

Response to:

Smart Metering Implementation Programme:

Consultation on the second version of the Smart Metering Equipment Technical
Specifications (URN 12D/258)

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Comments and Evidence

Paragraph 1. “...energy suppliers will be required to offer domestic customers an In-Home Display (IHD) which will present real-time information on energy usage.”

Smart meters and In-Home Display

Darby (2010) notes that whilst real-time displays of usage can in some instances be of benefit, there is little evidence that the rollout of smart meters and IHD will result in an overall reduction in energy demand. The UK already charges 50% more for daytime electricity use than at night (Anderson & Fuloria 2010) - so savings are not guaranteed by a change in system. Experts have already voiced concerns about both smart meters and IHD.

Research by van Dam et al., (2010), indicates that initial savings created through the use of in-home displays may lessen over time as their novelty wears off. Their 15-month study found that initial electricity savings of 7.8% after four months were not sustained medium to long-term. Richard Lloyd, Director of Consumer Action, Which? Notes, “We have asked consumers what they think about smart metering, and only one in 10 said that they saw smart meters as a means of reducing their energy consumption.” (House of Commons Oral Evidence, 2011).

There is also debate over how many people will actually use IHD. Ogi Kavazovic Vice President of Marketing and Strategy at OPOWER (a customer engagement platform for the utility industry) appears highly sceptical about IHDs being a success (Berst 2011). Jesse Berst, chief analyst of Smart Grid News, agrees stating: “[IHDs] will never catch on. If the average electricity bill is, let's say, \$100 and the average savings is, let's say, 10%, then we are talking \$10 per month. For that amount, most homeowners will scan a report every month or three and then make tweaks to pre-programmed settings. That's it.” (Berst 2011a).

DECC estimates that smart metering will “result in an increase in annual domestic energy and gas bills for the average dual fuel customer of £6 by 2015 but by 2020 it will deliver a net annual saving of £23,” NAO (2011). This infers that on average £1.92 per month (approximately £0.06 per day) might be saved per day by 2020 - though no widespread savings are expected before 2015 - if IHD were used as intended by a large proportion of the population.

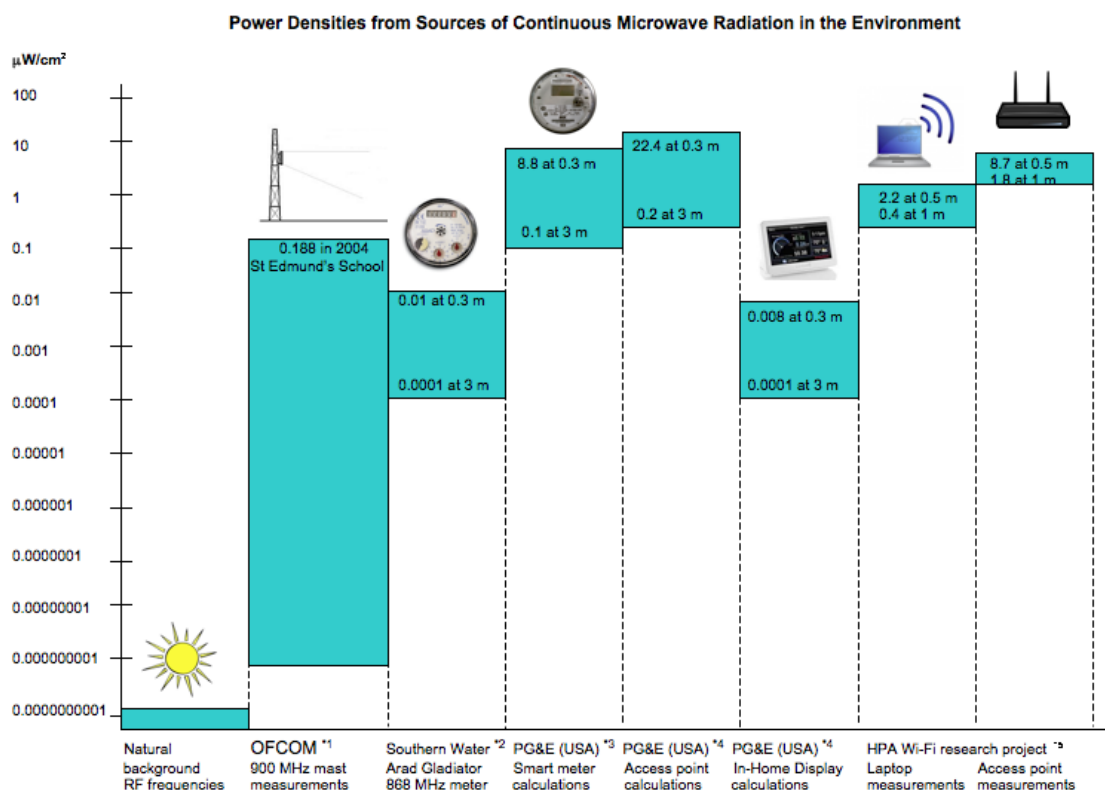
In apparent response to such suggested consumer apathy Google axed its PowerMeter electricity monitoring tool in 2011 due to poor sales (LaMonica 2011). As noted by Berst (2011a), companies that are unrealistic about future trends, or belief overly optimistic forecasting “could literally put themselves out of business.” It is vital that the energy market is better understood so that products and services can be properly developed and specified for the end consumer.

The effectiveness of IHD consumer monitoring versus advising customers to simply avoid having electrical items on standby and turn them off when not in use, promoting more energy efficient building design, having simple tariff schemes, and industry creating more energy efficient (and biologically and environmentally friendly) devices appears not to have been fully taken into consideration. Billions are being unnecessarily spent on smart metering technologies when far cheaper alternatives can save more money.

Research indicates that manually operating appliances when the price is low is the consumers’ favoured way of optimising energy consumption (Paetz et al. 2011). Recent research by the Energy Saving Trust, DECC and DEFRA found that “On average ... households spent £50-86 a year on their appliances in a ‘non-active’ state,” Energy Saving Trust (2012).

Educating people to switch off and unplug electrical appliances when they are not in use would potentially save 2-3 times more money and energy than the adoption of IHD and smart metering are optimistically predicted to achieve by 2015.

Health effects of exposure to RF/microwave radiation from smart meters and IHD - to date it appears that detailed research still has to be taken into the potential health effects of radiation from smart meters and IHD. As can be seen by the illustration below, the exposures that many people will receive from them can be greater than that they regularly receive from mobile phone base stations. Altpeter et al., (1997, 1995) indicated that abnormal blood pressure, digestive problems, fatigue, joint & limb pain, nervousness, sleep disorders & weakness could arise at power densities of only $0.002 \mu\text{W}/\text{cm}^2$ - below the levels that can be created by wireless IHD. The apparent health effects of exposure to smart meter radiation and RF/microwave exposures below those emitted by single smart meters are documented elsewhere in this present work.



Source: BEMRI.org (2012)

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Comments and Evidence

Paragraph 2. “The Mass Roll-out stage will result in smart electricity and gas metering systems being installed in all properties.”

The above statement suggesting that smart meters will be installed in all properties appears in direct contradiction to the ‘opt out’ guarantee given in the House of Commons in 2011 by Charles Hendry MP (Minister of State for Energy and Climate Change from 12th May 2010 to 4th September 2012):

When questioned by Guto Bebb MP on “*whether households will be able to choose not to have a smart meter installed if they have concerns about the health effects of exposure to radio frequency, such as non-thermal health effects,*” he declared “... we recognise that there may be some circumstances where it would not be practical to install a smart meter. ... **it will not be an offence for householders to refuse to accept a smart meter.**” (Hansard 2011) – emphasis added by current authors.

This stance echoes the statement given earlier by Moira Wallace, Permanent Secretary, Department of Energy and Climate Change: “*We are not mandating it for individuals. We are not going to come and say to anyone’s aggressive wife that we will get a warrant, burst into their home and fit a smart meter against their will. We want every supplier to offer this. ... We want to offer it to everyone, but we will not push it in the final cases.*” (House of Commons Oral Evidence 2011).

Both these Government responses categorically state that smart meters are non-compulsory. Why then does the Executive Summary of this consultation fail to mention this and imply that this is not so?

As noted by Richard Lloyd, Director of Consumer Action, Which?: “*There is probably a very good reason why no one else in Europe is trying to achieve the kind of penetration that we are.*” (House of Commons Oral Evidence 2011). Such reflections should be given proper consideration.

It has been noted on many occasions that for smart metering to be as success the public’s trust has to be gained. If such basic promises are broken how will trust be achieved?

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Comments and Evidence

Paragraph 28. “The HAN will be at the heart of the smart metering system. These devices may, in turn, enable smart appliances and smart grid technology.”

Paragraph 31. “This consultation looks at the criteria, evidence and options for defining a HAN standard(s) under SMETS 2. The HAN evaluation has taken into account a number of factors including the ability to deliver the expected benefits in the Impact Assessment, the extent of wireless propagation in GB properties, the availability and deployment of the technology, Evidence underpinning the analysis and options has been gathered from a number of workstreams,”

Home Area Networks (HAN)

“The Home Area Network (HAN) is a critical part of the [UK] smart metering programme. As these HAN devices are to be connected into every home in Great Britain, the HAN must be both reliable and secure in order to provide the consumer with a top class user experience...”

SmartReach (2011).

Built In Security of HAN

The US GAO states that “increasing the use of new system and network technologies can introduce new, unknown vulnerabilities. ... our experts stated that smart grid home area networks ... do not have adequate security built in, thus increasing their vulnerability to attack.” To counter such risks, over \$30 million (£18.62 million) has been awarded to address these cyber-security and reliability issues (Schwartz 2010). Even with such massive funding, some experts still express grave concerns (Mills & LaMonica 2010) and it is recognized that cyber security plans can often be incomplete or lack sufficient detail (US DOE 2012). It appears the same risks exist in the UK.

Health concerns

Public health concerns, the recent classification of RF/microwave radiation as a Class 2B carcinogen (WHO/IARC 2011), the BioInitiative Working Group (2007) recommending drastically lower RF/microwave exposure levels, and the recommendation by the Parliamentary Assembly of the Council of Europe (PACE 2011) that electromagnetic emissions should be “as low as reasonably achievable” (ALARA) indicate that as a matter of best practice wired (and not wireless) HAN systems should be sought wherever possible.

HAN design and specification

Wireless HAN

Signals from wireless HAN can be blocked or degraded by the presence of some types of building materials. In particular, signals can often be blocked by foil-backed plasterboard (used in many buildings) and some types of foil-backed high thermal insulation. Wire mesh used in some old buildings for plaster and lath work also blocks signals. Concrete and some dense building materials too can compromise signals.

Signals can also be deliberately blocked by the use of particular materials and finishes by electrosensitives who attempt to screen themselves and their homes from RF/microwaves which they state can often make them feel unwell.

The result of such factors is that reliable signals cannot be received in some areas, whilst increased signals can be encountered in others, **thereby raising occupancy exposure to RF/microwave radiation.**

Whilst present proposals for HAN in the UK greatly promote the use of wireless networks, one of these systems, M-Bus, can be used wirelessly (and was originally conceived as a simple wired

network especially for smart meters). The wired option of M-Bus is used to create wired HAN networks in several European countries including Germany and is likely to cause fewer problems for those who are electrohypersensitive (EHS).

Wired HAN

Ideally wired options should be available to reduce risk to those who are considered particularly vulnerable to RF/microwave radiation, those who for personal reasons do not wish to be exposed to such regimes, and those who wish to optimally use smart appliances without signal degradation. Powerwatch (2010) suggest that it may be appropriate for the UK to consider supplying smart meters that can have their wireless function disabled and allow for wired M-Bus port to be used as single screened wire connections instead of wireless. *It further suggest that as the UK forbids there being any directly wired connections to gas meters, either opto-isolated couplings (at the outside of gas meter enclosures) or short lengths of fibre-optic cables should be used as the final connection.*

HAN are now considered essential by many consumers, with growing numbers of people wishing them to be preinstalled in new homes. This can be achieved in a more biologically friendly and environmentally friendly manner by using plastic optical fibre (POF) in every room instead of wireless or copper cabling. POF is easy to install (without the need for an electrician) and can be used for distances of up to 100 m (328 feet) - industrial glass fibre optic cables send digital signals far further but are more expensive and should only be installed by professionals. A POF system is also available which has a low voltage DC distribution system allowing digital products to be run more energy efficiently (FL 2011).

The use of fibre-optic cabling, in contrast to other alternatives, allows built-in systems to be 'future proofed' against increasing needs for bandwidths whilst helping to create 'electromagnetically clean' environments and good transmission.

It is proposed by the present authors that the use of wired alternatives, such as fibre-optic HAN, should be recommended as a 'best practice' option in HAN standards.

Smart Appliances

Smart appliances allow communication between consumers' HAN and utility HAN. Manufacturers allow communications solely through RF/microwave connections, with no provisions being made for wired connections, or for their 24/7 signals to be disabled. When such appliances are used, the pulsed RF/microwave signals they emit are supposed to be transmitted very infrequently. Milham (2011), however, has reported measuring [almost] "continuously radiating RF from internal power transmitters" from a smart oven and smart dishwasher designed to transmit their energy usage to wireless smart meters. Emissions only ceased when the power to them was switched off.

The range of smart appliances and devices includes: coffee makers, cooker, dishwashers, microwave ovens, standard ovens, thermostats, toasters, tumble dryers, washing machines, water heaters, freezers and refrigerators. Smart electric sockets also exist for offices and home use.

The extent to which wireless smart appliances are desirable is highly questionable to many. A number of commentators and consumers also take issue with the 'need' for some appliances to be smart. As an example, one US pilot study has shown that consumers do not want utilities to tell them when to do the laundry or use the dishwasher (Ansell 2010). ***Orders are already being lost because some consumers refuse to have smart appliances and devices (that emit RF/microwaves throughout the day) installed in their homes and workplaces.*** Exposures to such radiation can make some individuals quite ill. *Possibly around 5% of the UK may be electrohypersensitive (EHS). They and their families form a relatively large sector of the public to risk alienating.*

As mentioned at the start of this section, smart electric socket extension leads are also now available. One brand offers units that emit RF/microwave radiation at 2.4 GHz at a typical time interval of 10 seconds down to 1 second if required. That socket extension lead is being sold as being “ideally suited for use within an office environment as a simple replacement for traditional 4 way extensions typically found under desks.” Possible health risks and potential liability claims resultant through increased RF/microwave exposures (particularly at very close distances to such items) appear not to have been considered.

Trade Unions may also influence the degree to which particular smart formats are adopted, especially as a result of the recent WHO/IARC (2011) classification of RF/microwave radiation as a Class 2B carcinogen. The Trades Union Congress in the UK (TUC 2008) states: “... trade unions believe the aim should be to remove all exposure to any known or suspected carcinogen in the workplace,” and “Caution should be used to prevent exposure to substances in Group 2B,” there may be a call for the removal, or boycotting of such devices, when it becomes generally known that ‘safer’ alternatives are available.

“Rather than let the smart metering industry have a period of relative stability to confirm their technical specifications, complete trials and educate users, this new mania around [smart] appliances adds a level of unnecessary technical uncertainty,” Hunn (2011).

Some consumers have started to question how many smart appliances actually benefit them by being ‘smart’. **Increased exposure to RF/microwave emissions 24/7 from smart appliances may prove a particular problem in bedsits and studio flats due to the high concentrations of equipment often within very limited space.** These matters need to be properly addressed, especially as related to the possible effects of their RF/microwave emissions on potentially vulnerable individuals, such as children, pregnant women, the elderly, and those with debilitating conditions.

Ideally, wireless transmissions from smart appliances should be able to be disabled and wired smart interfaces (that can also be turned off) built in as standard for those who wish to use them. The cheaper appliances of a number of companies advocating the use of smart technology presently have been shown to have poor energy performance. “The industry needs to consider whether the prospect of a smart appliance is worth pursuing in the short term, as it has the potential to do more harm than good,” Hunn (2011).

By delaying the rollout of a number of smart appliances at the present time, and with proper government backing, appliance manufacturers could allow themselves a ‘window of opportunity’ to better develop more ecologically, biologically and environmentally friendly technologies and launch them when the public is ready to receive them – a true ‘Win/Win’ situation.

Impact Assessment

DECC’s Impact Assessment (DECC 2012) is far less rigorous than it should be. This is covered in detail elsewhere in the present document.

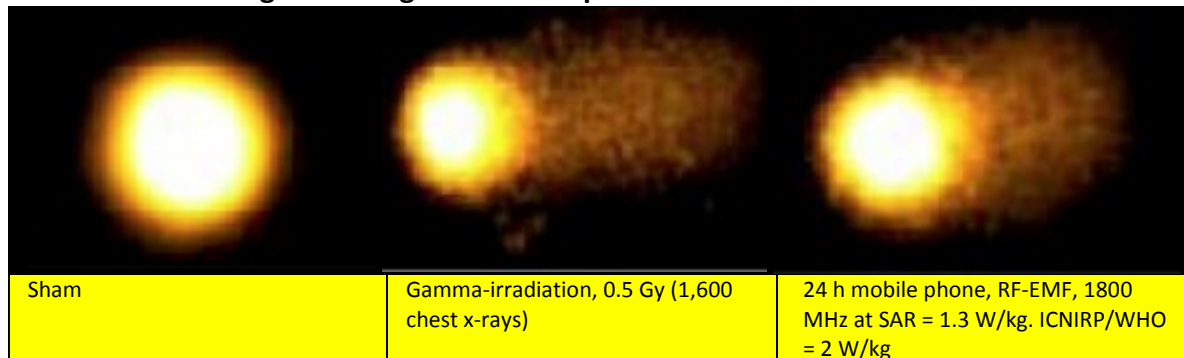
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Comments and Evidence

Paragraph 52. "... The Government recognises that some consumers remain concerned that their health may be affected by radio waves and draws attention to the work of Health Protection Agency showing that the evidence to date suggests exposures to the radio waves produced by smart meters do not pose a risk to health. ..."

It is proposed by the present authors that smart meters and related RF microwave emitting technologies do cause potential health risks



Comet Assay - a typical picture after RF-EMF-exposition of HL60 leukaemia cells

Image source: Adlkofer (2004).

The photos above show the effects of different types of radiation on gene expression of human HL60 cells. The effects of radiation from the mobile phone, which is below current ICNIRP/WHO standards, creates a similar effect to the high dosage of gamma radiation (Adlkofer 2004). Some tests which found "no effect" from exposure used methods 10-100 times less sensitive than those shown in the above (Morgan et al. 2009).

"... children, the elderly, and some chronically ill people might have a lower tolerance for one or more forms of [non-ionising radiation] exposure than the rest of the population."

International Commission on Non-Ionizing Radiation Protection (ICNIRP 2002).

It would appear prudent to undertake similar tests to assess the effects of RF/microwave radiation from smart meters and smart appliances, particularly as RF/microwaves are now regarded as possibly carcinogenic to humans by the WHO/ International Agency for Research on Cancer (WHO/IARC 2011).

Health concerns

On 2nd February 2012, in answer to a Parliamentary question by Guto Bebb MP, the Secretary of State for Energy and Climate Change acknowledged that *there were questions related to concerns about the potential health effects of smart meters and stated that people were legally entitled to refuse smart meters if they wished* (Hansard 2011).

Partially as a result of this, and the concerns of other MPs, members of the public and NGOs, a consultation process (which included a workshop on the 'Potential health concerns linked to smart metering') was co-organised by DECC and Consumer Focus to provide input into the Programme. Whilst earlier work by DECC had recognised the need to ensure that *"risks to vulnerable consumers in relation to installations are minimised,"* **none** of the significant health concerns raised during that consultation are addressed or even acknowledged in the present DECC0099 Impact Assessment (DECC 2012) or the current Smart Metering Implementation Programme Consultation on the second version of the Smart Metering Equipment Technical Specifications.

This is a serious omission, particularly as substantial documentation (including details of peer-reviewed research indicating serious potential health risks and discrimination of vulnerable individuals, as related to metering provisions, had been provided both to the UK Government and DECC in the first months of 2012.

Failure to take such matters into account properly greatly weakens the validity and credibility of the DECC and UK Government smart metering consultation process, and potentially breaches the Human Rights Act 1998. See separate comments and evidence on this matter given elsewhere within this submission.

The UK Government's and the Health Protection Agency's stance on RF/microwave emissions from smart meters is not shared by Industry. *"I want to be very clear. Industry has not said once- once- that ... [RF/Microwave radiation is] safe. The ... government and various interagency working groups have said it is safe."* K. Dane Snowden, Vice President, External & State Affairs, CTIA-The Wireless Association® (an International Association for the Wireless Telecommunications Industry) (Safeschool 2010). *Wired solutions are also available and are used in other countries* (Jamieson 2011).

Health Problems

It appears that the HPA and DECC have neglected to mention to the Government that health problems are already being reported abroad as a result of smart meter rollouts. Excerpts from the results of an online survey on this issue are shown below:

Health & Smart Meter safety survey (SDA 2011)	
Condition	Detrimental effects
Sleep problems	49.1%
Stress, anxiety, irritability	43.1%
Headaches	40.9%
Ringing in the ears	38.1%
Concentration, memory or learning problems	34.6%
Fatigue, muscle or physical weakness	34.3%
Disorientation, dizziness, or balance problems	25.8%
Eye problems, including eye pain, pressure in the eyes, blurred vision	33.0%
Cardiac symptoms, heart palpitations, heart arrhythmias, chest pain	25.8%
Leg cramps, or neuropathy	19.2%
Arthritis, body pain, sharp, stabbing pains	18.2%
Nausea, flu-like symptoms	17.3%
Sinus problems, nose bleeds	14.5%
Respiratory problems, cough, asthma	13.8%
Skin rashes, facial flushing	12.6%
Urinary problems	8.8%
Endocrine disorders, thyroid problems, diabetes	8.8%
High blood pressure	7.2%
None of the above	8.8%
Other	30.5%
I don't know	24.8%

*The figures reflect whether individuals or members of their homes experienced health impacts (n = 318).

Measured exposures

As the HPA is not yet providing published figures on measured exposures, reference is given to the work of others on what is likely to be found. **Moldan (2009) noted pulsed microwaves emitted by a single**

smart meter resulted in a power-density of $0.05 \mu\text{W}/\text{cm}^2$ at 1 m (3.28 ft). This increased to $0.2 \mu\text{W}/\text{cm}^2$ 0.5 m (1.64 ft) from the unit and $5.5 \mu\text{W}/\text{cm}^2$ at 30 cm (0.98 ft). Pulsed RF/microwaves can be more biologically active than non-pulsed radiation (Belyaev 2005).

CCST (2011) recorded a power-density of $8.8 \mu\text{W}/\text{cm}^2$ 30.5 cm (1 ft) from a single wireless smart meter. In that work, power densities of $1.0 \mu\text{W}/\text{cm}^2$ and $0.1 \mu\text{W}/\text{cm}^2$ were measured at distances of 91.4 cm (3 ft) and 304.8 cm (10 ft) from the signal. Higher power densities will occur nearer individual wireless smart meters and when multiple units and other RF/microwave emitting items are in use. Reflections can also occur, causing potential hotspots and increasing local radiation levels. These will increase the exposure of those spending prolonged periods nearby.

In the assessment of RF/microwave radiation emissions from smart meters undertaken by Sage Associates (Sage Associates 2011), it is mentioned, [citing Khurana et al. (2010) and Kundi & Hutter (2009)] that **chronic exposure of above $0.05\text{-}0.1 \mu\text{W}/\text{cm}^2$ is associated with cardiac problems, increased cancer risk and adverse neurological symptoms.**

The exposures that individuals would receive would be determined in part by building construction and distance they were away from the unit(s) and any other pieces of related smart appliances and technology that are relaying information 24/7. Exposures from other RF/microwave emitting equipment would further contribute to apparent risk.

Findings from Peer-Reviewed Literature

Studies matrix of power densities similar to those caused by <u>single</u> wireless smart meter		
Power Density	Reported Biological Effects	References
$0.000000001 \mu\text{W}/\text{cm}^2$	Altered EEG in humans' brain waves & behaviour	Bise (1978)
$0.002 \mu\text{W}/\text{cm}^2$	Abnormal blood pressure, digestive problems, fatigue, joint & limb pain, nervousness, sleep disorders & weakness	Altpeter et al., (1997, 1995)
$0.06 \mu\text{W}/\text{cm}^2$	Altered adrenal hormone levels & enlarged adrenals, disturbed carbohydrate metabolism, altered EEG, structural changes in brain, liver, spleen & testes of animals	Dumanskij & Shandala, (1974)
$0.1 \mu\text{W}/\text{cm}^2$	EEG brain waves altered under exposure to cell phone signal	von Klitzing (1995)
$0.6 \mu\text{W}/\text{cm}^2$	Cardiac arrhythmias & sometimes cardiac arrest (frogs)	Frey (1986)
$1.0 \mu\text{W}/\text{cm}^2$	Headache, dizziness, irritability, fatigue, weakness, insomnia, chest pain, difficulty breathing, indigestion (humans – occupational exposure)	Simonenko et al., (1998)
$0.168 - 1.053 \mu\text{W}/\text{cm}^2$	Decrease in newborns & irreversible infertility in mice after 5 generations	Magras & Zenos (1997)
$5.0 \mu\text{W}/\text{cm}^2$	Biochemical and histological changes in brain, heart, kidney & liver tissue	Belokrinitskiy, V.S. (1982)
$8 \mu\text{W}/\text{cm}^2$	Association between increased incidences of childhood leukaemia & mortality through RF fields	Hocking et al., (1996)

As indicated in the studies matrix above a number of adverse of adverse health effects may be linked with inappropriate exposures to radio waves / microwaves.

Cancer

“Cancer is the world’s leading cause of death, followed by heart disease and stroke. ... cancer also has the greatest economic impact from premature death and disability of all causes of death worldwide,” ACS (2010). Cancer rates are rising in the UK. The UK charity Macmillan Cancer Support claims 4 in 10 individuals in the UK may have cancer at some point in their lives (Brimelow 2011). ***The annual cost of cancer to England*** (not the whole UK – *present authors’ comment*) ***in terms of healthcare costs, lost productivity and costs to patients and families is £18.33 billion. These figures are set to rise to £24.72 billion over the next ten years.*** This figure is 6% higher than the European average (Featherstone & Whitham 2010).

As the International Agency for Research on Cancer (IARC) - which is part of the World Health Organization (WHO) - now classifies RF/microwave radiation as possibly carcinogenic to humans in recognition of growing concern over “the possibility of adverse health effects resulting from exposure to radiofrequency electromagnetic fields, such as those emitted by wireless communication devices,” (WHO/IARC 2011); it might be more prudent to opt for meter options that reduce such this risk.

The Parliamentary Assembly of the Council of Europe (PACE 2011) state that ***“electromagnetic emissions should be as low as reasonably achievable”*** (the ALARA Principle) and that ***“all reasonable measures to be taken to reduce exposure to electromagnetic fields”*** – a call similar to that of the BioInitiative Report (BioInitiative Working Group 2007).

It is already recognised by the UK Trades Union Congress (TUC 2008) that ***“...trade unions believe the aim should be to remove all exposure to any known or suspected carcinogen in the workplace” and “Caution should be used to prevent exposure to substances in Group 2b.”***

Eger et al. (2004) found increased risk of malignant tumours in individuals exposed to RF/microwave radiation from mobile phone base stations. Their work, covering the period 1999-2004, indicated that after 5 years, ***risk of malignant blastoma for those in the vicinity of the phone mast was 3 times that of individuals living further away.*** [Earlier animal tests by Repacholi et al (1997) found long-term (up to 18 months) intermittent exposure to pulsed 900 MHz fields resulted in significantly enhanced probability of cancer in cancer-prone mice]. *Refer also to the graphic comparing recorded power densities adjacent mobile phone base stations, smart meters and other RF/microwave emitting devices.*

Wolf & Wolf (2004) found relative cancer rates for females living adjacent to a base station were significantly higher ($p < 0.0001$) than those living in a low field area and the rest of the city. *They recorded 4.15 times more cases in the area adjacent the base station than for the entire population. Dode et al. (2011) too found a strong association between increased exposures to RF/microwave emissions from base stations (as determined by distance from base stations) and human deaths from cancer* in research undertaken in the city of Belo Horizonte in Brazil. ***Their findings led them to “strongly suggest the adoption of the Precautionary Principle”*** until satisfactory limits of human exposure can be determined. *The present authors suggest that such a stance should also be taken with smart meter technology.*

“The influence of electrosmog on the human body is a known problem. ... The risk of damage to health through electrosmog has also become better understood as a result of more recent and improved studies. When for example, human blood cells are irradiated with electromagnetic fields, clear damage to hereditary material has been demonstrated and there have been indications of an increased cancer risk. ...” Swisscom AG - major Swiss telecommunications provider (Swisscom AG 2003).

Lloyds of London will not cover claims linked with RF/microwave radiation. They are now amongst a growing number of similarly unsupportive insurance companies (Ryle 1999).

Childhood Leukaemia

An association has also been noted between increased incidences of childhood leukaemia & mortality through RF fields at power densities of $8 \mu\text{W}/\text{cm}^2$ (Hocking et al. 1996); a power-density lower than that noted by PG&E (2011) as being created by a single wireless smart meter. Additionally, RF/microwave exposure has been shown to cause DNA damage (De Iuliis et al. 2009). Changes in DNA can be a precursor of cancer and cause genetic mutations.

The above studies, whilst being in no way definitive, do provide good reason for lowering field emissions wherever practical as a precautionary measure.

Alzheimer's disease

It has been suggested that the rise in Alzheimer's disease and other dementias may be the "*Most Significant Health Crisis of the 21st Century.*" The number of people with dementia is predicted to double by 2030 and more than triple by 2050 (ADI 2010). **The cost of Alzheimer's and other dementias to the UK economy is presently £23 billion per year (ARUK 2011).**

Increased risk of Alzheimer's disease and other neurodegenerative disorders is linked to increased production of peroxynitrite, which can damage a wide variety of molecules in cells (including proteins and DNA). Its production can be increased by RF/microwave radiation that causes NADH-oxidase to create extra free electrons in a dose related manner that stimulate its production (Friedman et al. 2007). Increased peroxynitrite production is a pathogenic contributor to conditions such as: **cancer, chronic heart failure, chronic inflammatory diseases, circulatory shock, diabetes, myocardial infarction, stroke, myocardial infarction and stroke** (Pacher et al. 2007).

Earlier animal research by Dr Sam Koslov, who was the Director of the Applied Physics Laboratory at John Hopkins University in the US, led him to accidentally discover that exposing chimpanzees to **repeated low-level non-thermal microwave exposures produced clinical Alzheimer's disease** - *lack of funding prevented his findings being followed up at that time* (Becker 1990).

Research in Sweden and the USA have indicated a link between occupational exposures to EMFs and Alzheimer's disease (Davanipour et al. 2007, Feychting et al. 2003, Sobel et al. 1996). It has also been indicated that there is a dose-response link between environmental exposures to EMFs and senile dementia and Alzheimer's disease (Davanipour & Sobel 2009, Huss et al. 2009). It is known that very weak microwave radiation can change the shape of cellular proteins in the brain causing them to clump together into formations that resemble pathological fibrils associated with this disease (MWN 2003).

The number of individuals in the UK with dementia is presently predicted to rise as the population ages. Reducing inappropriate RF/microwave exposure may be a novel way to help reduce the number of future sufferers. This may be achieved in part through optimising the design of meters, and related technologies and using wired as opposed to wireless alternatives.

Autism

The lifetime costs for someone with high-functioning autism is £3.1 million and the lifetime costs for someone with low-functioning autism is £4.6 million. The number of individuals diagnosed with autism appears to be steadily increasing. The present annual cost of autism to the UK economy is £27.7 billion (Knapp et al. 2009).

In 1978 it was estimated that approximately 0.04% of individuals exhibited classic autism. Around 1% of the UK population now exhibits autism-spectrum conditions (including classic autism), with approximately 1.57% of school children exhibiting autism-spectrum conditions. This may be due to, amongst other factors, improved detection and recognition (Baron-Cohen et al. 2009).

Kane (2004) suggests that electromagnetic pollution could be a contributory factor to this condition.

Whilst there are a number of other potential factors that could in part be responsible for any increases that may actually have arisen: ***his hypothesis is worthy of further study, particularly if lower field regimes are shown to reduce the risk and severity of such conditions and their cost to the national economy.*** The reasoning behind his suggestion is “... that human exposures to RF radiation have become pervasive during the past 20 years, whereas such exposures were uncommon prior to that time,” and that the increased fetal or neo-natal exposures that could have occurred as a result of such variations may be a driver of increased incidence. Lathe (2010) notes that, in the absence of firm data demonstrating that RF/microwave radiation cannot influence brain tissue, Kane’s hypothesis is plausible.

Presently anecdotal evidence as to why such a theory should be taken seriously, at least till it can be properly tested, is provided by an unpublished pilot study by Dr Dietrich Klinghardt MD, PhD. It intriguingly links raised levels of microwave radiation [0.011-0.171 $\mu\text{W}/\text{cm}^2$], in the bedrooms of pregnant women to increased risk of autism and other neurological impairments in their children compared to low field bedrooms [0.0001-0.004 $\mu\text{W}/\text{cm}^2$] (Klinghardt 2008).

Also of interest is a related study of 13,159 children by Divan et al. (2008), which found a 54% higher chance of children having emotional and social problems at school age if their mothers used mobile phones during pregnancy. Whether there is in fact a link remains open to conjecture. It appears prudent to determine if raised EMF exposures (*as would be caused by the proposed smart meter roll out*) do increase autism risk, and if so how new generations of ‘bio-friendly’ technology could mitigate, or even reverse, such likelihood of risk.

Infertility

Animals: Research by Magras & Zenos (1997) recorded **irreversible infertility in mice after 3 generations at exposures of 1.053 $\mu\text{W}/\text{cm}^2$** from a RF tower – measurements were taken in the 80–900 MHz range. Lower exposures of 0.168 $\mu\text{W}/\text{cm}^2$ (further away from the tower) were linked with total infertility in mice after 5 generations. These levels of exposure are considerably less than the power-density of 8.8 $\mu\text{W}/\text{cm}^2$ recorded 30.5 cm from a single wireless smart meter by PG&E (2011).

Mailankot et al. (2009) reported that exposing male Wistar rats to active mobile phone radiation at frequencies of between 900 MHz to 1.8 GHz for 1 hour per day for 28 days significantly decreased sperm motility. They also suggested that exposure to RF/microwave radiation may impair fertility. The review by Desai et al. (2009) further covers the effects of RF/microwave radiation on animal fertility and also discusses possible mechanisms that might lead to the RF/microwave related infertility in human males.

Humans: Falzone et al. (2011) found that 1 hour exposure to 900 MHz radiation (from mobile phones) caused significant reduction in sperm head areas ($9.2 \pm 0.7 \mu\text{m}^2$ versus controls $18.8 \pm 1.4 \mu\text{m}^2$), and noted a significant decrease in sperm binding compared to controls – their results indicated that RF/microwaves could have a significant effect on sperm fertilisation potential.

A pilot study by Agarwal et al. (2009) also revealed a significant reduction in sperm motility and sperm vitality as a result of exposure to such radiation. Additionally, Santini et al. (2002) found a significant loss in libido for subjects within 100 m of a base station ($p < 0.05$).

Davoudi et al. (2002) tested men who had normal spermiograms ($n = 13$). They were tested 5 days after not carrying or using mobile phones, then tested 4 weeks later (after carrying mobile phones on their belts and using them 6 hours per day for the 5 days before their final test). **Increased exposure to RF/microwaves (through mobile phone use) was indicated as possibly reducing sperm motility by 32.3%** ($p = 0.01$). In research by De Iuliis et al. (2009), purified human spermatozoa exposed to raised levels of RF/microwave radiation exhibited significantly reduced sperm motility and vitality. Significantly elevated DNA fragmentation and mitochondrial generation of reactive oxygen species were found to occur after exposure ($p < 0.001$).

De Iuliis et al. (2009) concluded that their own research indicated that there were “**clear implications for the safety of ... [increased RF/microwave exposures to] males of reproductive age, potentially affecting both their fertility and the health and wellbeing of their offspring.**”

At present exposure to many types of Smart Meter and smart appliance would increase RF/microwave radiation indoors 24/7. Research urgently needs to be undertaken to determine suitable solutions so that metering regimes do not impact negatively on health.

Dramatically reduced birth rates would cause a declining labour force, crucially undermining the UK's economic viability and increasing the burden of supporting the ill and elderly.

Ailments listed in the Health & Smart Meter safety survey

The EMF Safety Network initiated the survey detailed earlier from 13th July to 2nd September 2011 to investigate to what extent there may be health and safety complaints related to wireless Smart Meters. The majority of respondents (78%) were from California and the survey results were analysed by Survey Design & Analysis (SDA 2011). *Numerous conditions were listed which appeared to be detrimentally effected by smart meter emissions. Three of these are now discussed:*

Sleep problems

Exposure to some RF/microwave radiation regimes have been linked with fatigue and insomnia (Eger & Jahn 2010, Hutter et al. 2006, Bortkiewicz et al. 2004). **49.1% of respondents of the online survey on smart meters stated that they or members of their families had encountered sleep problems after the installation of wireless smart meters** (SDA 2011).

Simonenko et al. (1998) noted occupational exposures of $0.1 \mu\text{W}/\text{cm}^2$ – *the level of intensity noted at 3m from an AMI smart meter (present authors' comment) - could cause both fatigue and insomnia in humans, whilst Santini et al. (2002) found a significant increase in individuals complaining of fatigue within 300m of a base station and sleep disturbances within 200m of a base station* ($p < 0.05$). **The present annual cost to the UK economy of chronic sleep deprivation is estimated at £1.6 billion** (Bupa 2010).

The extent to which EMF emissions by smart meters and related technologies may result in future increased fatigue and insomnia in the UK has yet to be adequately determined.

Lack of sleep may be a causal factor in premature ageing, high blood pressure, diabetes, obesity, depression and other mental health problems, and can also tax the immune system. 27% of UK workers regularly go to work tired and unrefreshed from sleep. Over 50% arrive at work fatigued more than 20 times a year. **Those with sleep debt take on average three days a year more sick-leave (at an average cost of £93.50 per employee day lost). When tired, workers are 23% less satisfied with their jobs.** As noted by Dinges et al. (1997), *individuals with less than 8 hours sleep exhibit reduced decision making abilities, dramatic attention lapses and distinct physiological and cognitive deficits, (including impaired memory).* The effects of these deficits increase as sleep debt continues. Long-term sleep deprivation increases the likelihood of motor vehicle accidents. *At present, driver fatigue is responsible for almost 20% of traffic accidents on main roads in the UK.* As noted by UK Department for Transport (DfT 2011), “*The only real cure for sleepiness is proper sleep.*”

If the wide scale increase in sleep problems (and reported related dissatisfaction) reported abroad after smart meter installation occur in the UK, it could prove highly detrimental to the UK economy and disastrously impact on the Prime Minister's National Well-being initiative.

Headaches

Headache disorders **presently** cost the UK around £7 billion a year in absenteeism and reduced productivity (Thomas 2009). *It is likely the number of headache disorders reported will significantly increase if a wide scale roll out of wireless smart meters is undertaken in the UK.* In the EMF Safety Network survey undertaken abroad, 40.9% of respondents said that they or members of their family reported headache problems after the installation of wireless smart meters (SDA 2011).

From a review of scientific literature, it is found that Eger & Jahn (2010) recorded a highly significant dose-response relationship between residential locations and headaches when comparing high field and low field exposure groups – mean exposures levels of 1.17 V/m compared to 0.70 V/m ($p < 0.001$). **Hutter et al. (2006), in separate research, documented a significant link ($p < 0.017$) between headaches and exposures to power densities $>0.05 \mu\text{W}/\text{cm}^2$ (maximum $0.41 \mu\text{W}/\text{cm}^2$) compared to $\leq 0.01 \mu\text{W}/\text{cm}^2$.** **Simonenko et al. (1998) recorded increased incidence of headaches at $1.0 \mu\text{W}/\text{cm}^2$.**

Santini et al. (2002) noted an increase in individuals, particularly women, complaining of headaches when living within 200 m of a base station as opposed to further away, or not exposed to radiation from a base station ($p < 0.05$). Bortkiewicz et al. (2004) also found incidence of headaches related to exposure and distance to base station. This was found for both those who associated their condition with being in proximity to the base station and those who did not. It is likely that similar findings will be made related to smart meters.

Concentration, memory or learning problems

In the online survey, 34.6% of respondents stated that they or members of their families had encountered concentration, memory or learning problems after the installation of wireless smart meters (SDA 2011).

Learning ability

The brain's hippocampus plays a vital role in consolidating information from short-term memory to the long-term memory and in matters related to spatial navigation. Some RF/microwave regimes have been indicated as damaging it and also compromising its development.

Animal research by Odaci et al. (2008) has shown that exposing pregnant rats to 900 MHz RF/microwave radiation (*created by a mobile phone in talk mode for 1 hour daily*) for the duration of the pregnancy resulted in far fewer nerve cells being present in this part of the brain in offspring ($p < 0.01$). This will have effects on learning and memory. Salford et al. (2003) additionally reported that exposing rats to 915 MHz RF/microwave regimes from mobile phones for 2 hours produced highly significant ($p < 0.002$) evidence of neuronal damage in the hippocampus and other parts of the brain.

Memory function

A number of animal tests have been undertaken to help determine the possible effects of RF/microwave exposures on learning abilities. To date none have been undertaken related to emissions from various types of smart meters and related technologies, though it is likely that they will be undertaken some time in the near future.

Nittby et al. (2008) investigated the possible effects of exposure to 900 MHz radiation on rats' cognitive functioning. 32 out of 56 rats (the rest being either sham exposed or controls) were exposed for 2 hours every week for 55 weeks to RF/microwave mobile phone radiation. After this protracted exposure, they were compared to sham exposed controls. **The RF/microwave exposed rats exhibited impaired memory for objects and temporal order of presentation compared to the sham exposed controls ($p = 0.02$).** Their results indicated significantly reduced memory functions in rats after 900 MHz RF/microwave exposures ($p = 0.02$).

Research by Fragopoulou et al. (2009) demonstrated that **exposing mice for approximately 2 hours per day to 900 MHz RF/microwave radiation from a mobile for four days caused cognitive deficits in spatial learning and memory.** In that study, the exposed mice were shown to be less proficient in transferring learned information to the following day, and exhibited deficits in consolidation and/or retrieval of learned information.

Narayanan et al. (2009), undertaking tests on 10-12 week old male rats, found exposing them to the 900/1800 MHz RF/microwave radiation of 50 missed calls a day from a mobile phone daily for 4 weeks induced behavioural changes though the exact cause of these undetermined. **The rats exposed to**

RF/microwave radiation took longer to undertake tasks, had poorer spatial navigation and exhibited poorer memory function than those unexposed.

Many wireless smart meters operate in the 2.4 GHz range. Again tests have not yet been undertaken to determine the biological effects of their operation 24/7 on learning ability or other biological functions. Research undertaken by Wang & Lai & (2000) and Li et al. (2008), however, has already indicated that exposure to some 2.45 GHz RF/microwave regimes may affect memory.

Electrohypersensitivity (EHS)

As mentioned earlier, DECC and Consumer Focus ran a workshop in early 2012 on the 'Potential health concerns linked to smart metering'. This included discussion of issues related to EHS. ***None of the significant health concerns raised during that consultation – such as those mentioned above - are addressed or even acknowledged in the present DECC0099 Impact Assessment (DECC 2012) or the current Smart Metering Implementation Programme Consultation on the second version of the Smart Metering Equipment Technical Specifications.***

There are many individuals who are EHS who would be adversely affected by the roll out of wireless smart meters. It is regretted that this has not yet been adequately addressed by the authorities.

EHS is also known by a variety of other terms including 'Electrosensitivity' (ES), 'Electromagnetic Hypersensitivity' (EHS) and 'Idiopathic Environmental Intolerance with Attribution to Electromagnetic Fields' (IEI-EMF). **The WHO began investigating EHS after Dr Gro Harlem Brundtland, their Director General (and the former Prime Minister of Norway) announced she had EHS before she retired.**

A variety of symptoms are reported by individuals who claim to be EHS. These include: depression, dizziness, fatigue, headaches, irregular heartbeat and palpitations, irritability, memory deficits, nausea, feeling stressed, sleep difficulties (including insomnia), skin rashes, whole-body skin symptoms, feeling of thirst (not quenched by drinking) and tinnitus.

Many of the above symptoms are reported by individuals exposed to radiation from wireless smart meters.

It is estimated by Schreier et al. (2006) that approximately 5% of the Swiss population may be EHS. If a similar fraction is affected in the UK, this would amount to approximately 3,090,000 individuals.

As documented in the smart meter rollouts overseas, EHS symptoms often only become apparent in many individuals when exposed to higher field regimes. Whilst it is recognised that psychosomatic responses can occur, the extent to which biological effects (and differences in autonomic system regulation between individuals – present authors' comment) may influence results has yet to be fully taken into account.

EHS is better recognised abroad than in the UK. It has become officially recognised as a functional impairment in Sweden since 2007. It is not regarded as a disease (Johansson 2010). Survey studies indicate that around 230,000 – 290,000 Swedish adults (out of a population of 9,000,000) report a variety of symptoms when in contact with manmade sources of EMFs (Miljöhälsorapport 2001). The work of Eger & Jahn (2010) also indicates a highly significant dose-response relationship between the RF/microwave field exposures and symptoms reported by some EHS individuals.

Rea et al. (1991), found that EHS is a real phenomenon in some environmentally sensitive patients (under special test conditions), as they exhibited consistent reactions while none of the controls did. A similar deduction was recently reached by McCarty et al. (2011) who concluded, "EMF hypersensitivity can occur as a bona fide environmentally-inducible neurological syndrome."

In 2011, the Labour Court in Madrid, Spain declared that hypersensitivity, caused in part by exposure to RF/microwaves, can cause permanent disability. The ruling is unique in this regard and sets a precedent for future conditions related to EHS. The college professor, who has been permanently incapacitated, was awarded a permanent disability pension at 100% of his base salary rate (GMJ 2011).

In the US, EHS patients are successfully attaining disability allowance for their 'functional impairment' in relation to unavoidable prolific EMF fields in normal working conditions (EHCD Dallas, June 2010). Russia described 'Microwave Sickness Syndrome' (which demonstrated great similarity to EHS and is considered eventually fatal) decades ago amongst workers with higher than average EMF exposure. As a result of this they created safety standards of 10 $\mu\text{W}/\text{cm}^2$ which remain, several orders of magnitude more rigorous those in the UK. These more appropriate and biologically based standards are shared by Austria, Switzerland, Poland and China.

WHO state that EHS is "certainly real and can vary widely in severity... EHS can be a disabling problem." The Smart Metering Implementation Programme needs to address this matter, and that of non-EHS having their health threatened by RF/microwave emissions, urgently.

***It is indicated from the above discussion on Health Problems that the cost to the national economy of inappropriate exposure to RF/microwave radiation may run into £ billions annually.** DECC has estimated that smart meters may deliver "a net benefit to consumers of around £5.98 billion over 20 years," (Ofcom 2009) - which works out to around an average of only £299 million annually. This is considerably less than the figure that may be lost through health problems exacerbated by wireless smart metering.*

Educating people to switch off and unplug electrical appliances when not in use could potentially save 2-3 times more money and energy than the present smart metering roll (Energy Saving Trust 2012) - without the risk to health or the need for high levels of funding from the tax payer.

Guidelines for health promotion - The Ottawa Charter for Health Promotion

"Good health is a major resource for social, economic and personal development and an important dimension of quality of life. Political, economic, social, cultural, environmental, behavioural and biological factors can all favour health or be harmful to it. Health promotion action aims at making these conditions favourable through advocacy for health."

"Health promotion goes beyond health care. It puts health on the agenda of policy makers in all sectors and at all levels, directing them to be aware of the health consequences of their decisions and to accept their responsibilities for health," (WHO 1986).

For details of other Health Promotion Charters that the UK has signed up to refer to Appendix 3 of Jamieson (2011)

Smart Meter Health Impacts Testimonials

The following comments from the website of the EMF Safety Network are about how the new wireless utility Smart Meters have [apparently – present authors' comment] affected people's health (EMFSN 2011). Most are posted anonymously. ...

*"My name is Diane Nagby and I and my pets are also a victim of the Smart Meter. **Dizziness, ringing in my ears, insomnia, nausea, rapid heart beat. I had none of these problems prior to the installation of the Smart Meter.** I came home from work and they had just finished installing the Smart Meter. That very night my animals started acting agitated. There is a constant feeling of uneasiness in my household now and at night a loud buzzing/humming noise takes place, which was never present prior to the installation of the Smart Meter. It is just plain old common sense that should tell us any amount of radiation in our household is NOT going to be good for us. A friend of mine that lives in Upland, California experienced a stroke just days after her Smart Meter was installed. How many people have to die, have their homes burned down (because the Smart Meter has been proven to be a fire hazard in some houses), get sick, watch their animals suffer, as I have, before we stand up and say ENOUGH is ENOUGH."*

"... My patients, Shivani Arjuna and her husband Dan Small, have asked me to write to you with regard to how Shivani is affected by exposure ... I share their concern.

People who are aware of experiencing symptoms as soon as they are exposed to radio (RF) and microwave (MW) frequencies are currently termed “electrically hypersensitive,” or EHS.

... However, these individuals are by no means the only people actually being affected by such exposure, ... chronic [RF/MW] exposure causes health damage to people who note no immediate symptoms.

Please see, for example, the bibliography of reported biological phenomena associated with radio-frequency and microwave radiation compiled by the US Navy Medical Research Institute in 1971, with over 2,000 references, at:

www.dtic.mil/cgibin/GetTRDoc?AD=AD750271&Location=U2&doc=GetTRDoc.pdf

Also, please see the summary of EMF effects at: www.icswebsite.com/emf/emfissues.html with 62 more recent references.

... here is brief information regarding a few known mechanisms:

- It is established from multiple, independent studies that EMR from ELF to RF/MW reduces melatonin in animals and human beings. Melatonin is not only vital for healthy sleep, it is the most potent, naturally produced antioxidant that helps to protect cells from genetic damage that leads to cancer, neurological, cardiac and reproductive damage, illness and death.
- Exposure to intensities and field strengths that are extremely low cause a biological effect called calcium ion efflux. Calcium ion alteration of cells by EMR is linked to neurological degeneration, to cancer and many other health effects. The heart is also an electromagnetic organ, with an electric pulse initiating a cascade of calcium ions that cause the cells in the heart to contract and produce a heartbeat. Exogenous electromagnetic signals can interfere with this regular, electrical pulse leading to heart disease and heart attack of the arrhythmic kind.

The most commonly reported symptoms from exposure to wireless Smart Meters are: difficulty concentrating, dizziness, fatigue, headaches, heart palpitations, irritability, short-term memory loss, nausea, difficulty sleeping and tinnitus.

- Physiological changes that are bedrock indicators of allergic response and inflammatory conditions that are stimulated by EMF exposures include: overreaction of the immune system; morphological alterations of immune cells; profound increases in mast cells in the upper skin layers, increased degranulation of mast cells and larger size of mast cells in EHS individuals; presence of biological markers for inflammation that are sensitive to EMF exposure at non-thermal levels; changes in lymphocyte viability; decreased count of NK cells; decreased count of T-lymphocytes; negative effects on pregnancy (uteroplacental circulatory disturbances and placental dysfunction); suppressed or impaired immune function; and inflammatory responses that can result in cellular, tissue and organ damage if exposure occurs on a continuing basis over time.

Mast cells are also found in the brain and heart, and this might account for some of the other symptoms commonly reported: headache, sensitivity to light, arrhythmias and other cardiac symptoms.

- **Many studies have shown that RF/MW radiation and ELF fields cause increased DNA strand breakage and chromosome aberrations. ...” Roy D. Ozanne, MD, HMD.**

“... Five people have reported symptoms in my home: My father has experienced headaches and visual migraines. My mother reported having pressure on the upper part of her chest and palpitations. One neighbor exposed to these 16 cluster meters is experiencing headaches and chest tightness. Another neighbor has difficulty opening her eyes in the mornings after 8 hours by the meters. Her ophthalmologist could find no explanation. She said she uses her fingers to open her lids. All of the above symptoms have occurred since the smart meter installations. The symptoms are worsening for everyone. ...” R.H., San Diego CA.

The following letter is from a prominent doctor in Napa:

"I have a patient who is being injured from the SmartMeter. She has a history of Cardiomyopathy from infection and was doing well until the SmartMeter went in last fall. She is now back in Atrial Fibrillation and needs meds she does not tolerate well. It is all a result of the extra EMF. I will send you copies of articles about how EMF affects patient's heart rate. Is there are special complaint form I could send off to the SmartMeter company that you use? I was going to dictate something for my patient and reference the EMF and heart rate issue".

"I have been in the ER overnight three times this week, with unexplained sickness. I have had a CT Scan of the brain, Stress Test, CTA, EKGs, Ultra Sounds, Blood work and still no definite answer. We recently had a Smart Meter installed and these symptoms began about a week after: Extreme Stress, diagnosed TIAs, dizziness, headaches, nausea and fainting. I mentioned this to a doctor and he suggested that the Smart Meters may have something to do with it because the hospital has had quite a rise in illness of this kind reporting to the ER. "J.W. (anon). ...

"Smart Meters were installed in my neighborhood on April 15, 2011. Since then I have had constant ringing in my ears. Smart Meters violate my constitutional right to be safe and secure in my home, 4th Amendment. Smart Meters violate my privacy and my health. This is a KILLER and you know it. S.B. Orange County CA"

"I am (was) a very healthy individual, and have all the past medical information to prove it. In the last year I have been suffering illness that I feel is directly related to the Smart Meter on my home. ... I have no alternative but to move to a house outside of the PG &E territory. Removing my meter alone won't solve the problem. My house is at the hub, the terminal, for the neighborhood distribution and the adjacent neighbor's meters are on my side of their houses, putting me in direct line of current for three homes. I want these things removed so I can resume my life, which is on hold. C.L. Yolo County."

"Like many with the symptoms, I am on my last and giving up... exhausted from trying to get help, afraid of my health, depressed, crying all the time, difficult to work, cannot get the proper sleep...I Don't know how much more I can tolerate w/o major support. All I want is my life back." ZEENA QUINN, Marin.

"Though I never was electrically sensitive before, an extreme exposure to Electro Magnetic Frequencies (EMFs) from just one of PG&E's digital SmartMeters, (from 10/31/09 to 3/3/10), left me as an electrically sensitive person. ... Now, a year after the SmartMeter was removed, 30% of the symptoms still rule my life. ..."

There are numerous other comments posted about the suggested health impacts of wireless smart meters at the above site: http://emfsafetynetwork.org/?page_id=2292

Also of interest are the following excerpts from a letter sent to the CPUC judge overseeing smart meter proceedings in California:

"Approximately four hours after [the Smart Meter] ... installation ... I developed a band-like headache ... unresponsive to medication. The next morning I awoke with the headache and slight nausea. ... after I was away from my apartment, I noticed that these symptoms resolved — only to return when I was back in my apartment ... I began to have trouble sleeping and difficulty concentrating. I also experienced some transient heart palpitations.

Prior to this I knew nothing about smart meters and had no idea that they could impact human health. ... I have spent the past 22 days living out of my car, finding shelter at various friends' homes in the evening. ... I am exhausted, frightened, and do not know where to turn," Gregory (2011). Surely such testimonials indicate a need for caution and re-evaluation over the appropriateness of wireless smart meters?

Possible (inexpensive) test methods to access health risk

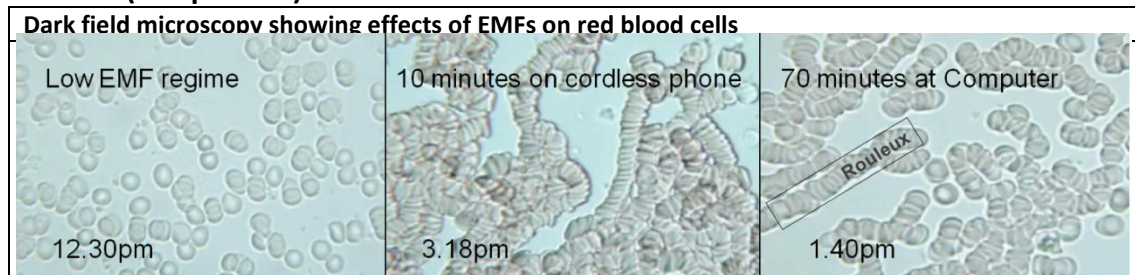


Image source: Havas (2010), <http://www.youtube/watch?v=L7E36zGHxRw>

Dark field microscopy

Dark field microscopy indicates that some electromagnetic field regimes can cause clumping of red blood cells similar to that found with cancer patients, diabetics and individuals with heart conditions (Havas 2010). Rouleaux formation (*where blood cells stack together*), which can be caused by exposure to raised field regimes, can reduce the amount of oxygen the body can use (*by reducing the red blood cells' exposed surface areas which are used for oxygen diffusion*) and is often a precursor to disease. Dark field microscopy may prove a useful, low cost, technique to help assess the potential health risks of different metering regimes.

Haemograms/Complete Blood Counts

Another way to assist determining the likelihood of any health impacts from exposures to different smart meter formats (and their related technologies) may be to undertake low cost Complete Blood Counts (CBCs) of communities (men, women and children) both before and a few months after smart meter installations – *as has been suggested for determining the possible effects of other similar (but not identical) exposure regimes from mobile phone base stations* (Next-up Organisation 2011, LLRC 2007, Mashevich 2003).

"In people who live close to relay antennas the CBC reveals noticeable changes, especially a significant drop in red corpuscles and/or white cells (leucocytes, cf leukemia, 'white blood', cancer of the white cells), an increase in lymphocytes, irregularities in the MCV and levels of hemoglobin below normal, an indicator of anemia and other problems." – Next-up Organisation (2011). Similar may prove true with regard to wireless smart meters.

It appears likely that the results of such procedures (as documented above), if undertaken for smart meters, would provide valid evidence acceptable in court on health related matters.

Health symptoms, RF/microwave radiation and dose response

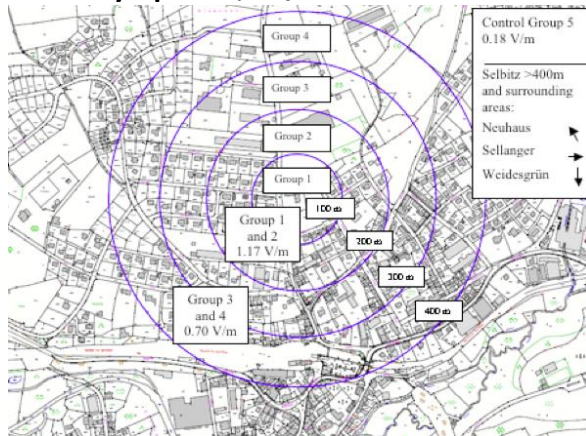


Image source: Eger & Jahn (2010).

The possibility of whether a relationship exists between RF/microwave radiation exposures and health symptoms was investigated by Eger & Jahn (2010) in relation to residential proximity to mobile phone base stations. In that work, 251 adults in Selbitz, Bavaria took part in a health survey in 2009 before the data collected was assessed (taking into account the levels of RF/microwave radiation they were exposed to from the base station and DECT phones), as determined by measurements at residential location and questionnaire. The residents were then classified into exposure groups.

A significant ($p < 0.01$) dose-response relationship was observed with the four exposure groups for: cardiovascular problems, cerebral symptoms, depression, disorders of the auditory and visual systems and gastrointestinal tract, infections, joint problems, skin problems, sleep problems as related to observed exposure levels and proximity to base station (exposure levels).

Their results demonstrate that a significant relationship can exist between individuals' mean exposure levels and reported health symptoms. Clear trends were shown for decreasing symptom scores in relation to decreasing mean RF/microwave exposure levels.

Within the framework of the Deutschen Mobilfunkforschungs-programms (German Mobile Phone Programme), the QUEBEB study (Berg et al. 2007) also investigated if health symptoms could be associated with RF/microwave exposure levels. As noted by Eger & Jahn (2010), it appears that that particular study did not find any significant relationships between exposure and health symptoms because the highest measurement found was 1 V/m, with 99% of the measurements being below 0.34 V/m. Whilst less than 1% of those in the QUEBEB study were exposed to RF/microwave radiation above 0.34 V/m, 82 out of the 251 participants in Eger & Jahn's study (32.7% of the group) were exposed to fields above 0.7 V/m.

"High exposure groups as found in Selbitz did basically not occur in the samples of the German Mobile Phone Programme. To a certain degree, this has to do with the method of random sampling and leads to a systematic underestimation of the risk for population groups with higher exposures," Eger & Jahn (2010A).

It is proposed that the protocol developed for Eger & Jahn's study might be suitably adapted to assess the possible human health impact of different types of smart meter rollouts in comparison with controls.

Many of the symptoms noted as exhibiting a dose-response relationship to RF/microwave exposure are noted in those who have submitted health complaints after some wireless smart meter installations.

Additional Health Risks

A document detailing further potential risks to health as a result of smart meters being more vulnerable to cyber attacks and natural and manmade electromagnetic pulse events was issued to the DECC and the UK Defence Committee in early 2012 (Jamieson 2012). It appears that the issues it raised have to date been ignored by DECC. **Additionally many UK smart meters are at present more likely to fail in cold weather than the units they are designed to replace due to inappropriate specification** (Jamieson 2012a). *The possible effects of this on the health and wellbeing of vulnerable members of the population have yet to be fully assessed.*

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Comments and Evidence

Possible effects of RF/microwave emissions on the health of flora and fauna Vegetation



OTLB (2011) <http://stopsmartmeters.org/2011/04/08/shrubs-dont-lie/>

In the photos above, taken 20 days apart in the USA, severe die off of the bush is noted after the installation of wireless smart meters. It was reported that none of the other plants or trees in the area (further away from the units) were affected. Similar was found in Canada after installation of a wireless smart meter (shown below). *The meter was in place less than two months at the time the photo was taken.* Prior to installation, leaves in the area where it was to be housed were green and healthy indicating (*anecdotally*) that radiation from smart meters may cause adverse effects on vegetation.



Image sources: http://www.youtube.com/watch?v=lsuP_WBBr2c, Weatherall(2011).

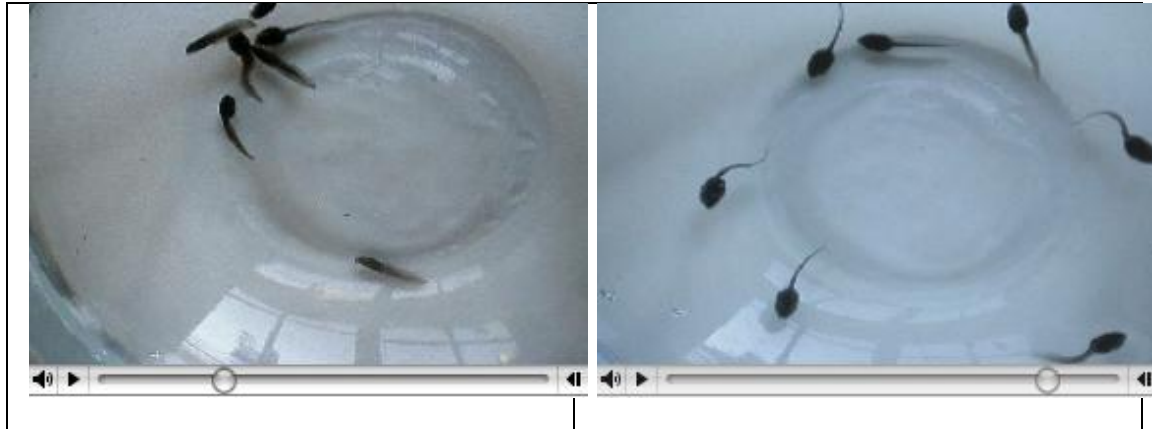
The possible validity of such conjecture is indicated in research by Roux et al. (2007), Sandu et al. (2005), Balmori (2004), Selga & Selga (1996), Magone (1996), Balodis et al (1996), Brauer (1950) – and that discussed by Firth (2010). *Some of that research indicates that RF/microwave radiation may damage vegetation, even at levels below those typically emitted by wireless smart meters.* The earliest research proving that microwaves could affect plant growth appears to have been undertaken in 1905 (Bose 1919). ***Research by Haggerty (2010) suggests that the RF/microwave background radiation may have strong adverse effects on trees.***

The use of wired smart meters, and the retention of existing meters until such problems as appear to exist are solved, would appear prudent.

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Amphibians



Videos of tadpoles exposed to antenna radiation (left) & shielded controls (right).

<http://bemri.org/component/content/article/43-heseuk/100-amphibians-eggs-and-tadpoles-of-common-frog.html> (© Balmori, A. 2008).

There is presently a drastic decline in wild amphibian populations, and an increase in the number of deformed amphibians being found (Blaustein & Johnson 2003). Balmori (2006) suggested electromagnetic pollution may have a role to play in this.

Balmori (2010) investigated whether RF/microwave emissions, at levels that could be found in the everyday environment, could affect frogs' biological development. In this study he exposed frogs' eggs and tadpoles to radiation from several mobile phone base stations at a distance of 140 m over a 2-month period. The group exposed to environmental RF/microwave fields of 1.8-3.5 V/m (n = 70) had poor coordination of movements, exhibited asynchronous growth (resulting in big and small tadpoles) and had high mortality (90%).

In comparison, the control group (n = 70) under the same conditions (with the exception of being protected from those fields by a Faraday cage), exhibited normal coordination of movements, synchronous development and only 4.2% mortality. - Refer also to the video link shown above.

These results indicate that RF/microwave radiation levels, even within current safety guidelines, may be harmful to wildlife, and that measures should be taken to reduce such emissions.

There is also the possibility (as yet apparently uninvestigated) that the drastic decline noted may in part be due to RF/microwave regimes suppressing immune system functioning, thereby allowing viruses to multiply more readily inside the body.

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Birds

Everaert & Bauwens (2007) recorded fewer male House Sparrows in areas with relatively high electric field strengths caused by RF/microwave field emitters (mobile phone base stations) than in lower field areas. Spatial variation was negatively and highly significantly related to the field strengths from such units ($p < 0.001$).

Similar findings were made by Balmori & Hallberg (2007) with regard to House Sparrows exposed to fields in the 1 MHz – 3 GHz range (*that UK wireless smart meters and appliances will operate within*). They noted reduced bird density in areas of increased field strength ($p = 0.0001$). *It is becoming increasingly reported that the dramatic decline being noted in some bird species is also partly due to falling insect numbers (Bentham 2012), which can in part be brought about by inappropriate exposure to manmade RF/microwave regimes – present authors' comment.*

Balmori (2005) had previously indicated that increased exposure to microwave radiation (as indicated by electric field intensity) may hinder the reproduction and productivity of white stork. Increased aggression of these birds was also noted under the higher field regimes. *Whilst the need for caution is apparent, further research (particularly as related to the potential effects of increased field levels that the presence of wireless smart meters and related technologies might cause) would appear warranted.*

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Insects

A growing body of scientific literature indicates that inappropriate electromagnetic field (EMF) regimes may adversely affect insects, including bees and other insect pollinators. *Greatly reduced numbers of insects would adversely affect Nature's food chain, and may partially explain reduced numbers of some bat and bird species.*

Ants

Ants perform many vital functions in the World's ecological cycle, including predation (Niemela & Laine 1986) and seed removal and dispersion (Zhou et al. 2007, Howe & Smallwood 1982). The

tasks they perform are vital for the continued survival of many crops and species. They are regarded as both 'Keystone Species' (Gove et al. 2007) and 'Ecosystem Engineers' (Sanders & Frank van Veen 2011, Zelikova, T.J. et al., 2011, Frouz & Jilkova 2008, Jouquet et al. 2006, Folgarait et al. 2002, Jones et al. 1994).

Unfortunately, it appears that ant colonies may be detrimentally affected by even very low levels of RF/microwave radiation.

Cammaerts et al. (2012), investigating the effects of exposure to simulated GSM 900 MHz radiation on ants, found that it significantly inhibited ($p = 0.016$) the ants' memories and association between food sites and encountered visual and olfactory cues. Additional physiological impacts were also observed. **The exposure level of $0.0795 \mu\text{W}/\text{cm}^2$ used was noted as being "realistic (and [of] even lower) power intensity than those usually encountered by living organisms."** [That level is far below that which can be measured from operational wireless smart meters and also below levels emitted by automatic meter reading (AMR) meters - Refer also to the BEMRI.org (2012) graphic shown at the beginning of this present document.]

The main findings of Cammaerts et al. (2012)'s research are as documented below:

- Exposed naïve (uninformed) worker ants unable to gain skill of linking encountered cues with presence of food.
- Following RF/microwave exposure, and subsequent 30 hours recovery period, ants that had been exposed could associate food and visual or olfactory cues but to a lesser degree than non-exposed ants.
- Ants that were either visually or olfactorily trained, to recognise associations between cues and food, **lost the ability to do so when exposed to RF/microwaves instead of that ability remaining unaltered.**
- Loss of association found between food and visual or olfactory cues under RF/microwave exposure.
- **Ants that were exposed completely lost their capacity to use visual cues instead of keeping part of it like the non-exposed ants.**
- RF/microwave exposure appeared to detrimentally effect ants' visual memory more than their olfactory memory.

A number of unexpected physiological impacts related to movement, feeding and brood development were also noted as a result of the 900 MHz exposures (but were unquantified by the scientific team as they had been unforeseen). These are as follows:

- Foragers proceeded more "slowly, hesitantly, often turning back or stopping instead of going quickly and directly towards their food sites or their nest entrances."
- ***Some ants displayed 'locomotor ataxia' (inability to precisely control their own bodily movements) – Refer also to Ott (1975) showing this response in ants exposed to radar.***
- The ants' food intake lessened during RF/microwave exposures.
- Ant larvae in exposed nests either ceased development or died before the end of the final test exposures. ***Some RF/microwave exposed nymphs (young ants) did not develop into callows (newly emerged workers) and were found either unchanged or dead. By comparison, the broods of every unexposed colony changed into callows and/or imagos (sexually mature insects).***
- Approximately 50 adult ants in each exposed colony, along with 1 colony's queen, were discovered dead in the foraging area. Unlike normal, other ants did not take them to colony cemeteries.

It was noted by Cammaerts et al. (2012) that the overall state of the RF/microwave exposed ant colonies appeared similar to bee colonies suffering from colony collapse disorder (CCD). They also noted that 900 MHz radiation may have a severe effect on nerve cells, and that such radiation "may have such a disastrous impact on a wide range of insects using olfactory and/or

visual memory, i.e., on bees."

It appears likely that exposure to other frequencies in the RF/microwave range emitted by smart meters and related technologies may cause similar detrimental effects.

Common fruit fly (*Drosophila melanogaster*)

Panagopoulos et al. (2004) found ***exposing common fruit fly to modulated nearfield 900 MHz GSM radiation for 6 minutes daily for the first 2-5 days of their adult lives decreased their reproductive capacity by 50%-60%***. Similar exposures with unmodulated waves were shown to cause a 15%-20% reduction. The effects of long-term exposures were not investigated.

Panagopoulos et al. (2010) further noted that ***bioactivity was greatest for intensities down to less than 10 $\mu\text{W}/\text{cm}^2$ and was still evident until 1 $\mu\text{W}/\text{cm}^2$ - a level of radiation less than that emitted by a single smart meter.***

Bees



Bee mortality after smart meter installation

Source: OTLB (2012).

Gallia et al. (2009), estimated that the total economic value of insect pollination worldwide is €153 billion (£135 billion).

It has been recognised for several decades that electromagnetic fields can influence bees' behaviour (Korall et al. 1988, Warnke 1976, Lindauer & Martin 1968). *Korall et al. (1988) noted that bursts of magnetic fields could induce jumps of misdirection in bees - they also noted ways that such problems might be avoided.*

Sharma & Kumar (2010) compared the performance of honey bee colonies either exposed or unexposed to RF/microwave radiation from mobile phones. Exposures were for 15 minutes twice a day, twice a week from February to April. ***They found a significant ($p < 0.05$) decline in colony strength and queen's egg-laying rate in those exposed. Forager bees were negatively influenced by exposure, and neither honey nor pollen was found in the exposed colony at the end of the experiment. According to the authors, the average power density experienced 8.5 $\mu\text{W}/\text{cm}^2$.***

Neelima et al. (2011), investigating the effect of short-term mobile phone radiation on adult worker honey bees found that exposure to RF/microwave radiation for up to 40 minutes altered worker bees' behaviour and physiology. Favre (2011), additionally found RF/microwave radiation from active mobile phone handsets had a dramatic effect on worker bee behaviour, principally by inducing a piping signal that announces either that a colony is disturbed or that it is going to swarm. Negative control runs using a radio did not induce changes in behaviour.

Whether the pulsed emissions from smart meters may induce jumps of misdirection, or adverse health effects in bees (*and if so how these may be remedied*), have yet to be properly assessed.

It appears that such assessments should be undertaken at the earliest possible opportunity.

Anecdotal evidence already documents reports of dead bees being found *en masse* after smart meter installations abroad (OTLB 2012).

RF/microwave radiation, alongside other contenders such as immunodeficiencies, mites and pesticides may be contributing to the dramatic decline of insect pollinators worldwide. Until such time as this might be disproved it would appear prudent to limit such emissions.

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Responses to consultation Questions

HAN Physical Layer

Summary of issue under consideration:

Wireless HAN standards can be implemented on a variety of radio frequencies and limiting the number of frequencies would simplify the specification, procurement and logistics of the supply chain. In practice there are constraints on the ability of a single frequency to operate in all GB properties and the Government has therefore considered options that achieve the required level of coverage (ability to work in GB properties) and bandwidth (ability to deliver SMETS functionality). The requirement for a wired option is also addressed.

Consultation questions

Question 5. “Do you have any comments on the criteria used in the evaluation of the physical layer of the HAN?”

Interference and security risks – this would be less of a problem with wired HAN.

Question 6. “What are your views on the compatibility of the reserved spectrum 870-876 MHz with 868 MHz and the value of considering the use of this band?”

The proposed use of this band does not appear appropriate.

Paragraph 52 states, “It should also be noted that smart meters are covered by UK and EU product safety legislation, which requires manufacturers to ensure that any product placed on the market is safe.”

According to the Guidance Notes for the General Product Safety Regulations 2005 (DTI 2005):

7.15 Where appropriate, enforcement authorities are to be guided by the **Precautionary Principle** when taking measures under the Regulations to protect consumers from unsafe products.

7.16 **The Precautionary Principle applies where there are threats of substantial, serious or irreversible harm to consumers but there is clear scientific uncertainty over the extent of the threats posed.**

It is indicated in the Comments and Evidence provided throughout this present documentation that there are “threats of substantial, serious or irreversible harm to consumers” through the roll out of smart meters and related RF/microwave technologies.

7.17 Judgements handed down by the Court of Justice (2004, 2004a) presuppose that for the Principle to apply the risk should be plausible and realistic based on the identification of potentially negative effects on health and safety and a comprehensive assessment of the risks based on the most reliable scientific data available (including international research). Where it proves to be impossible to determine with certainty the existence or extent of the alleged risk because of the insufficiency, inconclusiveness or imprecision of the results of the scientific study into the risk, but the likelihood of real harm to public health and safety persists should the risk materialise, the Precautionary Principle justifies the adoption of measures under the Regulations.

According to this, it is against product safety legislation to manufacture further products that may be unsafe to the public. The overall results of international research into biological effects of RF/microwave radiation have led to the recent classification of radiofrequency electromagnetic fields as possibly carcinogenic by the WHO/International Agency for Research on Cancer (IARC) (WHO/IARC 2011), and to the advice of the Parliamentary Assembly of the Council of Europe (PACE) to give preference to wired connections (PACE 2011).

The European Commission Communication on the Precautionary Principle (EC 2000) states: *“The precautionary principle applies where scientific evidence is insufficient, inconclusive or uncertain and preliminary scientific evaluation indicates that there are reasonable grounds for concern that the potentially dangerous effects on the environment, human, animal or plant health may be inconsistent with the high level of protection chosen by the EU.”*

For Europe there is also ‘The Consolidated Version of The Treaty on the Functioning of the European Union’ (CVTFEU 2010), which states in Article 191 (ex Article 174 TEC) that:

“Union policy on the environment shall aim at a high level of protection ... It shall be based on the precautionary principle and on the principles that preventive action should be taken, that environmental damage should as a priority be rectified at source and that the polluter should pay.”

It has already been indicated elsewhere within this current document that some RF/microwave regimes, including those created by smart meters, may cause environmental damage.

Proper risk assessment plays a key contributor to the precautionary principle. The Council of Europe / Conseil de L’Europe (2011) suggest:

“Risk assessment [should be] more prevention oriented.

- improve risk-assessment standards and quality by ... making the indication of the risk level mandatory, commissioning several risk hypotheses and considering compatibility with real life conditions;

- pay heed to and protect “early warning” scientists; formulate a human rights oriented definition of the precautionary and ALARA principles; increase public funding of independent research, inter alia through grants from industry and taxation of products which are the subject of public research studies to evaluate health risks; ...

- “... the issue of independence and credibility of scientific expertise is crucial to accomplish a transparent and balanced assessment of potential negative impacts on the environment and human health.” CE (2011).

Ensuring that smart meters, and other types of electronic technology, are ‘environmentally sound’ can create direct beneficial financial impact whilst also helping to future proof such systems. ***Such ‘best practice’ measures could be directly recouped by the UK through savings on overall healthcare expenditure and increased workforce productivity.***

The responsibility for environmental impact lies with the provider – providing impetus for proper development and the creation of World-class clean-technology products and services.

Responsibly undertaking risk assessment and investment may greatly benefit corporations and the UK, and could lead to numerous innovative solutions and technological breakthroughs that may benefit the next generations of electronic technology.

Question 7. “Do you consider that additional measures should be taken to encourage the development of an 868 MHz solution?”

No, additional measures should instead be taken to encourage the development of a wired solution that meets GB requirements.

Signals from wireless HAN can be blocked or degraded by the presence of some types of building materials. In particular, signals can often be blocked by foil-backed plasterboard (used in many buildings) and some types of foil-backed high thermal insulation. Wire mesh used in some old buildings for plaster and lath work also blocks signals. Concrete and some dense building materials too can compromise signals.

Signals can also be deliberately blocked by the use of particular materials and finishes by electrosensitives (EHS) who attempt to screen themselves and their homes from RF/microwaves which they state can often make them feel unwell.

The result of such factors is that reliable signals cannot be received in some areas, whilst increased signals can be encountered in others, **thereby raising occupancy exposure to RF/microwave radiation.**

Question 8. “Do you agree with the approach to allow the market to determine the balance between 2.4 GHz and 868 MHz? If not, please provide rationale and evidence.”

No, this would be unnecessary for a wired solution. Also allowing market forces to determine the use of these frequencies, instead of adopting wired alternatives could have considerable safety implications. See elsewhere in this present document for evidence on safety concerns.

Question 9. “What are your views on the costs and benefits of the three options identified for deploying wireless solutions (i.e. 2.4 GHz as the default; dual-band communications hubs; or market led)?”

All options identified in the above question should be avoided.

Question 10. “Do you agree with the proposal for a ‘fit for purpose’ installation obligation on suppliers?”

Yes, as long as this involves a wired solution.

Question 11. “Do you have any views on the proposed approach to developing a wired HAN solution?”

Whilst the majority of present proposals for HAN in the UK promote the use of wireless networks, one of these systems, M-Bus, can be used wirelessly (and was originally conceived as a simple wired network especially for smart meters). The wired option of M-Bus is used to create wired HAN networks in several European countries including Germany and is likely to cause fewer problems for those who are EHS.

Ideally wired options should be available to reduce risk to those who are considered particularly vulnerable to RF/microwave radiation, those who for personal reasons do not wish to be exposed to such regimes, and those who wish to optimally use smart appliances without signal degradation. Powerwatch (2010) suggest that it may be appropriate for the UK to consider

supplying smart meters that can have their wireless function disabled and allow for wired M-Bus port to be used as single screened wire connections instead of wireless. *It further suggest that as the UK forbids there being any directly wired connections to gas meters, either opto-isolated couplings (at the outside of gas meter enclosures) or short lengths of fibre-optic cables should be used as the final connection.*

HAN can be developed in a more 'biologically friendly' and environmentally friendly manner by using plastic optical fibre (POF) in every room instead of wireless or copper cabling. POF is easy to install (without the need for an electrician) and can be used for distances of up to 100 m (328 feet) - industrial glass fibre optic cables send digital signals far further but are more expensive and should only be installed by professionals. A POF system is also available which has a low voltage DC distribution system allowing digital products to be run more energy efficiently (FL 2011).

The use of fibre-optic cabling, in contrast to other alternatives, allows built-in systems to be 'future proofed' against increasing needs for bandwidths whilst helping to create 'electromagnetically clean' environments and good transmission.

It is proposed by the present authors that the use of wired alternatives, such as fibre-optic HAN, should be recommended as a 'best practice' option in HAN standards.

See also notes on fibre-optic meters at end of this present document.

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Comments and Evidence

Paragraph 171. “Smart metering security requirements cover all components of the solution and modifications to the requirements should consider inputs from all parties, ...”

Question 31: “Do you agree with the proposed approach to the governance of security requirements? If you propose alternative arrangements please provide evidence to support your views.”

Refer to text below.

Security of Supply - Vulnerability to Space Weather, Terrestrial Weather, Manmade EMP & Cyber Attack

“In a world of startling change, the first duty of the Government remains: the security of our country.”
UK Prime Minister David Cameron and UK Deputy Prime Minister Nick Clegg (HMG 2010).

Both natural and malicious manmade events can affect security of supply as can the design of smart grids, smart meters and smart appliances.

Present Risk from Space Weather

“The risks posed by space weather are known and significant, ... a severe event could potentially have serious impacts upon ... infrastructure and society more widely. It is essential that this hazard is sufficiently recognised and addressed by the Government and relevant civil bodies” ... The UK National Security Strategy (NSS) identifies space weather as a Tier 1 risk, the highest of identified “priority risks” (UK House of Commons Defence Committee 2012).

“Smart Grid electronics may introduce additional vulnerabilities if the grid is exposed to [electromagnetic pulse (EMP)] threats ... ” (Radasky 2011). The electromagnetic pulses created by solar storms – and manmade EMP events - can greatly compromise the integrity of electrical grids and damage electrical equipment and satellites. Smart meters, as they are currently designed, are more vulnerable to such threats than the analogue meters they replace and will, at present, introduce further potential points of failure into the system.

In the USA, Dr Peter Vincent Pry, former Director of the US Nuclear Strategy Forum and President of EMPact America, states “... **given our current state of unpreparedness, within 12 months of an EMP event, about two-thirds of the total population... would perish from starvation, disease and societal collapse**” (Pry 2011). *US Center for Security Policy President Frank Gaffney Jr. (former US Deputy Assistant Secretary of Defense for Nuclear Forces and Arms Control Policy), says such an event could cause 9 out of 10 deaths within a year from such factors (Gaffney Jr. 2011). No figures on potential losses appear available for the UK.*

Space Weather

“Modern society depends on high-tech systems such as smart power grids, GPS, and satellite communications - all of which are vulnerable to solar storms” (NASA 2011). “It is ... vitally important that the work of hardening ... infrastructure is begun now and carried out as a matter of urgency” (UK House of Commons Defence Committee 2012). This will require a major rethink on how smart grids and their components are designed and deployed. It is imperative that smart meters (and smart appliances) do not further increase such vulnerability.

Solar Super Storms

It is predicted by some scientists that the Sun's 11-year cycle will hit its maximum in late 2013 or early 2014. According to NASA and the US National Oceanic and Atmospheric Administration (NOAA), the Sun may be entering a particularly vicious solar maximum in 2013, similar to that in which the Solar Super Storm of 1859 (***the most powerful solar storm ever recorded***) occurred (Moskowitz 2011, NASA 2010, US NRC 2008). Phillip Chamberlin of NASA's Solar Dynamics Observatory said that ***there could be very energetic solar storms "every couple of months instead of years" during that time*** (Mosher 2011). According to Riley (2012), there is an approximate 1 in 8 chance that a solar storm of equal magnitude to the 1859 event could cause devastating disruption to electric power transmission networks within the next decade. Such an occurrence could also result in significant (and preventable) loss of life (Pry 2011, Gaffney Jr. 2011).

Scientists are already talking about the likelihood of "a black swan event" in 2012 due to increased solar activity (Telegraph 2012). According to Dr Richard Fischer (Hough 2010), director of NASA's Heliophysics Division, the next solar storm of such a magnitude hitting Earth "will disrupt communication devices such as satellites [including those used for some smart grid communications – present authors' comment] and car navigations, air travel, the banking system, our computers, everything that is electronic. It will cause major problems for the world." Such storms are already a major threat to less vulnerable (non 'smart') grid systems (Birnback 2011). The risk of such events and their potentially detrimental effects on society, is far higher than other matters normally taken into account in risk planning.

John Kappenman (NRC 2008) modeled the potential effect of exposure to a storm of similar magnitude to the great solar storm of May 1921 on the modern US power grid and calculated that over 300 large EHV transformers would be at risk of permanent damage. Marusek (2007) claims that a solar super storm aimed earthwards could cause long-term blackouts in the USA, Canada, Europe and elsewhere. ***The UK's National Grid recognise that in the event of a severe solar storm, long-term blackouts of at least two months could arise for individual damaged transformers being restored or replaced. The probability of a disconnection event under such circumstances is presently foreseen as being 62% for England and Wales and 91% for Great Britain as a whole*** (UK House of Commons Defence Committee 2012). ***The possibility of multiple solar EMP events happening over an extended period of time that might damage repaired/replaced transformers does not appear to have been taken into consideration, nor does the additional time / labour force that could be required to replace smart meters damaged by the solar EMPs.***

Avi Schnurr, Chair and CEO of the US Electronic Infrastructure Security Council, suggests that ***shorter individual power transmission lines (as found in the UK) may be at greatest risk of solar EMP.*** To back his case, he mentioned that detailed modeling in the US has indicated that densely concentrated sectors of the (US) grid were more at risk from solar EMP, and that for European power grids (of similar design to those in the UK), very large geomagnetically induced currents (GICs) had been noted for comparatively minor storm events. Whilst this is at odds with evidence presented by the UK's National Grid (UK House of Commons Defence Committee 2012), Schnurr's comments appear worth taking into consideration as the stakes are so high.

Satellites and spacecraft such as ACE, GOES, SOHO and the STEREO craft provide the main information required for forecasting solar storms. There is a risk that at least some of these may fail. Apparently, scientists are "keeping their fingers crossed" that the elderly Advanced Composition Explorer (ACE) and Solar & Heliospheric Observatory (SOHO) satellites are able to keep transmitting data on solar storms. "ACE is particularly important as it sits at the L1 point, a million miles from Earth, and is able to detect the polarity of incoming Coronal Mass Ejections (CMEs). ACE was launched in 1997 for an operational mission of three years. ... Crucially, it is a single point of failure in our ability to forecast Space Weather" (UK House of Commons Defence Committee 2012).

According to Michael Hesse, Director of the Modeling Center at the Goddard Space Flight Center, as quoted by Kerr (2009), these satellites ***“can fail any time, no one knows.”*** It was further noted by Kerr (2009) that ***“One-third of major [solar] storms arrive unheralded and almost one-quarter of the warnings turn out to be false alarms...”*** It was additionally noted in written evidence from the UK National Grid that ***“CMEs can take from 18 hours to three days to reach Earth. Forecasting models are used to decide on their trajectory and timing. NASA issue forecasts of arrival time giving a six hour window. However these forecasts are frequently inaccurate, with the actual arrival being many hours early or over a day late.”*** Present UK protective measures are ***“based to a large extent on pre-emptive action, such as shutting down equipment as a precaution, ...”*** (UK House of Commons Defence Committee 2012). **As this is the case, it appears that forecasts may fail to provide adequate warnings.**

It is predicted that upcoming solar flares could greatly endanger National Security and may take down key services such as electricity grids, electronics and communications for prolonged periods. It appears imperative that the UK protects its power grids to the best degree possible against such events. At best, such an event could cause individuals to be without electricity for hours or days. Under the worse case scenario, large areas would be without electricity for longer periods, possibly several months. Countries, and areas, with *“fragile”* grid infrastructures are likely to be affected most. **The UK House of Commons Defence Committee (2012) state that it is *“vital that the ... electrical grid is as resilient as possible to potential threats such as these. ... Government departments ... must work with National Grid to ensure that its backup procedures and equipment are sufficient to meet the reasonable worst-case scenario for a severe space weather event.”***

The present authors contend that backup plans should also take into account the possibility that it may be necessary to deal with several severe space weather events over an extended high-risk period and that additional components that are sensitive to EMP should be avoided where possible. *The present design of many high-tech devices (including smart meters) makes them more vulnerable to EMP effects than the units and technologies they replace. Transformer designs could also be improved* (Birnbach 2011, EMPrimus 2011). There is also a need to ensure that generic civil contingency plans that *“address blackouts and temporary loss of electronic infrastructure caused by a range of events”* are improved, as at present they are inadequate (UK House of Commons Defence Committee 2012).

The estimated worldwide economic cost in the first year alone after such an extreme event is \$1 trillion to \$2 trillion. *“Even a recurrence of the lesser super-storm of May 1921 could lead to blackouts affecting 130 million Americans and half of North America”* Kerr (2009). Russia and China have already been hardening their grids against such risk (Pierobon 2011).

According to Connor (2011), *the US and UK are planning to undertake “controlled” power cuts to their national electricity supplies to protect them against potential damage from large solar storms that might otherwise take months or even years to repair. However, such “controlled” power cuts can only take place if warnings are given in time and, as noted above, this is not always possible. The 1859 event, the most powerful solar storm ever recorded (which is considered to be 10 times greater in magnitude than anything observed in the last 50 years), caused shorting in the telegraph systems in North America and Europe, creating electric shocks and numerous fires (Odenwald 2000). Nowadays the effects would be far more damaging and widespread due to the increased use of electricity and more complex technology and components that are more easily damaged by EMP.*

With a possible lack of accurate forecasting, and overstretched staff, there is the real chance that there will be insufficient warning time for effective mitigative actions to be taken on some occasions when solar storms present danger, thereby further increasing grid vulnerability. **As an example of the possible suddenness of events that might occur, during the huge solar storm of 1989 in Canada operating conditions in Quebec went from normal *“to complete Province wide blackout in an elapsed time of 92 seconds”*** (Horizon 2012). For the space weather warnings that do come through before the event, *it is noted in the report by the UK House of Commons Defence Committee (2012), that for some events there may be two or three days warning and with others there may be only eight minutes notification.*

The effects that the electromagnetic pulses (EMP) of solar super storms would have on Smart Meters, smart grids and smart technologies have yet to be fully assessed. The International Electrotechnical Commission (IEC) does not yet have immunity tests covering the effects of solar storms on smart meters (Radasky 2011). It is known however that they are less robust to EMP threats than analogue meters, and that the wireless telecommunications systems that many of them operate through could be damaged by the late-time (E3) portion of High-altitude Electromagnetic Pulses (HEMP) from nuclear detonations, which exhibit strong similarities (in terms of spatial distribution and time variation) to the GIC of extreme solar storm events (Radasky et al. 2001).

Solar Storm of 1989

The geomagnetically induced currents (GICs) that the solar storm of 1989 created caused the overloading of circuits, tripping of breakers, and (in severe cases) even melted the windings on heavy-duty transformers (NASA 2010). Transformers were damaged in the USA, Canada and the UK. Satellites were also damaged – this latter fact is mentioned as some smart grids use satellites for communication which might get damaged (and even potentially fall out of orbit) as a result of future solar storms. Microwave relays too (as used in smart grid communications) are also vulnerable to damage, as are the control chips of smart technologies.



Generator step-up transformer damaged by March 1989 solar storm.

Images: Kappenman (2011). Images originally provided courtesy of Public Service Electric and Gas and Peter Balma.

The March 1989 event was of considerably lesser strength than the 1859 event (a disturbance storm time (Dst) value of -589 nT was registered in 1989 compared to a Dst of -1760 nT for the 1859 event (Lakhina et al. 2005). [The Dst index is a measure of geomagnetic activity used to assess the severity of magnetic storms. It is expressed in nanoteslas and based on the average value of the horizontal component of the Earth's magnetic field measured hourly at four near-equatorial geomagnetic observatories. *A negative value is shown when the Earth's magnetic field is weakened*].

Fortuitously, that solar storm hit in the middle of the night: if it had hit during peak load conditions, grid closure may have cascaded into the USA (Riswadkar & Dobbins 2010). It caused over 200 power anomalies in North America. These included (as previously mentioned) the blackout of the province of Québec in Canada due to a voltage depression that could not be mitigated by automated compensation equipment); melting of power transformers in New Jersey (including the failure of a transformer at a Nuclear Power Plant); voltage swings at major substations; and generators tripping and going out of service (US NRC 2008).

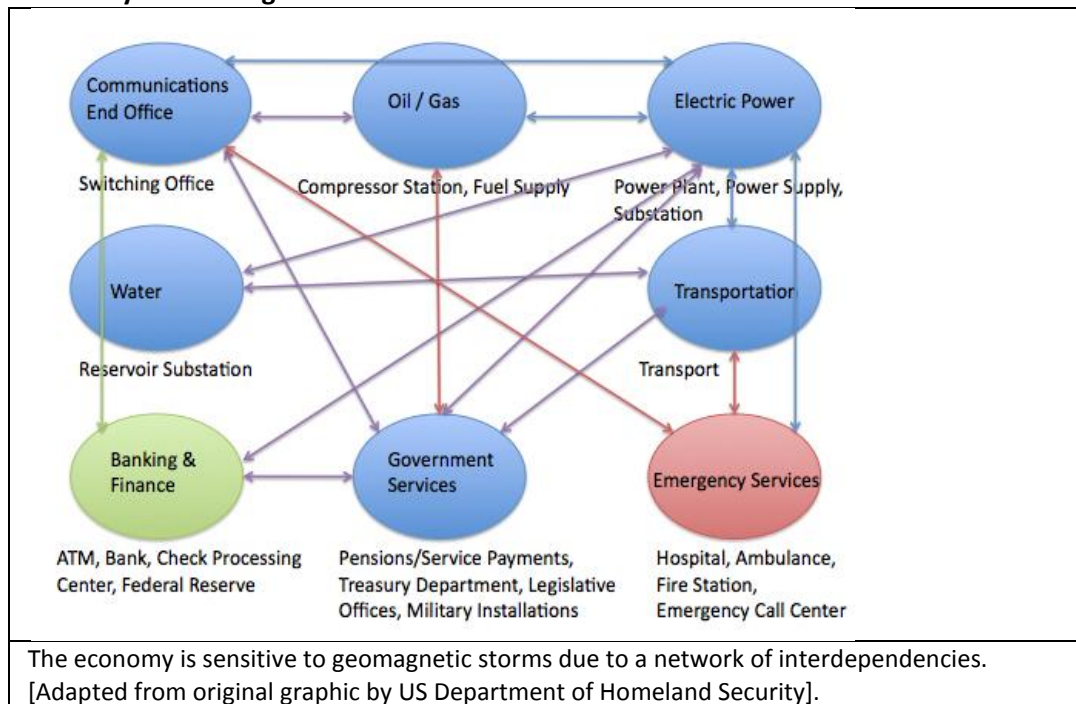
A utility firm placing a top priority order for the replacement of a damaged generator step-up transformer as a result of the 1989 event was told it would take almost 2 years to fulfill [at present there is a 3-year lead time for orders to be fulfilled (which could be greatly extended in future) if orders for replacements were high – comment by present authors]. Luckily, a spare was available which was installed within 6 weeks (Marusek 2007). Within 25 months of the March 1989 storm, 12 Nuclear Plants had transformer incidents that were suspected as being delayed failures caused by that storm

(Kappenman 2011). **The direct cost of the March 1989 solar storm was over \$2 billion [£1.245 billion]. The cost of protecting key areas of the US grid against EMP would be \$150 million [£94 million]** (Riswadkar & Dobbins 2010). The costs could be substantially greater for smart grids as a result of their additional electronics introducing increased potential EMP vulnerabilities into grid systems (Radasky 2011). Measures to reduce risk are already being put in place by governments to secure their “critical electric infrastructures” (EIS 2011, 2010).

Solar storms of equal, or greater, magnitude to that of the 1989 solar storm have occurred in 1859, 1872, 1882, 1903, 1909, 1921, 1928, 1938, 1958, 1989 (Gonzalez et al. 2011). Other solar flares of similar or greater magnitude to that experienced in the March 1989 solar storm have occurred in 2001, 2003, 2005, 2011 and 2012 (NASA 2012, 2012a, 2012b).

It appears more cost-effective to create robust EMP protected smart grids and electrical equipment now than to have to do so in retrospect. Solar events are not particularly rare (and the risk from manmade EMP, as discussed later in this document, is rising). Research now indicates that large GICs are also possible at low-latitudes as well as at high latitudes (Kappenman 2011). It appears that utility grids will need to be protected against both solar EMP and manmade EMP to comply with the International Infrastructure Security Roadmap. It is proposed that such matters should be urgently addressed.

Sensitivity to Geomagnetic Storms



The US National Research Council (NRC 2008) states, ***“Because of the interconnectedness of critical infrastructures in modern society, the impacts of severe space weather events can go beyond disruption of existing technical systems and lead to short-term as well as to long-term collateral socioeconomic disruptions.”*** As noted by Arbuthnot et al., (2010), ***“There is limited time to upgrade national electric grids to avoid solar flare-induced, global scale burn out.”*** Unfortunately such time is quickly running out with much still remaining to be done. The consequences of such an event, or series of events, should they occur, could be dire as the effects could cascade through other systems dependent, either directly or indirectly on electricity. *It is therefore vital that utility grids and meters are as robust as possible to try to withstand such potential threats.*

Distribution of drinkable water could be greatly compromised by a severe solar storm, as could cooking and food refrigeration facilities, fuel supply, heating, lighting, Internet and telephone communications, sewage disposal and transport (fuel pumps require electricity to work). Banking, government, medical treatments and emergency services could also be affected to various degrees. "The longer the outage, the more problematic, and uncertainty-fraught the recovery will be" (Foster Jr. et al. 2004). The effects of a solar super storm(s), as predicted for 2012/2013/2014, could take many years to correct and severely damage national economies. There is no room for complacency.

UK Government Expert Opinion

The UK Government is aware of the threat of solar storms and has already taken various contingency measures, including allowing some transformers to be switched off if necessary (Connor 2011). The UK Government's chief scientific adviser, when speaking at the annual meeting of the American Association for the Advancement of Science (AAAS) in Washington DC in 2011, further noted that solar storms could cause catastrophic damage to the world's economy. ***"The potential vulnerability of our systems [to space weather] has increased dramatically. Whether it's the smart grid in our electricity systems or the ubiquitous use of GPS."*** Professor Sir John Beddington (Brewster 2011).

Similar concerns were raised by The Right Honourable Liam Fox MP, when he was UK Defence Secretary, when he warned that with our heavier reliance on technology our way of life is now more at threat from such solar events than ever before (EIS 2010). To help address this matter an assessment of space weather was carried out for The UK's National Risk Register of Civil Emergencies (UK House of Commons Defence Committee 2012), this noted that ***the relative likelihood of severe space weather within the next 5 years was between 1 in 2 and 1 in 20*** (UK Cabinet Office 2012).

Whilst severe solar storms occur infrequently, they have the potential to create catastrophic long duration impacts on electricity supply and end users (US NRC 2008). Less severe storms can also cause significant damage. As smart meters are more vulnerable to stray high-energy electrical fields than the units they replace, and it appears that they may be more vulnerable to severe space weather, retaining (and reinstalling) analogue meters might be worth considering for these reasons alone.

"Severe space weather can cause disruption to a range of technologies and infrastructure, including communications systems, electronic circuits and power grids" (UK Cabinet Office 2012). Erinmez et al., (2002) noted that whilst the power transmission systems of UK's National Grid are "generally designed to operate reliably under challenges mainly related to terrestrial weather conditions ... the measures [used to increase their] robustness have also made transmission systems more vulnerable to the risk of space weather through geomagnetic storm activity."

US Expert Opinion

In similar vein to Professor Beddington, Jane Lubchenco, Head of the National Oceanic and Atmospheric Administration (NOAA), is on record as having said at the American Association for the Advancement of Science (AAAS) 2011 meeting that the US also needs to be better prepared than at present to avoid loss of electrical power and communications as a result of solar flares. She stated that ***"This is not a matter of if, it's simply a matter of when and how big. We have every reason to expect we're going to be seeing more [potentially harmful] space weather in the coming years, and it behooves us to be smart and to be prepared."***

"Many things we take for granted today are so much more prone to the effects of space weather than was the case during the last maximum," Lubchenco declared (Moskowitz 2011a). The challenge faced may increase as the World is likely to become more 'technologically dependent' as it edges towards 2013 and other periods of solar maxima – it appears wise to start 'future proofing' technology now and industry needs help from governments to do so. As noted by Tom Bogdan, Director of the US Space Weather Prediction Center, *"What's at stake are the advanced technologies that underlie virtually every aspect of our lives."* He also mentioned that forthcoming individual solar events could be particularly powerful (Lovett 2011).

These comments echo the earlier thoughts of John Kappenman at the 2008 US National Research Council workshop on the societal and economic impacts of severe space weather events (US NRC, 2008). He additionally noted that **lack of preparedness could result in “significant societal impacts and with economic costs that could be measurable in the several-trillion-dollars-per-year range.”**

Seven months after that meeting, NASA found a giant breach in the Earth’s protective shield (Phillips 2008) that will dramatically increase the impact of solar storms discussed in the report above – comment by present authors.

Need for Robust Power Grid Solutions to Space Weather

Since 1989, development of open access on transmission systems has encouraged the transport of large amounts of energy across grid infrastructures to benefit economic returns by delivering less expensive energy to areas on demand. **That rationalisation, however, taken alongside the increased likelihood of multiple equipment failures from solar events (and manmade EMP events) has increased the risk of collateral damage – sophisticated items, such as smart meters (and satellites used for smart grids), are more likely to be damaged by such events than the equipment they replace. Smart appliances too may be more easily damaged than their conventional counterparts.**

The vulnerabilities of electric grids to EMP events are now being addressed in the USA by the US National Security Working Group (NSWG 2011). Also in February 2011, US Congressman Trent Franks proposed for federal legislation the H.R. 668 SHIELD Act (Secure High-voltage Infrastructure for Electricity from Lethal Damage Act), *“to amend the Federal Power Act to protect the bulk-power system and electric infrastructure ... against natural and manmade electromagnetic pulse (‘EMP’) threats and vulnerabilities,”* (Franks 2011). Further support for increasing the robustness of the UK grid systems – as related to EMP risk – beyond what is already being achieved might prove appropriate?

Riswadkar & Dobbins (2010) propose the hardening of system and critical assets through installing circuits or passive devices to prevent, or reduce, geomagnetically induced currents (GICs) flowing into electrical grids. Both aging transformers & grid infrastructure and smart grids create mitigation challenges. The risk of solar flares to the low orbiting satellites that can be used for smart grid data transference also has to be taken into consideration, these too should be hardened, as X-class flares, which are on the increase till 2013 (Moskowitz 2011a), can cause their orbital decay.

Some locations where it is presently proposed that smart meters will be installed are more vulnerable than others. In particular, electrical grids are at greater risk from the effects of geomagnetic activity in areas where igneous rock (such as granite) is present (Odenwald 2009). [The high resistance of such rock encourages geomagnetically induced currents (GICs) to course through power lines situated above them raising risk of damage].

Shielding just 10% of critical infrastructure could reduce anticipated damage from EMP events considerably (The Sage Policy Group, 2007). The authors of this present document suggest that, as it is possible that more than one solar super storm may inflict damage during this period, ideally protection levels should be ‘As High As Reasonably Achievable’ (AHARA). Uncharted territory is being entered into where the intensity of a severe space weather event might even exceed that of the 1859 Carrington Event and lesser severe space weather events (in comparison) may also arise that may cause considerable damage and loss of life.

As noted by Professor Sir John Beddington, the UK Government’s chief scientific adviser, **“The risk we face from solar events] is slightly scary, and I think properly so. ... We’ve got to be scared by these events otherwise we will not take them seriously”** (Moskowitz 2011a).

Many of the precautions taken to protect smart grids and technology from natural EMP events will also help protect them / reduce the potential impact from manmade EMP events by rogue nations and terrorists.

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Terrestrial Weather - Smart Meters and Weather Extremes: What happens when weather is colder than smart meters can operate?

In the UK some utility meters are located indoors and others outdoors. When located indoors, the meters are normally protected from weather extremes. ***When located outdoors, smart meters may be more likely to fail or malfunction during weather extremes than the analogue meters they were designed to replace. It appears that the Smart Metering Design Group (SMDG) may have failed to fully take into consideration the need for meters to operate at the extremely low temperatures that can sometimes be encountered outdoors.***

Such malfunctioning could prove of particular concern as a result of smart meters being designed to automatically turn off electric power and gas supplies when they fail. This alone could greatly damage consumer confidence in them.

There is also the possibility that during prolonged power cuts in conditions of severe cold even indoor smart meters may fail due to the low temperatures and that additional problems (and insurance claims) may be caused by frozen / burst water pipes resultant from reinstatement being delayed. *Whether the provision of the automatic cut-off feature under such situations might lead to increased likelihood of loss of life in extreme conditions has yet to be ascertained.*

In the UK, the SMDG has stipulated that smart meters **"shall operate over a minimum temperature range of -10°C to +40°C [+14°F to +104°F]"** within the Maximum Permissible Exposure (MPE) (SMDG 2011). *Whilst the upper figure appears sensible, as the maximum temperature recorded in the UK to date is 38.5°C [101.3°F], the lower figure appears far less so, as the minimum temperature recorded there to date is -27.2°C [-17.0°F] (Met Office 2011).*

As a result of the Industry's Draft Technical Specifications (SMDG 2011) referred to above, many smart meters in the UK now have a stated operational temperature range that only goes as low as -10°C [14°F] (e.g. Landis+Gyr 2008). ***This shortfall in specification - as related to temperature extremes - could prohibit them working, or greatly reduce their reading accuracy, when they are exposed to even lower temperatures.***

There are many instances where UK temperatures have dropped greatly below -10°C. As an example from quite recent times, very low temperatures – *for the UK* - (and significant snowfalls) occurred in November and December 2010. As noted by the Met Office (2012) talking of that period, *"Temperatures*

widely fell below -10 °C [14°F] on several nights and on occasion [in some places] below -20 °C [-4°F]...".
Refer also to the following link indicating how widespread significant temperature drops can be in the UK:
http://www.metoffice.gov.uk/climate/uk/interesting/dec2010/tmin_031210.jpg

Lowest daily minimum temperature records in UK per country			
Country	Location	Date	Temperature
Scotland	Braemar (Aberdeenshire)	11 Feb 1895	-27.2°C (-17.0°F)
		10 Jan 1982	
	Altnaharra (Highland)	30 Dec 1995	-27.2°C (-17.0°F)
England	Newport (Shropshire)	10 Jan 1982	-26.1°C (-15.0°F)
Northern Ireland	Castlederg (County Tyrone)	24 Dec 2010	-18.7°C (-1.7°F)
Wales	Rhayader (Powys)	21 Jan 1940	-23.3°C (-9.9°F)

Source: Met Office (2011).

In the past, extremes in temperature were shown to cause an earlier generation of smart meters to malfunction (Frontier Utilities 2012), *it would therefore appear prudent to check smart meter operational abilities under worse case extreme weather scenarios at the earliest possible opportunity.*

• *In the UK, England, Scotland, Northern Ireland and Wales have all experienced daily minimum temperatures below the -10°C [14°F] that UK smart meters are designed to operate down to.*

Often smart meters which are located outdoors are unenclosed, or when they are enclosed, the design of the units containing them is insufficient to prevent their exposure to temperature extremes.

"The largest source of long-term errors in the meter is drift in the preamp, followed by the precision of the voltage reference. Both of these vary with temperature as well, and vary wildly because most meters are outdoors. Characterizing and compensating for these is a major part of meter design," Wikipedia (2012a).

There appears to be a very real risk that extreme low weather temperatures may cause many existing smart meters to malfunction, or cease to supply power as a result of potential automatic disconnects.

The effects of weather extremes need to be considered to a far greater degree in the design of utility meters. As there appears to be little published research on the effects of extreme cold on smart meter functioning, reference is made to other research carried out on digital technologies. As an example, in a study undertaken at Environ Laboratories in Minneapolis, **digital technology was shown to start to fail at temperatures of -12.2°C [10°F], with most devices tested failing at -40°C [-40°F]** (Popular Mechanics 2009).

In addition to electrical equipment not functioning properly in weather extremes, it can also become damaged. *Such findings reinforce the need for the effects of extreme low weather temperatures on smart meter operation to be investigated further at the earliest possible opportunity for the benefit of the public and utilities alike.*

As recent research by Greene & Monger (2012) indicates that the likelihood of more severe winters is increasing, the need for the right type of meter to be specified is paramount.

Smart meters, if/where installed, should be allowed to fail in a "supply on" mode – a measure that may save many lives. Their likelihood of causing overbilling during extreme weather conditions should also be properly assessed.

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Practicality, Security, War, Terrorist or Cyber-Attack

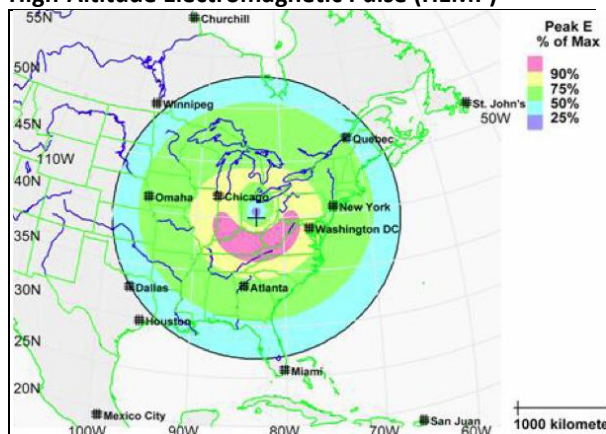
"If the world's industrial countries fail to devise effective ways to defend themselves against dangerous electronic assaults then they will disintegrate within a few years" UK House of Commons Defence Committee (2012).

If EMP vulnerabilities remain unaddressed they will present increased invitations for attack (Graham et al. 2011). *It appears prudent to reduce such risks wherever practical rather than adding to them by inappropriate design, component and/or operation specification.* Sleep walking into the future could rapidly lead to nightmare scenarios.

As noted by William R. Graham, Chairman of the US Commission to Assess the Threat to the United States from Electromagnetic Pulse Attack, *"A serious national commitment to address the threat of an EMP ... can lead to a national posture that would significantly reduce the payoff for such an attack ..."*

Manmade EMP Events

High-Altitude Electromagnetic Pulse (HEMP)



Source: Kappenman (2011).

“Several potential adversaries have or can acquire the capability to attack the United States with a high-altitude nuclear weapon-generated electromagnetic pulse (EMP). A determined adversary can achieve an EMP attack capability without having a high level of sophistication. EMP is one of a small number of threats that can hold our society at risk of catastrophic consequences. EMP will cover the wide geographic region within line of sight to the nuclear weapon. It has the capability to produce significant damage to critical infrastructures and thus to the very fabric of... society, as well as to the ability of the United States and Western nations to project influence and military power.” Commission to Assess the Threat to the United States from Electromagnetic Pulse Attack (Foster Jr. et al. 2004).

The term HEMP is often used for EM signals created from a nuclear detonation interacting with the Earth’s upper atmosphere. ***EMP can cause “temporary upset and even catastrophic failure to modern electronics and electrical systems over considerable geographic areas of the Earth”*** (NATO 2011).

HEMP Components

HEMP Type	Intensity	Time to reach intensity
E1	50,000 V/m	≤ 10 ns
E2	100 V/m	1 microsecond - 1 second
E3	40 V/km	1 - several hundred seconds

Source: Radasky (2011).

E1 and E3 HEMP are indicated as being the greatest threat to power systems. As noted by Radasky (2011), ***“as more Smart Grid electronics are placed in substations, these E1 HEMP fields become a significant concern to their performance. Also the placement of new Smart Grid communication antennas and electronics in substations should consider the threat of E1 HEMP. ... E1 HEMP will also couple efficiently to aboveground medium and low voltage power lines that are typical for the distribution grid and also to the low voltage drop lines to homes or businesses.”*** ***Burial of distribution line reduces EMP risk – and can also provide additional health benefits*** (comment by present authors).

Radasky (2011), also notes that for ***“the shorter drop lines to homes, levels on the order of several hundred kV are possible that could seriously damage solid-state Smart Meters.”*** *Additionally, it is often seen as impracticable to protect wireless systems (such as used in Smart Meter systems – present authors’ comment) against EMP attack.* The US National Security Working Group (NSWG 2011), notes ***“... vintage type electronic systems are much more robust and tolerant to EMP effects. The bad news is that these systems are growing old and must be replaced, and they will be replaced with modern versions that are inherently more vulnerable to EMP.”***

Source Region Electromagnetic Pulse (SREMP)

These are caused as a result of nuclear detonation, such as can be created by an air-burst EMP cruise missile, interacting with the Earth’s and its adjacent atmosphere. A single SREMP event could cause irreparable damage to most electronics within a 30 km (18.6 mile) area (Powerwatch 2010). **Power supplies for large areas of a smart grid could be easily disabled by such devices unless suitable precautions are taken - as a matter of best practice smart meters should be designed to fail in a “supply on” mode.** *The vulnerability of electronic smart meters to such events appears far greater than that of the electromechanical rotating-disk meters they are designed to replace which are unlikely to be damaged by such events.*

Non-Nuclear EMP (NNEMP) / Intentional Electromagnetic Interference (IEMI)



NNEMP Level EMP Source. Source: Kappenman (2011).

Non-Nuclear EMP (NNEMP) is also known as Intentional Electromagnetic Interference (IEMI) and is labeled as the "Intentional malicious generation of electromagnetic energy introducing noise or signals into electric and electronic systems, ... disrupting, confusing or damaging these systems for terrorist or criminal purposes," (IEC 2005).

Extremely powerful portable radio transmitters (which can be mobile and coordinated) can be built to create NNEMP. Its effects are similar to solar threats and HEMP but are usually more localised, unless a coordinated attack is undertaken (where they could create effects far larger than those achievable by large nuclear EMP pulses). The additional electronics used to create smart grids and related smart technologies, including smart meters, may increase system vulnerability. As noted by Radasky (2011), "... **the IEMI threat to Smart Meters, distribution electronics, substation electronics, substation communications, control rooms and power generating facilities (including wind and solar facilities) is the same as for the E1 HEMP.**" This matter needs to be urgently addressed.

NNEMP/IEMI present a comparable risk scenario likelihood to that of Cyber Attack (Kappenman 2011). They pose a serious threat to medium and high voltage transformers and smart grids. **Technical solutions are being created to address such threats** (Birnbach 2011, Radasky & Savage 2010), **but do not yet appear to have been applied to smart meters.**

Close Range EMP

"There is no protection on a smart meter against a EMP (Electro Magnetic Pulse) which could be as simple as a coil of wire and a battery at close range. It could blow the electronics in the meter or simply change memory bits which might change the rate figures or readings. It could also trigger the electric cut off circuit and allow burglars to cut your power even if your breaker box is locked" (Electron 2011).

Power Surges

A recent sustained power surge in California appears to further indicate the increased susceptibility of smart meters to such events compared to the conventional analogue meters they replace (Dremann 2011). In that incident 80 PG&E SmartMeters caught fire and burned out after the power surge, causing some residents and utilities officials to question their safety. **The surge, which lasted 80 minutes, affected 200 homes and businesses. None of the analogue meters were affected.**

"The idea with SmartMeters is to make the customers' and the utility's life better, but this is a good example of how sometimes the old way is the good way," Debbie Katz, spokesperson for Palo Alto utilities. Katz further commented that **the advantage of the analogue meter over its intended 'smart' replacement is that it does not have internal electronics which can be shut down or disrupted by power surges** (Dremann 2011). At that time Palo Alto city officials were seeking to undertake additional research and investigative work to ensure smart meter shortfalls and glitches were resolved before investing further in them. On 21st February 2012 Palo Alto Municipal Utility District decided to reject smart meter deployment at the present time. It was the 50th Californian local government body to do so (OTLB 2012).

Measures should be taken to ensure that smart meters, if deployed, are robust enough to withstand the technical challenges documented above – present authors' comment.

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Preventing Natural and Manmade EMP Catastrophes

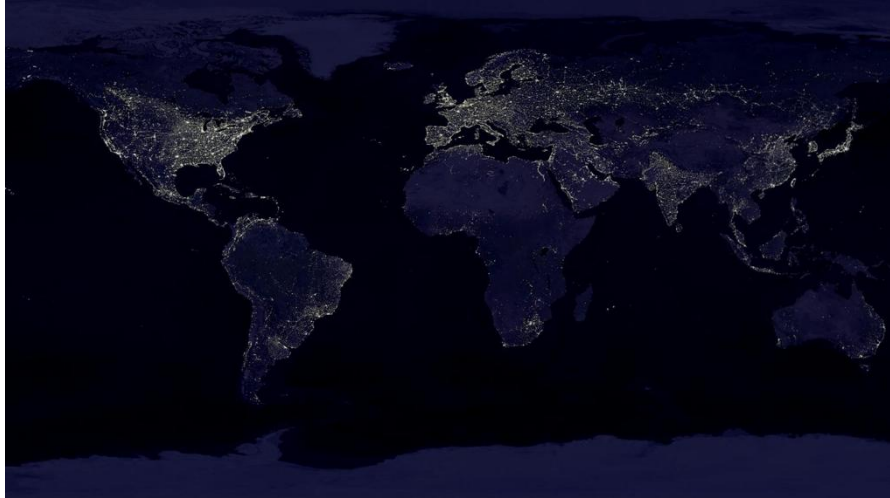


Image source: NASA

Smart grids create more potential points of failure from EMP than traditional grids. Ideally, protective measures should be considered early in the brief and applied before rollout. Cost effectiveness is essential (EMPrimus 2011, Koepke 2010). ***It is possible through robust planning to prevent EMP catastrophes. Action is required sooner rather than later for protecting smart grids, smart meters and smart appliances, and could create numerous opportunities for investment and the development of new sustainable technologies.***

At present there are no procedures to “perform “black start” [restoring a power station to operation without requiring use of using the external power grid] under severe damage scenario,” as these require energy and telecom transport that are power dependent (Graham et al. 2011). ***It is recognised that if substantial numbers of transformers fail the restart of the grid will be more complicated*** (UK House of Commons Defence Committee 2012). ***Problems will be further exacerbated if meters also fail due to inappropriate non-EMP resilient design.***

Power grids, meter systems and related technologies should be designed where practical to prevent / reduce likely adverse effects from EMP.

Recommendations (partial listing as related to EMP – various authors)
• Adhere to the Electric Infrastructure Security Council (EIS) International Infrastructure Security Roadmap (EIS 2011).
• Determine grid and network level vulnerabilities & prioritise actions.
• Improve forecasting ability for EMP events.
• Protect important infrastructures and “high value” assets through appropriate design measures - including hardening.* “High value” assets include essential government operations and those of other national institutions.
• Grid-level protection systems should be installed to protect against EMP threats to transformers.
• Harden smart grid infrastructures and related technologies against EMP risk.*
• <i>Delay rollout of additional smart meters till after main period of solar risk if unhardened. Ideally also harden against risk of manmade EMP attacks and allow retention of analogue meters.</i>
• Develop regional and national smart grid restoration plans and survival plans for populations.
• Provide Government endorsement & tax incentives for required work.

<ul style="list-style-type: none">• Undertake “controlled” power cuts when necessary to protect grid.
<ul style="list-style-type: none">• Identify & address regulatory gaps that preclude effective mitigation.
<ul style="list-style-type: none">• Manufacture robust essential components for infrastructure, such as large transformers, within UK – <i>this may greatly help shorten recovery periods and create extra jobs.</i>

*If budget does not stretch to automatically protecting Smart Meters in this way, individuals should be allowed to retain or have analogue meters reinstalled.

“The technology to protect critical infrastructures from natural or malicious electromagnetic threats now exists. Implementation costs are estimated at less than 0.01% of GNP. For example, costs for protection of the U.K. electric grid are estimated at approximately £ 0.1B EIS (2010). Since much of this cost would in any case be incurred for normal periodic upgrade and modernization, the net costs are even lower.” Arbuthnot et al. (2010).

Recovery periods are shortened as level of grid protection increases (Birnbach 2011). Significant, affordable improvements can be made to prevent, prepare, protect and recover from EMP events (Graham et al. 2011). It is anticipated that the costs of EMP protection may in part be compensated by reduced insurance costs (Birnbach 2011).

“If addressed, our reduced vulnerability helps deter attack, enhances infrastructure resilience and confers added protection against cyber threats and damaging geosolar storms.”

Commission to Assess the Threat from High Altitude EMP (Graham et al., 2011).

Certain measures, such as a widespread changeover to fibre-optic data and signal cabling, may greatly increase system robustness to EMP threats (Cikotas & Kappenman 2011) and also open up other streams of revenue (Fehrenbacher 2009) – the hardening of such systems will further increase their attractiveness to investors.

Cyber Security

“... it is quite possible that a nation state might launch ... [a cyber-attack targeting smart meters to switch off a country’s electricity supply] during a time of international tension. A second possibility is a terrorist organisation. A third possibility could be environmental activists; ... A further possibility is a criminal, who switches off a number of an energy company’s meters and threatens widespread havoc unless a ransom is paid. ... Yet another angle is the possibility of criminal energy theft ...” The introduction of smart meters create significant new cyber-vulnerabilities. (Anderson & Fuloria 2010).

The UK National Security Council now recognises cyber-attacks as a Tier One threat – the highest priority for UK national security (HMG 2010, AEPN 2010).

Experts at the IEEE Smart Grid Comm 2010 conference warned that consumers and utilities’ infrastructures are becoming more vulnerable to cyber-attack due to the increased security vulnerabilities and the two-way communication of smart grids as compared to existing systems. They predict that the smart grid will present up to 440 million possible points to be hacked by 2015 (Schwartz 2010). The US Department of Energy also recognise shortfalls in the cyber security plans (US DOE 2012).

It is recognised by the US Government Accountability Office (US GAO) and the US Department of Energy (US DOE) that the transition to smart grids is opening electric grids open to increased cybersecurity weaknesses that risk damaging their efficient operation (US DOE 2012, US GAO 2011, Mills & LaMonica 2010). ***It has already been claimed that hackers from a major foreign country have reconnoitered the US electricity grid possibly seeking to discover exploitable***

systemic vulnerabilities such as those presented in present smart meter systems (Anderson & Fuloria 2011).

In 2009 cyber security analyst **Morgan Wright, when leading the Global Public Safety and Homeland Security Program at CISCO Systems, claimed that having the US electric grid standardised on a single platform, instead of a more distributed layered model, had caused a lot of cyber vulnerabilities and that its operating system had been hacked into by foreign state sponsored spies. He further claimed that when they gained access they scoped out vulnerabilities and control systems and may have left backdoors in place, remote control devices, or things they could activate at a later date to carry out set tasks such as shutting down or redistributing the nation's power** (Wright 2009). The same may be true in the UK.

Blackout Attacks

One of the gravest scenarios is that of “a ‘cyber-nuke’ [through the smart meters] that would reduce ... [a country's] population to destitution. Recovery from such an attack would be painful [loss of life may also be high – present authors' comment]. As a matter of national survival, the government would probably authorise any electrician or other competent person to short-circuit dead meters. Utility contractors might need to spend a year or more visiting every house to rekey or replace them” (Anderson & Fuloria 2011). This risk does not exist with analogue meters.

Network security experts state that once a hacker gains access to the smart grid he/she may gain control “of thousands, even millions, of [smart] meters and shut them off simultaneously.” Individual hackers may also be able to substantially raise or lower power demand, disturbing the local power grid's load balance and creating a blackout. They also state that **such outages would “cascade to other parts of the grid, expanding the blackout,” with no one being able to predict the possible scale of such damage** (Meserve 2009).

There is a high cost to blackouts, the Northeast Blackout of 2003 in North America cost \$3 billion (£1.86 billion). A coordinated attack on the grid “could lead to even more significant economic damages” (ICFC 2003). The cost of precautionary and protective measures are far less. **“As the nature of our technology becomes more complex, so the threat becomes more widespread. ... However advanced we become, the chain of our security is only as strong as its weakest link”**, the Rt. Hon. Dr. Liam Fox MP when UK Defence Secretary (Fox 2010).

The development of appropriate solutions to realistic threats to security of supply should be carried out before further large-scale smart grid rollouts are undertaken. “Without securely designed smart grid systems, utilities will be at risk of not having the capacity to detect and analyze attacks, which increases the risk that attacks will succeed and utilities will be unable to prevent them from recurring,” (US GAO 2011).

Unnecessary National Security risks should be avoided/reduced wherever possible. The present installation of remote off-switches for smart meters further increases risk of blackouts - ideally Smart Meters should be designed to fail in the ‘on’ mode to reduce this risk. This safety measure would also be in accord with Human Rights laws in Europe which stop defaulters simply being disconnected (Anderson & Fuloria 2010a).

Manipulation of Smart Grid Data

Electricity theft is a cause of great concern to utility companies, and already there are devices existing that allow smart meters to be altered remotely to register less energy consumption than actually used (Wisniewski 2012, Mills & LaMonica 2010). Assistant Professor Le Xie of Texas A&M University notes that **it is likely that some attackers could be virtual traders seeking to benefit financially through intercepting and manipulating smart grid data to place safe bets on**

energy demands (Schwartz 2010).

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Security Issues related to privacy

In the UK, the Smart Metering Equipment Technical Specifications and the Draft Communications Data Bill fail to adequately address privacy issues related to smart meter communications data. The UK Government presently wishes to introduce smart metering into all UK homes by 2019 and wishes to access all smart metering information. ***This highly intrusive plan would allow it access to highly detailed information on all individuals' lifestyles and whatever they are doing in their homes in real time (as well as through historical load data collected with such systems).*** *Such a proposition appears extremely intrusive and completely unwarranted.*

"... if the data protection rights of consumers are not sufficiently taken into account, then their acceptance of the new technology will be lacking, which could lead to its unsuccessful implementation," Knyrim & Trieb (2011).

Unlike conventional meters that measure total energy use through day and night tariffs (which are normally read four times every year), smart meters allow energy use to be read with far finer granularity. **The UK industry's draft technical specifications for smart meters state a requirement for real time information every 5 seconds for electricity and every 30 minutes for gas (SMDG 2011).** *The intended access to, and retention of, such data by the UK Government appears to be in direct contradiction to EU Privacy Law and Human Rights legislation* (Anderson & Fuloria 2010).

Built In Security of Home Area Networks

The US GAO states that *"increasing the use of new system and network technologies can introduce new, unknown vulnerabilities. ... our experts stated that smart grid **home area networks** ... **do not have adequate security built in, thus increasing their vulnerability to attack.**"* To counter such risks, over \$30 million (£18.62 million) has been awarded to address these cyber-security and reliability issues (Schwartz 2010). Even with such massive funding, some experts still express grave concerns (Mills & LaMonica 2010) and it is recognized that cyber security plans can often be incomplete or lack sufficient detail (US DOE 2012). *It appears the same risks exist in the UK. Smart meters being hacked could result in local and widespread disruptions, sensitive facilities being 'taken out', loss of data privacy (including information on the types of equipment individuals own, building occupancy patterns and identity theft).* Loss of data privacy may also arise from data collected by smart meters through non-intrusive appliance load monitoring being sold by utilities to third parties unless appropriate safeguards are put in place (Quinn 2009).

Electrical Appliances

Every electrical appliance has its own energy fingerprint readable by smart meters. Those accessing such information from smart meter data, either legally or illegally, have indications of the appliances individuals have and how often they use them, raising numerous security issues.

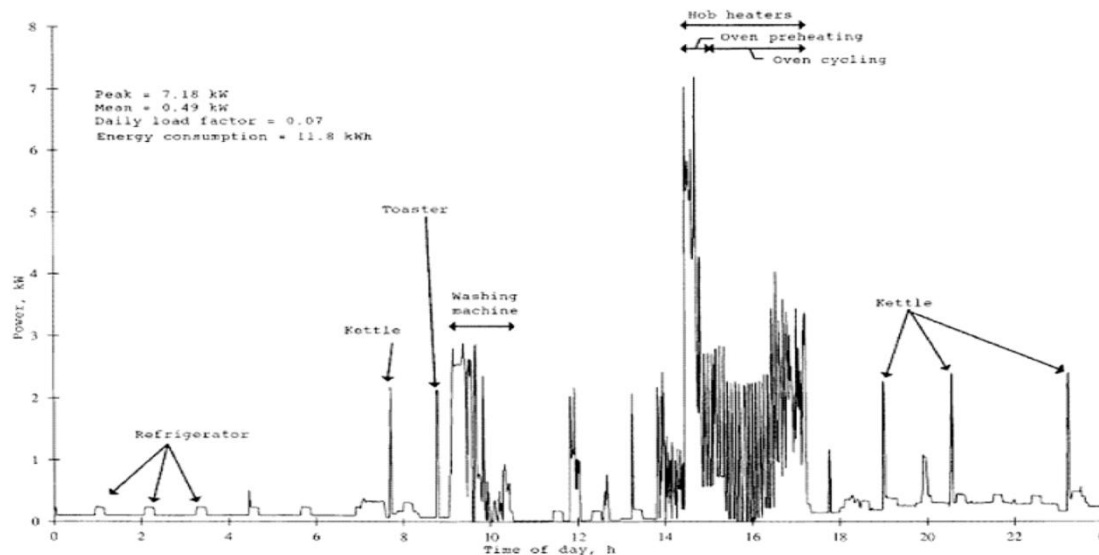


Image source: Newborough & Augood (1999).

The analogue meters the UK Government currently seeks to replace with smart meters are unhackable. The hacking of smart meters by criminals, rogue nations and terrorists could result in loss of customer data privacy (including information on the types of equipment individuals own, lifestyle information, building occupancy patterns and identity theft), plus local and widespread power disruptions and sensitive facilities being 'taken out' (Chalk 2012, Jamieson 2012, Mills & LaMonica 2010, Peev 2012, Stop Smart Meters! (UK) 2012, Woolsey 2011).

"We ... have the technology to record ... (energy consumption) every minute, second, microsecond, more or less live... From that we can infer how many people are in the house, what they do, whether they're upstairs, downstairs, do you have a dog, when do you habitually get up, when did you get up this morning, when do you have a shower: masses of private data. ... We think the regulator needs to send a strong signal to say that the data belongs to consumers and consumers alone. We believe that's a blocker to people adopting the technology," Martin Pollock of Siemens Energy, quoted by Wynn (2010).

Real time surveillance of all homes – a privacy issue

Paragraph 3 of Section 13.10 of DECC Impact Assessment (IA) DECC0009 (DECC 2012) declares, *"The availability of data to suppliers, particularly at a half-hourly level, raises some potential privacy issues."* **The requirement for provision of data at 5-second intervals (SMDG 2011) raises for even more cause for concern – comment by present authors.** This taken alongside the ability of technology to infer what members of the general public are doing in real time in parts of their own homes, and store data collected on what they have done in the past, represents a true threat to privacy and democracy.

As noted by Quinn (2009), ***"high resolution electricity usage information can be used to reconstruct many intimate details of a consumer's daily life ... [there are many ways], that information could be used in ways potentially invasive of an individual's privacy."***

Parties wishing smart meter data?	Potential use (partial listing)
Utilities	Efficiency analysis, monitoring of electricity usage & load for forecasting & bills
Electricity usage advisory companies	To promote energy conservation & awareness measures
Insurance companies	Determining health care premiums based on unusual behaviours, that might indicate illness
Marketers	Profiling for targeted advertisements

Law enforcers	Identifying suspicious or illegal activities
Civil litigators	Determining when home occupied, by how many parties & activities undertaken
Landlords	To verify lease compliance
Private investigators	Monitoring for specific events
The Press	Information on famous individuals' movements & lifestyle
Creditors	Determination of behaviour that might indicate creditworthiness
Criminals	To identify the best times for burglary or to identify high-priced appliances to steal

Original source: SGIP (2010).

It was recently shown at the 28th Chaos Computing Congress (28c3) hacker conference that hacking into a smart meter could in, addition to identifying activity patterns in homes (including whether they were occupied) and the types of equipment being used, even allow identification of the movies being played by occupants. They stated that the security encountered was poor and the data resolution the meters provided was too high (Wisniewski 2012) – ***as is the case with UK smart meters.***

Smart grid privacy issues			
Privacy threat		Service required	Existing protection mechanisms
Network threats	Shallow packet inspection	Anonymity	Anonymity networks
	Deep packet inspection	Confidentiality	Encryption
Data usage threats	Unauthorised usage/access	Access control	Policies, legislation, secure storage
	Customer privacy	Customer control of customer data	

Original source: Sooriyabandara & Kalogridis (2011).

Whilst undertaking robust measures to anonymise smart metering data and remove recognisable appliance load signatures would help to address privacy concerns (for some) according to (Efthymiou & Kalogridis 2010, Kalogridis et al. 2010, Meserve 2009) - ***existing analogue meters are far better at protecting individuals' privacy*** (comment by present authors).

Smart meters being hacked could result in local and widespread disruptions, sensitive facilities being 'taken out', loss of data privacy (including information on the types of equipment individuals own, building occupancy patterns and identity theft). The adoption of smart meters can make the countries that use them considerably more vulnerable to hacking and expensive cyber terrorism and electromagnetic pulse threats (Jamieson 2012, Mills & LaMonica 2010, Peev 2012, Stop Smart Meters! (UK) (2012), Woolsey 2011). ***Cyber security expert David Chalk (2012) states that there is a "100% certainty of a total catastrophic failure of the entire energy grid within 3 years" creating a scenario "worse than nuclear war."*** ***Such comments indicate the need for caution and an urgent reconsideration of policy.*** [Additionally, it is now becoming recognised that the use of smart meters may not necessarily save energy (Hargreaves 2010) and can cause symptoms of ill health (Jamieson 2011) - *the RF/microwaves they normally emit during operation are now regarded as being possibly carcinogenic to humans* (WHO/IARC 2011)].

As noted by the Rt. Hon. Dr. Liam Fox MP, when he was Defence Secretary, ***"As the nature of our technology becomes more complex, so the threat becomes more widespread. ... However advanced we become, the chain of our security is only as strong as its weakest link."***

Smart Meter data & Human Rights as related to privacy

European Convention of Human Rights

"it [is] imperative that proper consideration is given to individuals' fundamental rights to privacy," EC (2011). Under EU Data Protection Law, consumers' rights to privacy *"may not be overridden"*.

A court in the Netherlands has already determined that the mandatory collection of non-essential fine-grained smart meter data – such as the UK seeks to collect - is against Article 8(1) of the European Convention of Human Rights. That ruling has led to mandatory smart meter installation being halted in the Netherlands (Cuipers & Koops 2008, metering.com 2009). **However, even where policy exists for voluntary acceptance of Smart Meters, the individual's right to privacy would be breached whenever they are present in other locations where smart meters are present and their privacy is breached.**

A report by the University of Tilburg for Consumentenbond (the Netherlands' main consumer organisation) concluded that **smart meters could give away sensitive information that might fall into the hands of third parties (including police and insurance companies) on consumers' energy usage habits, including when individuals' leave and return to their homes (which could also be particularly useful to burglars).** *It further stated that the insights these intelligent monitoring devices would provide into living patterns and relationships could affect individuals' freedom to do as they please within their own homes and therefore be in breach of the European Convention of Human Rights* (Cuipers & Koops 2008).

In the UK, Which?, the product-testing and consumer campaigning charity, is also calling for a halt to the smart meter rollout consumer over a number of issues and concerns including data security (Which? 2012).

United Kingdom

UK - Human Rights Act 1998

The Human Rights Act 1998 is based on the European Convention of Human Rights. ***It is one of the most important statutes ever passed in the UK*** (Hoffman & Rowe 2010).

Article 3 - Prohibition of torture

"No one shall be subjected to torture or to inhuman or degrading treatment or punishment" (HRA 1998).

The European Court defines 'degrading treatment' as "... such as to arouse ... feelings of fear, anguish and inferiority, capable of humiliating and debasing... and possibly breaking... physical or moral resistance," (IUK 1980).

As noted by Hoffman & Rowe (2010), *"...all people have a level of basic respect and dignity as human beings." Prohibiting them enjoying proper privacy in their own homes through smart monitoring and surveillance of devices they use and personal timings they keep is potentially demeaning and degrading to both self-respect and dignity.*

Article 8 - Right to respect for private and family life

1. "Everyone has the right to respect for his private and family life, his home and his correspondence." (HRA 1998).

In the Draft Communications Data Bill (2012) the following is declared, *"It is well established that ... communications are covered by the notion of private life and correspondence in Article 8(1) [of the Human Rights Act 1998]."*

The case of *Malone v UK* (1984) 7 EHRR 14 (paragraphs 83 to 88) provides some limited guidance on the application of Article 8 to State activities concerning communications data: “.... **a meter check printer registers information that a supplier ... may in principle legitimately obtain [data]**, notably in order to ensure that the subscriber is correctly charged or to investigate complaints or possible abuses of the service. **By its very nature, metering is therefore to be distinguished from interception of communications**, which is undesirable and illegitimate in a democratic society unless justified.”” Emphasis added by present authors.

The above quotation from the Draft Bill appears to **incorrectly** imply that the use of **fine-grained** smart meter data obtained in such a fashion is therefore justified, desirable and legitimate. This appears misguided, particularly as such data can reveal so much about individuals’ private lives to third parties without their express consent being given.

Paragraph 5 of Section 13.10 of the DECC0009 document (DECC 2012) appears to take a similar relaxed attitude over the use of fine-grained data declaring: “We have also committed to the principle that consumers should have a choice about how their data is used and by whom, **except where it required to fulfil regulated duties.”**

The UK Government presently seeks to access to all UK metering information, every half hour with gas and every 5 seconds with electricity through smart meter readings from every UK household (SMDG 2011). This taken alongside the ability of technology to infer what members of the general public are doing in real time in parts of their own homes, and store data collected on what they have done in the past, represents a true threat to privacy and democracy.

The access to lifestyle information the Draft Bill and the UK industry’s draft technical specifications for smart meters seek to allow is inconsistent with EU privacy law and, as mentioned previously, has already been successfully contested in the Netherlands (Cuipers & Koops 2008).

It appears that claims that “economic benefits outweigh the rights of those affected” could be disputed related to: the right for individuals to be able to enjoy their property in the manner to which they have become accustomed, as this may become compromised by having details of their private activities and peaceful use of possessions logged and accessible to third parties.

“Respect for home and home life means more than just providing some form of dwelling or shelter: it extends to maintaining the situation to which a person has become accustomed, and the very permanence of which gives comfort,” (Hoffman & Rowe 2010).

2. “There shall be no interference by a public authority with the exercise of this right except such as is in accordance with the law and is necessary in a democratic society in the interests of national security, public safety or the economic well-being of the country, for the prevention of disorder or crime, for the protection of health or morals, or for the protection of the rights and freedoms of others,” (HRA 1998).

Article 8 may be violated through the potential weakening of “national security, public safety or the economic well-being of the country” by the introduction of smart meter technology and excessive data harvesting by the authorities and other parties if the Draft Bill is passed. It appears highly likely the UK would experience the potential weakening of national security, public safety, economic well-being, increased disorder and crime, risk to health and morals, and diminution of the protection of the rights and freedoms of others through the roll out of smart meters and related technologies (Jamieson 2012, 2011).

Article 14 - Prohibition of discrimination

“The enjoyment of the rights and freedoms set forth in this Convention shall be secured without discrimination on any ground such as sex, race, colour, language, religion, political or other opinion, national or social origin, association with a national minority, property, birth or other status,” (HRA 1998).

It may be contested that data derived from smart meters, and other data recording and transmitting devices, may be used for discriminatory purposes by third parties. Possible examples include insurance companies that may determine health care premiums based on what they *perceive* to be unusual occupational lifestyle behaviours, and creditors making determinations on behaviours they *perceive* might indicate creditworthiness (SGIP, 2010).

The First Protocol

Article 1: Protection of property

“Every natural or legal person is entitled to the peaceful enjoyment of his possessions. No one shall be deprived of his possessions except in the public interest and subject to the conditions provided for by law and by the general principles of international law,” (HRA 1998).

The preceding provisions shall not, however, in any way impair the right of a State to enforce such laws as it deems necessary to control the use of property in accordance with the general interest ...”

The “peaceful enjoyment of ... possessions”, and the right for individuals to be able to enjoy their property in the manner they have become accustomed to (such as being able to use their possessions as they have in the past [without worries about outsiders gaining unprecedented knowledge of their personal habits]), may be compromised through inappropriate and unwarranted data harvesting and retention and use of such data by the authorities and others.

Possible risks to property that would be increased through the use of smart metering include: data hijacking that could allow thieves to determine the types of electronic equipment individuals’ possess (as a result of their unique electronic signatures) and also thieves gaining knowledge of when buildings are unoccupied. It is proposed by the present authors that the introduction, or escalation, of such risks, through measures proposed in the Draft Bill, are contrary to the general interest.

United Nations Convention on the Rights of the Child as related to privacy

All UN member states, with the exception of the US and Somalia, have formally approved it. These rights apply equally to every child, and came into force in the UK on 15th January 1992 (UNICEF 2012).

Background

The UN Convention on the Rights of the Child (CRC) stipulates what children (specified in the Convention as all those under the age of 18) require to “*survive, grow, participate and fulfil their potential.*”

“The CRC is the most complete statement of children’s rights ever produced and is the most widely-ratified international human rights treaty in history. It enshrines specific child rights in international law, defining universal principles and standards for the status and treatment of children worldwide,” UNICEF (2012).

UN Convention on the Rights of the Child (United Nations 1989)

Article 16

- 1. No child shall be subjected to arbitrary or unlawful interference with his or her privacy, family, home or correspondence, nor to unlawful attacks on his or her honour and reputation.**
- 2. The child has the right to the protection of the law against such interference or attacks.**

The surveillance monitoring of children's activities within customers' homes, that would occur through the use of fine grained data collection obtained from smart metering technologies, is in direct contravention of Article 16 of that Convention.

"Human rights must be part of all policy making," UK Department for Constitutional Affairs (DCA 2006).

Smart meters - Freedom or Oppression?

"Digital information and communication technology offers the possibility of a new world of freedom. It also offers possibilities of surveillance and control which dictatorships of the past could only struggle to establish. The battle to decide between these possibilities is being fought now," Stallman (2010).

At present in addition to seeking "real time" data through smart meters, the UK Government is seeking to gain new powers to monitor all UK email, phone and web use in "real time" at a potential cost of £2 billion to UK citizens (BBC News Politics 2012). **In its present format, the smart metering system that the UK Government wishes to impose on its citizens, and the present Draft Communications Data Bill's (covert) aim of accessing and data harvesting its communications data at the expense of hard won civil liberties, is ill conceived and would leave the nation vulnerable on many levels – comment by present authors.**

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Comments and Evidence

Smart Meters as related to Human Rights in General

There is increasing talk worldwide of individuals coming together to pursue Human Rights claims related to smart meters and related RF/microwave emitting devices. Where possible, it is desirable to be aware in advance of the type of claims that may be made so that suitable measures can be taken to reduce the need for such recourse. It is vital for all concerned that potential Human Rights issues related to smart metering are properly addressed.

European Convention of Human Rights

Article 8(1) of the European Convention of Human Rights

In 2009, the Dutch government retreated on its former position of making smart meters compulsory in all homes. The Dutch Minister of Economic Affairs, Maria van der Hoeven, had intended that refusing installation of a smart meter would be punishable by either a €17,000 (\$23,053) fine or six months in prison. She now backs the installation of such units being voluntary (metering.com, 2009), but this does not deal with the issue of individuals' rights being breached where they are exposed to the emissions and data logging of smart meters others have.

The Dutch Government's proposed mandatory rollout of smart meters was opposed by privacy watchdog groups and consumer organisations, including Consumentenbond (the Netherlands' main consumer organisation) which commissioned a report into the matter by the University of Tilburg (Cuipers & Koops 2008).

That report concluded that smart meters could give away sensitive information that might fall into the hands of third parties (including police and insurance companies) on consumers' energy usage habits, including when individuals' leave and return to their homes (which could be particularly useful to burglars). **It also stated that the insights these intelligent monitoring devices would provide into living patterns and relationships could affect individuals' freedom to do as they please within their own homes and therefore be in breach of the European Convention of Human Rights.**

The UK appears to have failed to have adequately addressed these and other Human Rights issues related to smart metering, a number of which are outlined below:

UK - Human Rights Act 1998

This Act is based on the European Convention of Human Rights and is recognised as one of the most important statutes ever passed in the UK (Hoffman & Rowe 2010). **Human rights are required to be part of all UK policy making (DCA 2006).**

Article 2 - Right to life

1. *"Everyone's right to life shall be protected by law. No one shall be deprived of his life intentionally save in the execution of a sentence of a court following his conviction of a crime for which this penalty is provided by law."*

Right to Life: All EU States agree that the human embryo/fetus belongs to the human race (Hoffman & Rowe 2010). As research indicates that some RF/microwave regimes (at levels lower than current limits) may raise risk of infertility, miscarriage, and cause damage to both animal and human offspring (Davoudi et al. 2002, Falzone et al. 2011, Agarwal et al. 2009, De Iuliis et al. 2009, Mailankot et al. 2009, Santini et al. 2002, Cherry 2000, Magras & Zenos 1997); claims might be brought in the UK that increasing involuntary exposures to such regimes may be against individuals' and embryos' right to life.

As shown in the case of LM & R v Switzerland (LMRS 1996), Article 2 is relevant in situations where health may be put at risk, and is not restricted to risk of death or actual death. The results of an online survey, which investigated occurrence of detrimental health effects reported after smart meter installations abroad, is shown below:

Health & Smart Meter safety survey (SDA 2011)	
Condition	Detrimental effects
Sleep problems	49.1%
Stress, anxiety, irritability	43.1%
Headaches	40.9%
Ringing in the ears	38.1%
Concentration, memory or learning problems	34.6%
Fatigue, muscle or physical weakness	34.3%
Disorientation, dizziness, or balance problems	25.8%
Eye problems, including eye pain, pressure in the eyes, blurred vision	33.0%
Cardiac symptoms, heart palpitations, heart arrhythmias, chest pain	25.8%
Leg cramps, or neuropathy	19.2%
Arthritis, body pain, sharp, stabbing pains	18.2%
Nausea, flu-like symptoms	17.3%
Sinus problems, nose bleeds	14.5%
Respiratory problems, cough, asthma	13.8%
Skin rashes, facial flushing	12.6%
Urinary problems	8.8%
Endocrine disorders, thyroid problems, diabetes	8.8%
High blood pressure	7.2%
None of the above	8.8%
Other	30.5%
I don't know	24.8%

*The figures reflect whether individuals or members of their homes experienced health impacts (n = 318).

When authorities are aware (or should be aware) of real risk to life they are under obligation to take appropriate mitigative action to protect those at risk (Hoffman & Rowe 2010). Taking into account the health effects reported abroad from wireless smart meters (American Academy of Environmental Medicine 2012, KCRA 2011, SDA 2011), it appears that (if installed) some systems may be a cause of real risk to life and health in the UK.

Environmental Pollution: Incidents of environmental pollution can also be regarded as being in violation of Article 2 (LMRS 1996). **The case of Guerra v Italy (GI 1998) demonstrates that Article 2 can apply to situations where environmental quality may be at risk.**

Anecdotal and peer-reviewed scientific evidence already exists indicating that RF/microwave emissions - even at levels below those be emitted by single smart meters - may cause environmental damage and be highly detrimental to birds, insects and vegetation (Cammaerts et al. 2012, Favre 2011, Neelima, et al. 2011, OTLB 2011, Balmori 2010, 2007, 2006, 2005, 2004, Firth 2010, Panagopoulos et al. 2010, Sharma & Kumar 2010, Weatherall 2010, Gallia et al. 2009, Everaert & Bauwens 2007, Tkalec et al. 2007, Roux et al. 2007, Sandu et al. 2005, Panagopoulos et al. 2004, Blaustein & Johnson 2003, Balodis et al 1996, Magone 1996, Selga & Selga 1996, Korall et al. 1988, WHO 1986, Warnke 1976, Lindauer & Martin 1968, Brauer 1950, Bose 1919).

Article 3 - Prohibition of torture

"No one shall be subjected to torture or to inhuman or degrading treatment or punishment" (HRA 1998).

Article 3 embodies a fundamental human right. ***"... the right to freedom from bodily harm is second only to the right to life, and is equally based on the right which all people have a level of basic respect and dignity as human beings,"*** (Hoffman & Rowe 2010).

The European Court defines 'degrading treatment' as *"... such as to arouse ... feelings of fear, anguish and inferiority, capable of humiliating and debasing... and possibly breaking... physical or moral resistance,"* (IUK 1980). These appear very similar to descriptions provided by some electrohypersensitive (EHS) individuals describing how their condition makes them feel.

As noted by Hoffman & Rowe (2010), *"...all people have a level of basic respect and dignity as human beings."* Prohibiting them enjoying proper privacy in their own homes through smart monitoring and surveillance of devices they use and personal timings they keep is potentially demeaning and degrading to both self-respect and dignity.

It appears from NTSM (2002) that Article 3 also covers living conditions, and that when/if violations are proved, the inconvenience and cost of rectifying matters is placed on the State.

The adverse effects apparently created by exposure to emissions from some types of smart meters may, if proven to exist, prove very expensive to the UK economy.

Article 5 - Right to liberty and security

1. *"Everyone has the right to liberty and security of person. No one shall be deprived of his liberty save in the following cases and in accordance with a procedure prescribed by law. ..."* (HRA 1998).

Under Article 5, the rights of vulnerable individuals may be violated if emissions from smart meters and other forms of electronic technology prevent them from being able to go where they wish (even in their own homes and gardens) unhindered by man-made electromagnetic field regimes detrimental to their well-being.

As shown by ethical hackers in Germany (Leyden 2012), and as warned about by the FBI (SSM UK! 2012), GCHQ (Peev 2012) and former CIA Director James Woolsey (Woolsey 2011), the smart grid represents a threat to security of not just the individuals in a smart metered property, but to the grid itself. Any attempts to legislate away risk through more punitive measures on hacking offenders (instead of reducing risk) would be doomed to fail as the threats are very real and criminals and rogue nations tend not to pay attention to statutory provisions by definition.

Article 8 - Right to respect for private and family life

1. *"Everyone has the right to respect for his private and family life, his home and his correspondence."* (HRA 1998).

In the Draft Communications Data Bill (2012) the following is declared, "It is well established that ... communications are covered by the notion of private life and correspondence in Article 8(1) [of the Human Rights Act 1998]."

The case of *Malone v UK* (1984) 7 EHRR 14 (paragraphs 83 to 88) provides some limited guidance on the application of Article 8 to State activities concerning communications data: ***".... a meter check printer registers information that a supplier ... may in principle legitimately obtain [data], notably in order to ensure that the subscriber is correctly charged or to investigate complaints or possible abuses of the service. By its very nature, metering is therefore to be distinguished from interception of communications, which is undesirable and illegitimate in a democratic society unless justified."*** Emphasis added by present authors.

The above quotation from the Draft Bill appears to **incorrectly** imply that the use of ***fine-grained*** smart meter data obtained in such a fashion is therefore justified, desirable and legitimate. This appears misguided, particularly as such data can reveal so much about individuals' private lives to third parties without their express consent being given.

Paragraph 5 of Section 13.10 of the DECC0009 document (DECC 2012) appears to take a similar relaxed attitude over the use of fine-grained data declaring: *"We have also committed to the principle that consumers should have a choice about how their data is used and by whom, **except where it required to fulfil regulated duties.**"*

The UK Government presently seeks access to all UK metering information, with gas and electricity meter readings to be taken from every UK household. **The UK industry's draft technical specifications for smart meters state a requirement for real time information *every 5 seconds* for electricity and every 30 minutes for gas (SMDG 2011).** This taken alongside the ability of technology to infer what members of the general public are doing in real time in parts of their own homes, and store data collected on what they have done in the past, represents a true threat to privacy and democracy.

The access to lifestyle information the Draft Communications Data Bill and the UK industry's draft technical specifications for smart meters seek to allow is inconsistent with EU privacy law and, as mentioned previously, has already been successfully contested in the Netherlands (Anderson & Fuloria 2010, Cuipers & Koops 2008).

It appears that claims that *"economic benefits outweigh the rights of those affected"* could be disputed related to: the right for individuals to be able to enjoy their property in the manner to which they have become accustomed, as this may become compromised by having details of their private activities and peaceful use of possessions logged and accessible to third parties.

Additionally, individuals may seek to claim that the unwarranted introduction of electromagnetic pollution from smart meters may reduce the capital value of their homes (*some individuals abroad are already being forced to relocate in an attempt to escape such exposures*).

With Guerra v Italy (1998), the European Court found the state guilty of failing to take 'positive steps' to provide essential information pertaining to matters in hand as related to environmental pollution. The Court also determined that environmental pollution may *"affect individuals' well-being and prevent them from enjoying their homes in such a way as to affect their private and family life adversely, even without seriously damaging their health,"* (Hoffman & Rowe 2010). Refer also to the results from the Health & Smart Meter safety survey (SDA 2011) shown earlier in this present document.

The right for people to be able to enjoy their property in the manner to which they have become accustomed can become severely compromised by RF/microwave emissions from smart meters making them feel unwell. **Some may claim that the installation of wireless smart meters and wireless smart technology is an actionable nuisance**, the radiation from which interferes with their right to peacefully enjoy their possessions (*including parts of their homes and their gardens*). It is already documented that wireless smart meters prevent some individuals using parts of their homes in order to avoid/reduce adverse health effects (EMFSN 2011, Gregory 2011, Havas 2011).

"Respect for home and home life means more than just providing some form of dwelling or shelter: it extends to maintaining the situation to which a person has become accustomed, and the very permanence of which gives comfort," (Hoffman & Rowe 2010).

2. "There shall be no interference by a public authority with the exercise of this right except such as is in accordance with the law and is necessary in a democratic society in the interests of national security, public safety or the economic well-being of the country, for the prevention of disorder or crime, for the protection of health or morals, or for the protection of the rights and freedoms of others," (HRA 1998).

It may be claimed by some that Article 8 may be violated through the potential weakening of “*national security, public safety or the economic well-being of the country*” unless certain precautions are undertaken – *Refer to sections on ‘Security of Supply’ and ‘Health Matters’ in Jamieson (2012, 2011).*

Article 12 - Right to marry

“Men and women of marriageable age have the right to marry and to found a family, according to the national laws governing the exercise of this right,” (HRA 1998).

Claims may be brought if the emissions from technology being employed in some smart meters and related technology are proven to reduce human fertility and increase risk of miscarriage thereby hindering individuals’ right to found a family. Peer-reviewed research by Falzone et al. 2011 found that 1 hour exposure to 900 MHz radiation caused significant reduction in human sperm head areas versus controls and noted a significant decrease in sperm binding compared to controls – *their results indicated that RF/microwaves could have a significant effect on sperm fertilisation potential.* A pilot study by Agarwal et al. (2009) also revealed a significant reduction in sperm motility and sperm vitality as a result of exposure to such radiation. Additionally, Santini et al. (2002) found a significant loss in libido for subjects within 100m of a base station ($p < 0.05$).

Tests by Davoudi et al. (2002) on men who had normal spermiogramms revealed that increased exposure to RF/microwaves was indicated as possibly reducing sperm motility by 32.3% ($p = 0.01$). Additional research by De Iuliis et al. (2009) found RF/microwave exposed human spermatozoa exhibited significantly reduced sperm motility and vitality. Significantly elevated DNA fragmentation and mitochondrial generation of reactive oxygen species were also found to occur after exposure ($p < 0.001$). De Iuliis et al. (2009) concluded that there were “*clear implications for the safety of ... [increased RF/microwave exposures to] males of reproductive age, potentially affecting both their fertility and the health and wellbeing of their offspring.*”

Dramatically reduced birth rates in the UK - as might result from increased RF/microwave exposures due to the roll out of wireless smart meters - would cause a declining young labour force, crucially undermining the UK’s economic viability and increasing the burden of supporting the ill and elderly per capita.

Exposure to many types of smart meter and smart appliance would considerably increase RF/microwave radiation indoors 24/7.

Article 14 - Prohibition of discrimination

“The enjoyment of the rights and freedoms set forth in this Convention shall be secured without discrimination on any ground such as sex, race, colour, language, religion, political or other opinion, national or social origin, association with a national minority, property, birth or other status,” (HRA 1998).

It may be contested by some, particularly those with EHS, that the widespread introduction of some types of RF/microwave emitting smart meters (and related wireless emitting technology) may be discriminatory, as it would interfere with their basic rights and freedoms. **Others who also found their health detrimentally effected as a result of smart meter roll outs might also claim that they were being discriminated against.**

It may be additionally contested that data derived from smart meters, and other data recording and transmitting devices, may be used for discriminatory purposes by third parties. Possible examples include insurance companies that may determine health care premiums based on what they perceive to be unusual occupational lifestyle behaviours, and creditors making determinations on behaviours they perceive might indicate creditworthiness (SGIP, 2010).

Prohibition of discrimination and Section 149 of the Equality Act 2010

The UK Government is subject to the public sector Equality Duty set out in Section 149 of the Equality Act 2010 that came into force on 5 April 2011 (UK Government 2011). It requires public bodies to consider *all* individuals when shaping policy and delivering services. *It also requires public bodies to have due regard to the need to eliminate discrimination and advance equality of opportunity.* Under Section 149 of the Equality Act Ministers and the Department are under a legal duty to have 'due regard' to the need to eliminate unlawful discrimination, harassment and victimisation.

See above.

Health concerns

On 2nd February 2012, in answer to a Parliamentary question by Guto Bebb MP, the Secretary of State for Energy and Climate Change acknowledged that there were questions related to concerns about the potential health effects of smart meters and stated that people were legally entitled to refuse smart meters if they wished (Hansard 2011).

Partially as a result of this, and the concerns of other MPs, members of the public and NGOs, a consultation process (which included a workshop on the 'Potential health concerns linked to smart metering') was co-organised by DECC and Consumer Focus to provide input into the Programme. Whilst earlier work by DECC had recognised the need to ensure that "*risks to vulnerable consumers in relation to installations are minimised,*" ***none of the significant health concerns raised during that consultation are acknowledged or addressed in the present DECC0099 Impact Assessment (DECC 2012) or the current Smart Metering Implementation Programme Consultation on the second version of the Smart Metering Equipment Technical Specifications.***

This is a serious omission, particularly as substantial documentation (including details of peer-reviewed research indicating serious potential health risks and discrimination of vulnerable individuals, as related to metering provisions, had been provided both to the UK Government and DECC.

Failure to take such matters into account properly greatly weakens the validity and credibility of the DECC and UK Government smart metering consultation process, and potentially breaches Article 14 of the Human Rights Act 1998 and Section 149 of the Equality Act 2010.

Under Section 149 of the Equality Act:

A public authority (or person who is not a public authority but exercises public functions) must, in the exercise of functions, have due regard to the need to eliminate discrimination, harassment and victimisation.

Electrohypersensitive (EHS) individuals may in the future claim that they are being discriminated as a result of being exposed to unwarranted additional exposure to RF/microwave radiation from smart meters, smart appliance and related devices. As documented in roll-outs overseas, many other individuals may also raise similar claims.

Energy suppliers are subject to Section 29 of the Equality Act 2010.

Provision of services, etc.

*Under Section 29, service-providers must not discriminate against individuals, as related to the terms on which they provide their service, **or subject them to any other detriment.** Services providers under Section 29 are also not allowed to harass, victimise or cause detriment to either individuals requiring the service or those to whom they provide the service in relation to the provision of such services.*

Taking into account strong (and growing) public opposition to smart meter roll outs overseas, it appears likely that claims of harassment and victimisation may in future be brought against UK services providers.

The First Protocol

Article 1: Protection of property

“Every natural or legal person is entitled to the peaceful enjoyment of his possessions. No one shall be deprived of his possessions except in the public interest and subject to the conditions provided for by law and by the general principles of international law,” (HRA 1998).

“The preceding provisions shall not, however, in any way impair the right of a State to enforce such laws as it deems necessary to control the use of property in accordance with the general interest ...”

1). The “peaceful enjoyment of ... possessions”, and the right for individuals to be able to enjoy their property in the manner they have become accustomed to (*such as being able to use their possessions as they have in the past [without worries about outsiders gaining unprecedented knowledge of their personal habits]*), may be compromised through inappropriate and unwarranted data harvesting and retention and use of such data by the authorities and others.

Possible risks to property that would be increased through the use of smart metering include: data hijacking that could allow thieves to determine the types of electronic equipment individuals’ possess (as a result of their unique electronic signatures) and also thieves gaining knowledge of when buildings are unoccupied. It is proposed by the present authors that the introduction, or escalation, of such risks, through measures proposed in the Draft Communications Data Bill (2012) and current smart meter specifications are contrary to the general interest.

2). The “peaceful enjoyment of ... possessions”, and the right for individuals to be able to enjoy their property in the manner they have become accustomed to (*such as having access to rooms in their homes and their gardens without feeling unwell*), may be compromised through some smart meter and smart technology regimes.

Refer also to: Smart Meter Health Impacts Testimonials in Jamieson (2011) or at the following EMF Safety Network link: http://emfsafetynetwork.org/?page_id=2292

Under English Law, the term ‘property’ includes buildings, land and animals owned by individuals (Hoffman & Rowe 2010).

Some smart meter regimes may cause individuals to be deprived of other possessions, including flora and fauna (*through creating inappropriate field regimes that may instigate their die-off*) – there is additionally the prospect that this deprivation may be caused through the presence of neighbouring smart meters even when an individual household has refused installation of smart meters itself.

The Council of Europe (CE 2011) draft resolution has already recorded concerns over “*the potentially pathogenic effects observed in livestock – calves, cows, horses, geese, etc. ... [and] unaccountable deformities of new-born calves, cataracts, fertility problems,*” that may be caused by RF/microwave radiation from mobile phone base stations. **The possible effects of emissions from wireless smart meters and related technologies that emit such radiation have yet to be properly assessed.**

The effects on individuals’ livelihoods of proposed metering schemes should be seriously taken into consideration. This appears to be a very good instance where the Precautionary Principle should be applied.

United Nations Convention on the Rights of the Child

These rights apply equally to every child, and came into force in the UK on 15th January 1992 (UNICEF 2012).

Background

The UN Convention on the Rights of the Child (CRC) stipulates what children (specified in the Convention as all those under the age of 18) require to “*survive, grow, participate and fulfil their potential.*”

“The CRC is the most complete statement of children’s rights ever produced and is the most widely-ratified international human rights treaty in history. It enshrines specific child rights in international law, defining universal principles and standards for the status and treatment of children worldwide,” UNICEF (2012).

UN Convention on the Rights of the Child (United Nations 1989)

Article 1

For the purposes of the present Convention, a child means every human being below the age of eighteen years unless, under the law applicable to the child, majority is attained earlier.

Article 2

1. States Parties shall respect and ensure the rights set forth in the present Convention to each child within their jurisdiction without discrimination of any kind, ...

Article 3

1. In all actions concerning children, whether undertaken by public or private social welfare institutions, courts of law, administrative authorities or legislative bodies, the best interests of the child shall be a primary consideration.

2. States Parties undertake to ensure the child such protection and care as is necessary for his or her well-being, ...

3. States Parties shall ensure that the institutions, services and facilities responsible for the care or protection of children shall conform with the standards established by competent authorities, particularly in the areas of safety, health, ...

It is proposed that exposing children to increased levels of RF/microwave radiation, a recognised Class 2B carcinogen (WHO/IARC 2011), may be unwise, particularly as safer alternatives are available. Resolution 1815 of the Council of Europe calls for all reasonable measures to be taken to reduce exposure to electromagnetic fields, particularly RF/microwaves (PACE 2011).

The allowed exposure levels in the UK are substantially higher than those permitted in many other countries, including Austria, China, Bulgaria, Italy, Poland, Switzerland and Russia. **If the Precautionary Principle was adopted, in line with Resolution 1815 of the Council of Europe and various charters that the UK is signed up to (refer to Appendix 3 of Jamieson (2011) for further details), it is likely that the UK limits would be substantially lower.**

Article 6

1. States Parties recognize that every child has the inherent right to life.
2. States Parties shall ensure to the maximum extent possible the survival and development of the child.

Refer to comments on Article 2 of the UK - Human Rights Act 1998 discussed earlier.

Article 12

1. States Parties shall assure to the child who is capable of forming his or her own views the right to express those views freely in all matters affecting the child, the views of the child being given due weight in accordance with the age and maturity of the child.
2. For this purpose, the child shall in particular be provided the opportunity to be heard in any judicial and administrative proceedings affecting the child, either directly, or through a representative or an appropriate body, in a manner consistent with the procedural rules of national law.

Article 14

3. Freedom to manifest one's ... beliefs may be subject only to such limitations as are prescribed by law and are necessary to protect public safety, order, health or morals, or the fundamental rights and freedoms of others.

Article 16

1. No child shall be subjected to arbitrary or unlawful interference with his or her privacy, family, home or correspondence, nor to unlawful attacks on his or her honour and reputation.
2. The child has the right to the protection of the law against such interference or attacks."

The surveillance monitoring of children's activities within customers' homes (*that would occur through the use of fine-grained data collection*) obtained through smart metering technologies, is in direct contravention of Article 16.

Article 19

1. States Parties shall take all appropriate legislative, administrative, social and educational measures to protect the child from all forms of ... injury or abuse, neglect or negligent treatment, maltreatment or exploitation, ... while in the care of parent(s), legal guardian(s) or any other person who has the care of the child.

Article 23

1. States Parties recognize that a mentally or physically disabled child should enjoy a full and decent life, in conditions which ensure dignity, promote self-reliance and facilitate the child's active participation in the community.
4. States Parties shall promote, in the spirit of international co-operation, the exchange of appropriate information in the field of preventive health care ...

Research indicates that increased exposure to RF/ microwaves at levels well below those the HPA presently consider may provide cause for concern, and even below levels of radiation emitted by single smart meters, may be detrimental to health - Refer to Jamieson (2011).

Article 24

1. "States Parties recognize the right of the child to the enjoyment of the highest attainable standard of health ..."
2. States Parties shall pursue full implementation of this right ... taking into consideration the dangers and risks of environmental pollution; ...

3. States Parties shall take all effective and appropriate measures with a view to abolishing traditional practices prejudicial to the health of children.

Increased exposure to a recognised Class 2B carcinogen (RF/microwave as emitted by smart meters and related technologies) may be considered to be detrimental to children's health and therefore contrary to the requirement of Article 24.

Article 37

States Parties shall ensure that:

(a) No child shall be subjected to torture or other cruel, inhuman or degrading treatment or punishment.

The prohibition of children's full enjoyment of proper privacy in their own homes as a result of smart monitoring and surveillance is potentially cruel, inhuman, demeaning and degrading.

Additionally, children who are Electrohypersensitive (EHS) may find mandatory 24/7 exposure to RF/microwave emissions from smart meters and related technologies which makes them feel unwell, and/or possibly restricts their actions, cruel and degrading.

Article 42

States Parties undertake to make the principles and provisions of the Convention widely known, by appropriate and active means, to adults and children alike.

"Human rights must be part of all policy making,"

UK Department for Constitutional Affairs (DCA 2006).

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Comments and Evidence

Fibre-optic metering - a forgotten alternative

As RF/microwave radiation is now classified as a Class 2B carcinogen (WHO/IARC 2011), it may prove prudent to consider the adoption of wired instead of wireless metering for the sake of the environment, health and wellbeing of the nation. Such a move would additionally be in line with the Parliamentary Assembly of the Council of Europe's recommendation that electromagnetic emissions should be "as low as reasonably achievable" (ALARA) (PACE 2011).

Not all smart grids are wireless. Some utilities companies have already opted for fibre-optic cabling for their primary communication needs.

Practicality of Fibre-optics

The high up-front costs of smart grids present financial challenges (*as do those of broadband projects*). Whilst utility companies use only a small amount of the broadband capacity that they put in to support smart grid applications, a strong case can be given for investing in that capacity to increase revenue potential, particularly if they choose to do so in an environmentally-friendly manner.

As proposed by Kennedy (2011), if utilities were to lease very high bandwidth 'future friendly' fibre-optic capacity to providers of general broadband services; they, the general broadband providers, and their customers would all benefit. This would allow more broadband projects to become economically viable and lower prices for broadband customers – a true 'Win/Win' situation. **Additionally, in situations where fibre-optics have already been put in by broadband providers, they could lease bandwidth to the utilities and avoid the need for wireless smart meter connections.**

The ruggedness of fibre-optic cables can provide tremendous benefits over their competitors. They are very secure, non-corroding, immune to water damage, electromagnetic and radiofrequency interference, difficult to damage (when in steel armoured cables or in underground conduit), and are more reliable than their competitors during poor weather and catastrophic events. They also have longer service lives – fifty years plus - and lower maintenance costs (Kennedy 2011, Fehrenbacher 2009).

With longer service lives, lower maintenance costs, additional potential revenue streams, extra bandwidth for future requirements, and a greater degree of ruggedness than their competitors; fibre-optics can bring tremendous benefits to smart grids and utilities companies over their competitors. Whilst the costs of fibre-optic and copper cables are similar at present, the price of copper cabling is likely to become more expensive, particularly as networking requires faster speeds and greater bandwidths.

As noted by Fehrenbacher (2009), "Some cities ... have decided to build out their own [fibre-optic] networks, largely to use it as a way to boost economic prosperity in their regions, delivering jobs and high-speed connections for businesses."

Fibre-optics case study

The Electric Power Board (EPB) utility company is installed a 100% fibre-optic network for smart grid applications for Chattanooga, Tennessee, USA, using specially designed fibre-connected (and wireless-enabled) smart meters (Baker 2011, Fehrenbacher 2009). The network also provides Internet, telephone and video capacity.

According to Fehrenbacher (2009), ***EPB claim that building out their \$200 million fibre-optic network (with the help of a DOE ARRA stimulus grant for \$111.5 million to accelerate the project) will create almost \$850 million in added value from both communications and smart grid services for the city (including new jobs and energy savings). It is predicted that for business, its time-of-use (TOU) rate program will save the 22 manufacturers that have already signed up to it \$2.3 million [£1.44 million] annually (Baker 2011).***

The creation of their fibre-optics infrastructure has already led to Chattanooga attracting new business (the new North American manufacturing headquarters for Volkswagen and an Amazon distribution plant). ***As a result of its utilisation of fibre-optics Chattanooga is now ranked as one of the World's top seven Intelligent Communities*** (ICF 2011). ***No UK communities are presently listed in this ranking. Chattanooga's ranking was in part achieved as a result of its fully-accessible fibre-optic one gigabit residential Internet service being "200 times faster than the current [US] national average and ten times faster than the FCC's National Broadband Plan (a decade ahead of schedule)," (Baker 2011).***

"Our 100% fiber-optic network will serve as a platform for accelerated innovation, job creation and deep creativity while serving as the backbone for the next generation of energy efficiency. All in all, with this infrastructure, we can't even imagine today what will be possible in the future – but we will be ready." David Wade, EPB's Executive Vice President and Chief Operating Officer (Baker 2011).

A fibre-optic network is also being built for Opelika, Alabama, USA. ***It is planned that the city's public power utility will use the network for smart-grid services and a private company be contracted to deliver triple-play services*** (Christopher 2010). ***The UK seeks to have the best Superfast Broadband Network in Europe by 2015 – perhaps fibre-optics could contribute to this in a major way?***

Investment returns in France

Fibre-optics are additionally being used for the 25 year European Union supported €123 million digital development project by the Syndicat mixte Ardèche Drôme Numérique public body (created by the Conseil général de l'Ardèche, Conseil général de la Drôme and Région Rhône-Alpes in France). Its fibre-optic network provides ultra-high speed broadband connection (100 Mbps), for a population of about a million people, with neither signal loss over distance nor creation of electromagnetic fields.

Estimated returns on investment (non-binding)

The total cost of the project cost is €123 million. The outlays from different parties are as follows: ADTIM (a subsidiary of Axione / Eiffage / ETDE / ETDE Investment) €73 million; the General Council of Ardèche €10 million; the General Council of the Drôme €10 million; Rhone-Alpes €20 million; and the European Union through the ERDF €10 million. There are 372,000 homes in the area. If a minimum of 27% of these opt for the 'triple play' service (Internet, telephone and television) offer at €20 per month, the annual turnover will be 100,440 x 20 x 12 = €24,105,600 (\$32,883,900).

As the basic outlay by ADTIM is €73 million (\$99,564,312), the gross return on its investment would be met in approximately 3 years. Going by the minimum estimate, the company should be making a clear profit margin in year 5 or 6 (Next-up 2010). ***As the fibre-optic network's extensive installation is indicated as creating a substantial short-term profit for both public and private investors - even under difficult circumstances - and is able to do so without creating environmental risks; it is proposed that similar schemes should be undertaken in the UK, and elsewhere, incorporating smart grid connections.***

“Considering the developments in technology and in economic matters ... and in view of the fears expressed by some ... concerning the effects of intense radio waves, the committee ... has decided to modify its strategy for providing this service for those areas not yet covered. As a result no new wi-fi or wi-max antennas will be used ...” Didier Guillaume, President of Conseil Général de la Drôme and Senator of the Upper House of the Parliament of France.

“I am keenly aware of the need to keep in mind the potential health risks linked to radiation, I give my full backing to this decision, which bears out the wish of the General Council to limit the sources of intense radio wave emission,” (Guillaume 2009).

Fibre-optics use in other countries

At present fibre-optics have been adopted in part for smart metering purposes areas in Canada and the USA (SMPM 2011). ***Fibre-optics networks present a more secure, cost-effective, alternative to wireless smart meters. They are also more environmentally friendly and ‘future proofed’ than wireless options.***

Whilst fibre-optics provides a smarter more biologically friendly alternative to wireless, other matters related to smart meters, such as Human Rights issues and EMP risk to smart meter circuitry, still have to be addressed.

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