs, and SSTBs will become minority due to new TV's all having integrated digital tuners.

Key factors[7]:

- 18% of total CE consumption in 2009
- SSTBs demand will decrease, more consuming CSTBs will persistently increase
- Stock expected to increase by 13%, from 31 million to 35 million in 2020
- Consumption projected to increase by 24% in 2020

DVD/VCR/Blu-Ray Video Recorders

The video recorder marker is relatively stable and almost exclusively DVD players, currently at its peak. Recording and archiving functionality will be replaced by internet connected hard disk drives including CSTBs and access downloadable content rather than removable media. Many of these devices will require much less energy than a DVD player, requiring only to power to hard drive. A small market will still exist for removable media in which case Blu-ray with higher quality and larger capacity will replace DVDs.

Key factors[7]:

- 15% of CE consumption
- 13% of total CE products in use
- Stock expected to fall by 43% from 44 million to 25 million by 2020
- Consumption expected to fall by 75% by 2020.

Games Consoles

Gaming is an area of concern as whilst relatively small, it is the fastest growing CE product type. The market is far from reaching saturation, and when it becomes mainstream and prevalent in the majority of households, it is then expected to grow further through multiple ownership.

Key factors[7]:

- 3% of total CE consumption
- Stock expected to rise from 18 million to 30 million 65% by 2020
- Energy consumption expected to rise 158% by 2020

External Power Supply Units / Chargers

Energy efficiency has greatly improved in recent years faster than the increase in actual units. However a 19% increase in multi-functional and portable devices is expected by 2020, and these devices will become more powerful, requiring increased battery capacity, and more powerful PSU's for recharging purposes. Conventional battery chargers — even when not actively charging a product — can draw as much as 5 to 20 times more energy than is actually stored in the battery. [6]

Key factors[7]:

- 24% of CE consumption in 2009 – second to TV's
- Expected to increase by 51% to 2020

Desktop/Laptop PC's

Highest energy consumer in ICT sector and expected to continue however transitioning from desktops to laptops. Laptops consume less energy than a desktop computer.

Key factors[7]:

- Desktops expected to decrease by 29%
- Laptops expected to increase 254%

Monitors

CRT monitors have now been replaced by LCD. The trend will follow TV's technologies, though likely to lag behind, and is very dependent on PC's in the market place.

Imaging Equipment and Peripheral PC Multi-Functional Devices

These devices are high in energy consumption, especially laser printers. Technology and consumption is not expected to greatly alter.

Mobile Multi-Function Devices

The number of products in use is expected to increase by 19%, from 185 million to 220 million in 2020 as a greater variety of multi-functional and portable products are marketed.[7]

INTERVENTION POLICY

There are a number of policies governing efficiency of energy using products, with regulatory labelling and minimum efficiency standards plus voluntary agreements. These policies set out to transform the market through additional innovation and minor technical modifications of products, and will require future revisions. Also the introduction of new policies is expected over the next 20 years as technology evolves and new technology develops.

Key Policies[7]:

- ENERGY STAR

  Signed in December 2000 between the US and EC, it is a voluntary voluntary energy labeling programme for office and IT equipment. The Energy Star logo helps consumers identify office equipment products that save them money and help protect the environment by saving energy. A second agreement runs for 5 years from 2006 with more demanding criteria.

- EU Directive

- Eu Ecolabel 2010 - awarded to products and services which have a lower environmental impact than other products in the same group. The label criteria were devised using scientific data on the whole of a product's life cycle, from product development to disposal.
- EcoDesign - CE label awarded to products that conform to the minimum efficiency standards for raw material selection and use; manufacturing; packaging, transport, and distribution; installation and maintenance; use; end-of-life

- Energy Saving Recommended scheme (Energy Saving Trust)
  - Administered by the Energy Savings Trust, the criteria is set by an independent panel and reviewed annually. ESR specifications are generally 5% more strict than ENERGY STAR, and are come into effect approximately 2 years later.

Key Policies Affecting Consumer Electronics - by product[7]

Energy Using Product Directive Modeled from 2012 – 2030, revisions in 2016, 2020, 2024, 2028. Follows the ENERGY STAR policies so tends to sweeping out products that have not made the ENERGY STAR spec.		
Standby Consumption (2008)	Mandatory reduction to: 1.0W by 2010	0.5W by 2013
External Power Supply Units (2009)	Two tiers 2010 and 2011 set mandatory improvements in efficiency during on-mode and 'standby' (no-load power).	2015 third revision planned to increase efficiency and no-load further. Will impact laptops, printers and all PSU using products in all modes of operation.
SSTBs (2009)	2010 On-mode consumption reduced and improvements in standby. Mandatory auto power down to put STB into standby after 3 hours of no use.	2012 further improvements to cover SSTBs with recording function (hard disk). 2015 further reductions for recording SSTBs and standardised feature for immediate standby upon completion of viewing. 2018 reduce on-mode further.
Televisions (2009)	2010 Minimum requirements for energy efficiency related to screen size, with improvements by 2012	2011 Auto-standby after 4 hours of no use 2015 requirements for TV's to detect when no one is viewing and disable screen.
Network Standby		Not presently agreed, however expected to address standby consumption by achieving 1W/0.5W as with other CE products and forcing standby mode when no activity is detected.
EU Energy Label for TV's		Proposed labeling for TV's with higher efficiency classes revised in 2012, 2015 and 2018. Target 60% of TV's sold achieving the highest class in each revision.
EST Energy Savings Recommended Scheme (2009) **Retailer Engagement**	Desktop PC specification approximately 15% more stringent than ENERGY STAR specification. Laptop PC specification approximately 22% more stringent than ENERGY STAR specification. Monitor specification based	Low uptake of label in market place to date. Spec of 230W had low effect as included TV's up to 65 inches Spec was lowered, retailer engagement programmes undertaken and improvement seen in 2009/10 before being superseded by EU Label. ESR specs are generally 5% more strict than ENERGY STAR specs, and as such there is only 1% influenced by it.

	on screen area approach.	
EU Code of Conduct (CoC) for Digital TV services (2003)	Sets maximum energy consumption for CSTB's. 100% market penetration due to both major TV platforms (cable and satellite) taking part.	CoC to set long term targets for further reductions to both on and standby modes. EuP ecodesign requirements heavily based on this.
Carbon Emissions Reduction Target (CERT) 2008 – 2011	Manufacturer subsidy for sales of TV's under 22" with integrated digital tuner in order to reduce sales of SSTBs. Almost all expected to occur without policy intervention.	Extended to December 2012 with higher targets.
Act on CO_2	Consumer targeted campaign in an effort to encourage switching STB's to standby	
Standardise high-definition multimedia interface on consumer electronics (HDMI CEC)	HDMI Consumer Electronics Control	Standardised feature for all CE products to 'network' to enable master to place peripheral devices to standby when not used. Requirement for manufacturers to enable HDMI CEC on all CE products by 2015.
Computers and Monitors		2012 EuP mandatory requirements based on ENERGY STAR specs, as new ones are introduced. Monitor requirements similar to televisions but more stringent.
Standard for cable modems - (Data Over Cable Service Interface Specification (DOCSIS) low power mode standards)		Low power mode for cable router and CSTBs. New products compliant on market in 2013.
Supplier Obligation	Under development. Could be revised from current CERT like implementation.	2011-2020. TVs achieving A class efficiency based on EU energy label and with smaller power consumption than the TV being replaced are awarded a subsidy. This has a relatively short term, temporary impact reducing on-mode power.
ENERGY STAR Modeled for the whole period 2009 – 2030 with product specific revisions in 2013, 2017, 2021, 2025, 2029. Energy Star entered the market four year ahead of EuP Directives, thus has stronger impact, and is particularly aimed at energy efficient office equipment.		
Televisions (1998)	Standby <1W On mode varies according to screen size and resolution. ePSUs must meet all requirements separately Version 4.1 - May 1, 2010	Version 5.1 - May 1, 2012
STBs (2009)	Qualifying models consume 30% less than conventional models	Revision scheduled 2011 In the UK STBs are provided by the service provider who signed up to the EU Code of Conduct (CoC) for digital TV services, so 100% market penetration.

<table>
<tr><td>Imaging Equipment (Printers/fax) (2008)

Includes copiers and fax machines; digital duplicators; printers, scanners and all-in-one devices;</td><td>Top 40% for energy efficiency, and feature efficient designs that help equipment run cooler and last longer.</td><td>Specs vary across products.</td></tr>
<tr><td>Displays & Monitors (2009)</td><td>Monitors originally qualified in 1992. Covers computer monitors, digital picture frames, and professional signage.

Version 5.0 in force:

<30” October 30, 2009

30” – 60” January 30, 2010.</td><td>In Sleep Mode, displays must consume 2 watts or less. In Off Mode, displays must consume 1 watt or less.

Assumed improvement on spec:<table><tr><td>Mode</td><td>On</td><td>Sleep</td><td>Off</td></tr><tr><td>2013</td><td>10%</td><td>0%</td><td>50%</td></tr><tr><td>2017</td><td>10%</td><td>0%</td><td>0%</td></tr><tr><td>2012</td><td>5%</td><td>0%</td><td>0%</td></tr></table></td></tr>
<tr><td>Computers (2009)</td><td>Consume 30% less than standard models to qualify</td><td>Revised every 4 years.

Desktop PC’s<table><tr><td>Mode</td><td>On</td><td>Sleep</td><td>Off</td></tr><tr><td>2013</td><td>10%</td><td>5%</td><td>70%</td></tr><tr><td>2017</td><td>5%</td><td>5%</td><td>0%</td></tr><tr><td>2012</td><td>5%</td><td>5%</td><td>0%</td></tr></table>Laptop PC’s<table><tr><td>Mode</td><td>On</td><td>Sleep</td><td>Off</td></tr><tr><td>2013</td><td>5%</td><td>5%</td><td>49%</td></tr><tr><td>2017</td><td>5%</td><td>5%</td><td>0%</td></tr><tr><td>2012</td><td>5%</td><td>5%</td><td>0%</td></tr></table></td></tr>
<tr><td>Battery Chargers (2006)</td><td>Consume 30% less than standard models to qualify

Spec tied in with EPS spec.</td><td></td></tr>
<tr><td>Video Players/Recorders (2010)</td><td>Consume 25% less than standard models</td><td>Reviewed 2012</td></tr>
</table>

EXAMINING POWER SUPPLY TO CE AND ICT

Adequate provision of Electrical sockets in the home to cope with the enormous increase in energy using equipment has long been problematic, and modern homes rely on the use of a spaghetti junction of extension cables to accommodate the increasing number of gadgets. This section examines some of the products on the market plus emerging technologies which can help overcome the problem - some by providing more outlets, others reducing the number of fixed sockets required by changing the way energy is supplied to the products.

Whilst the drive for higher energy efficiency and the desire for more energy using products seem to be opposing cultures, a good deal of the policies in place and future technology developments benefit both issues.

POWER SAVING PRODUCTS

Standby Savers

Standby Savers sent to customers and installed under the second phase of the Energy Efficiency Commitment (EEC2) which ran from 2005 to 2008, attributed to a saving of 1993 GWh's, which helped 8 of the major energy suppliers achieve approximately 144% of their overall target. It was only 1% of the total savings from measures installed, however, along with CFL light bulbs these are by far the cheapest measure, and there are many different models readily available on the market.

ADVANTAGES:

- ✓ ***Energy/cost savings***

  Energy Saving Trust suggest the average household wastes £37 each year by leaving on average 12 gadgets left on standby or charging at any one time[2]. This equates to more than £740m of electricity wasted, or in terms of CO2 emissions, equivalent to 1.4 million long-haul flights.

- ✓ ***Liberates some sockets***

  Some models are also mutually beneficial for socket availability issues as they combine master and peripheral equipment eg PC, printer, external HDD, speakers, into one adaptor.

- ✓ ***Promotes End-User Behaviour Change***

  Increasing awareness and promoting behaviour change and 'green habits' is a much more effective way to achieve efficiency both in the short and the longer term.

DISADVANTAGES

- ? ***Policy on Standby***

  With the progression of the policies for a reduction in standby consumption however, the need for standby savers should be designed out.

- ? ***Consumption of units themselves***

  Some do operate under a load themselves, and it can be argued that switching equipment off manually is even more efficient.

- ? ***Energy Cannibalism***

  The energy used over from cradle to grave over such a short product life cycle may outweigh its energy saving benefits

- ? ***Cost***

  Several are required to have the most impact to a home, and cost approximately £20. If 5 are used at a cost of approximately £100, they will not pay for themselves before they become superfluous.

Energy Monitors

Like Standby Savers, energy monitors are being offered to supplier customers, and are readily available on the market. Models and functionality vary, and most come as wireless and work by attaching to the mains cable at the meter, and using a battery operated transmitter to send the reading to a display module affixed in a highly visible place in the home, or as single units that are fitted inline between socket and product.

ADVANTAGES:

- ✓ ***Energy/cost savings***

  Studies have shown that such devices can encourage home owners to reduce energy use by 3-15%.

✓ ***Educates Consumers & Promotes Behaviour Change***

Increasing awareness and promoting behaviour change and 'green habits' is a much more effective way to achieve efficiency both in the short and longer term.

DISADVANTAGES

? ***Policy on Standby***

As a result of the Governments White Paper in 2007, Smart Meters will be fitted to all domestic properties by 2020, therefore will become superfluous.

? ***Consumption of units themselves***

Wireless models in particular use battery operated transmitters and receivers, thus offsetting some of the benefits of reduction.

? ***Energy Cannibalism***

The energy used over from cradle to grave over such a short product life cycle may outweigh its energy saving benefits

? ***Cost***

Currently priced ranged from £50 - £150, value for money depends solely on user participation.

? ***User Action required***

The units themselves do not reduce consumption, it requires the efforts of the user, and 'fad' type products can have a diminishing impact. It can be argued that once a user is educated and 'greener' habits formed, it will become superfluous over a much short period.

Wireless Power / Induction Chargers[8]

In April 2010 The Wireless Power Consortium delivered Part 1 of the Qi interoperability specification to its members, which defines the interface between wireless charging stations and power receivers. Part 2 (Performance Requirements) and Part 3 (Compliance Test Specification) are now being finalised. The technology is still relatively young, but appetite for it is large and rapid advances expected. In Q1 2010 membership to the consortium doubled, and include Nokia, Philips, Samsung, Sanyo, Panasonic, LG, Verizon, Sony Ericsson Mobile Communications among them.

Induction charging currently has a maximum transfer of 5W for proximity charging, which is sufficient for most mobile handheld devices on the market for which we use conventional chargers ie phones, cameras, media players, torches, etc, and can charge multiples items at a time.

ADVANTAGES:

✓ ***Replaces multiple conventional chargers***

Energy Saving Trust suggest the average household wastes £37 each year by leaving on average 12 gadgets left on standby or charging at any one time[2]. This equates to more than £740m of electricity wasted, or in terms of CO2 emissions, equivalent to 1.4 million long-haul flights.

✓ ***Reduces Standby (no-load) consumption***

One charging mat will reduce standby consumption by a factor of how many conventional chargers it replaces.

✓ ***Universal Convenience***

Different models of chargers no longer required.

DISADVANTAGES

? ***Limited to products below 5W***

With the progression of the policies for a reduction in standby consumption however, the need for standby savers should be designed out.

? ***Consumption (losses) of units themselves***

Due to the increased circuitry in wireless induction charger mats, it is estimated to have 70% efficiency of conventional chargers

? ***Short term compatibility***

Requires the mobile device being charged to have an induction battery, otherwise a receiver module or 'jacket' is required. Until manufacturers design their products to be used with induction chargers, multiple 'accessories' are still required.

? ***Cost***

Lower end models are from £30 for the charging mat only, up to £70 for the leading brands.

? ***Proximity***

Requires charging devices to be placed on top of it, so there is no true wireless 'space' that the power travels through and the device is still effectively 'tethered'.

http://www.wirelesspowerconsortium.com/

NETWORKING AND INTERFACING STANDARDS

Standardised Mobile Phone connectivity[9]

The GSMA and 17 leading mobile phones operators signed a voluntary agreement to use a standard Micro USB interface from 2012.

ADVANTAGES:

✓ ***Replaces multiple chargers***

An estimated 1.2 billion mobile phones were sold in 2008, of which between 50-80 per cent were replacement handsets. That equals between 51,000 and 82,000 tonnes of replacement chargers every year.

✓ ***Universal Convenience***

Different models of chargers no longer required, all peripheral devices and data cables will be compatible with every mobile phone

✓ ***Energy Efficiency***

Universal Charging Solution (UCS) chargers will also include a 4-star or higher efficiency rating, which is up to three times more energy-efficient than an unrated charger

✓ ***Reduced Manufacturing costs***

Potentially 50 per cent fewer chargers will be manufactured each year, reducing greenhouse gases in manufacturing and transporting replacement chargers by 13.6 to 21.8 million tonnes a year

DISADVANTAGES

? ***Compatibility***

Older accessories will need to be replaced

Standardised Networking Interface

Interoperability for electronic devices for the transfer of data and power management.

Common data interfaces generally used for computing

Technology	***Developers***	***Description***	***Power Spec***	***Cable length*** DC losses are greater than AC and are inversely proportional to voltage.
Firewire or Sony iLink (IEE1394 1995)[10]	Proprietary technology created by Apple,	Mostly used for AV/DV for its faster effective data rates and can be daisy chained as it works peer to peer i.e. two video cameras can communicate without an intermediate operating system or using system memory.	In its six-circuit or nine-circuit variations: Up to 45 watts of power per port at up to 30 volts, allowing moderate-consumption devices to operate without a separate power supply.	It can be up to 4.5 metres Nb future enhancements to carry a single mode fibre
USB[11]	Developed by Intel ICM among others, used for data transfer	It is host based (i.e. requires devices to go through an operating system to communicate	USB 1.0/2.0 supplies 5 V at up to 0.5 A (2.5 W). USB 3.0 supplies 5 V at up to 0.9 A (4.5 W)	Maximum of length 5 metres
Powered USB[12]	Developed by IBM, NCR, and FCI/Ber	Proprietary variation which is basically 2 stacked plugs to supply larger powered devices from the host	Supplies 5 V, 12 V, or 24 V at maximum 6A	Maximum of length 5 metres
Ethernet (IEEE 802.3 1980).[13]	**IEEE 802.3at-2009** PoE standard, also known as **PoE+** or **PoE plus** (ratified September 11, 2009),	Currently mostly used for Local Area Networks (LAN) for data, voice and power	provide up to 25.5 W of power, up to a maximum of 34.20 W with a maximum current of 600 mA on CAT5 cables	Variable due to DC losses: higher voltages up to 100m, but lower e.g. 5W to only a few metres which is comparable to USB lengths
Standardise HD multimedia interface on consumer electronics (HDMI CEC)[7]	Samsung Anynet+ LG SimpleLink Toshiba CE Link	Standardised feature for all CE products to 'network' to enable master to place peripheral devices to standby when not used. Requirement for manufacturers to enable HDMI CEC on all CE products by 2015.		

SUPPLY AND DISTRIBUTION

Smart Meters

Around 50 million gas and electricity meters will be fitted with smart meters as a major national project, and will transform the way electricity is used. They will offer real time feedback to both the customer and the supplier on consumption usage, through a display, or online. Suppliers are responsible for their installation, and Data from trials of smart meters around the world suggest a reduction in electricity consumption by 1-3% [6]

ADVANTAGES:

- ✓ ***Energy/cost savings***

  Trials suggest the £8bn scheme may help households save £28-£100 a year.

- ✓ ***Educates Consumers & Promotes Behaviour Change***

  Increasing awareness and promoting behaviour change and 'green habits' is a much more effective way to achieve efficiency both in the short and the longer term

- ✓ ***Encourages micro-generation***

  Smart electricity meters can monitor and facilitate the export of electricity to the grid from homes generating their own power

DISADVANTAGES

- ? ***Cost***

  Some of the cost of the estimated £340 per household will be passed on to the customer.

Micro Generation

Small-scale low carbon and renewable energy technologies can generate <45kWs heat and <50kWs for electricity. Electricity technologies include micro and small wind turbines, solar photovoltaics (solar PV) and micro-hydroelectric schemes[14].

- Micro and small wind turbines (renewable) – roof mounted microwind systems start at about £1,500 to install and larger mast mounted systems cost £11,000 - £19,000. Not enough data yet exists on financial savings. Not yet eligible for permitted planning (due to noise issues). Certificated wind turbines are eligible for feed-in tariffs.
- Solar PV (renewable) – an average system costs £8,000-£20,000 to install, depending on its size and grid connection. It can save up to £250 a year for 2.5 kWp system, providing 50 percent of a household's yearly electricity needs. Eligible for permitted planning. Certificated solar PV is eligible for feed-in tariffs, so the owner is paid for the excess electricity being fed back into the grid.
- Micro-hydro (renewable) – depending on location, a 5kW scheme (suitable for an average home) costs £20,000-£25,000 to install, and offers substantial savings due to the technology generating energy night and day. It is eligible for feed-in tariffs but not eligible for permitted planning as most home owners do not have right of access to local rivers.
- Micro-CHP (low carbon) – this is still under trial, but may eventually become competitive with domestic gas condensing boilers (around £3,000). Substantial savings are likely on electricity bills.

Smart Homes

Home automation technology has been on the market for a while now, but is generally niche, installed in very few homes at either end of the scale - extremely wealthy homes, or in sheltered housing as health and safety features, ranging from entry systems to zonal heating controls.

The four key aspects of a smart home are:

- an internal network through which devices talk to each other
- intelligent controls for managing the system
- sensors that collect information
- smart features, such as intelligent heating systems, which respond to information from sensors or user instructions

CONCLUSIONS

Ethical consumerism and the digital revolution are two opposing cultures that were diversifying greatly in the run up to the millennium, however since then efforts by governments, manufacturers, retailers and consumers to lessen the environmental impact as technology advances and changes the way we live has seen the two cultures being brought closer together towards a common aim.

A market has developed since the year 2000 for third party energy saving products, however with all consumer electronics being governed by the policies in place and these becoming more stringent with each revision, these products will most likely becomes superfluous within a short period of time, meaning their life cycle consumption may outweigh short term benefits they bring.

There is still scope however for improving infrastructure and the way products are supplied with power, with the development of Power Over Ethernet (PoE), wireless power and concepts that perhaps 'daisy chain' or work as power hub for masters products and peripheral devices for example. Several initiatives are in place for manufacturers to develop products with a standard interface for both data and power, which can greatly reduce the demand for traditional socket outlets, whilst also improving efficiencies in operating power management and losses associated with transforming AC to DC for every single device. With these improvements being built into the devices themselves it also means existing household stock (of which three quarters of what the 2050 stock is already standing[15]) can in the short term more easily accommodate consumer electronics without the need for major structural changes.

Longer term, increased micro-generation of renewables, improvements in battery technologies, and the installation of 'Smart Meters' opens up the possibility of a dual voltage power supply, perhaps supplying DC for consumer electronics and AC for white goods, further reducing consumption and feeding excesses back into the National Grid. With more and more products being designed with a common interface for data and power, smart homes will become a more realistic prospect for the masses, making our increasing reliance on technology a more sustainable model.

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