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Smart Meters – Smarter Practices

Solving emerging problems.

A review by Dr Isaac Jamieson.

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SMART METERS – SMARTER PRACTICES

Dr Isaac A Jamieson PhD DIC RIBA DipAAS BSc(Hons) MInstP

Introduction

This review - *intended for the general public, governments and industries* - is composed of items written by the present author and excerpts of scientific papers, report or articles written by others. It also contains public comments.

To allow rapid review, important items of information are highlighted throughout this briefing document.

"*Today, more that ever before, science holds the key to our survival as a planet and our security and prosperity as a nation. It's time we once again put science at the top of our agenda ... It's about listening to what our scientists have to say, even when it's inconvenient, especially when it's inconvenient*."
US President Barack Obama (2008).

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SMART METERS – SMARTER PRACTICES

Dr Isaac A Jamieson PhD DIC RIBA ARB DipAAS BSc(Hons) MInstP

EXECUTIVE SUMMARY

Introduction

Problems reported worldwide with Smart Meters and related technology may (without appropriate action) occur in future rollouts and could generate health, legal, security and infrastructure difficulties unless appropriate measures are taken.

The recent classification of RF/microwave radiation as a Class 2B carcinogen by the International Agency for Research on Cancer (IARC)), the Council of Europe's recommendation that electromagnetic emissions should be "as low as reasonably achievable" and calls, such as the Seletun Resolution, to reduce electromagnetic fields (EMF) exposures also create strategic challenges.

Through learning from present successes and mistakes, taking suitable precautions, undertaking best practice and instigating further research and development, Governments and the Energy Sector can undertake appropriate measures to help ensure smooth and efficient Smart Meter rollouts that give positive environmental impact and consumer feedback.

Properly handled, there is a window of opportunity for best practice and innovation to create a better future and new business opportunities where 'everybody wins'. Timing and system development, however, must be right.

Undertaken robustly, the development of bio-friendly 'smart' technology and robust grids can provide the opening for real progressive change and a truly dynamic revolution where both eco-sustainability and bio-sustainability 'kick start' the future.

Public Perception

Existing rollouts

Whilst some Smart Meter rollouts have gone smoothly, others have met with strong resistance from the general public and authorities. In some instances Smart Meters have even had to be removed and replaced with analogue meters. It is necessary to understand why this has occurred.

Among the issues raised are financial viability, safety issues (including risk of fire), human rights issues (including privacy), health matters (primarily related to RF/microwave emissions), their interference with other electrical items (including security devices and baby monitors) and the accuracy of readings provided by some meters. One US utility has stopped Smart Meter rollout due to cost.

The trend of consumers wishing wired Smart Meters units instead of wireless ones may continue to grow as the WHO/IARC now classify RF electromagnetic fields as possibly carcinogenic.

It is now recognised that unless public concerns are addressed "*there is a very great risk that Smart Meter deployment will turn out to be a [very expensive] … mistake that ratepayers can ill afford*".

Smart Alternatives

Fibre-optics

Financially viable wired fibre-optic alternatives to wireless Smart Meters are garnering good press, can help 'future proof' smart systems and may increase public support.

Power Line Communications (PLC/'Linky'/BPL)

PLC using wired Smart Meters is being adopted by some countries and States. The possible biological effects of the radiofrequency waves they create have yet to be assessed. Complaints are being made in some circles that their use can have a serious impact on radio communication.

Suggestions are also being made that their adoption may inadvertently create additional energy usage as broadcasters have to increase the power of their output to get over the interference they cause.

It is proposed, by some, that existing meters should be retained until the issues that have arisen with the present Smart Meter rollouts are resolved, as this will help improve their overall cost effectiveness and improve customer confidence. It will also help ensure that the correct decisions are made.

Human Rights and Smart Meters

The Dutch Government has retreated on its policy of making Smart Meters compulsory. This concession was made after claims that obtaining information from these intelligent monitoring devices would be in breach of Human Rights. Similar claims may be brought worldwide and indicate the benefits of properly anonymising data.

Other Smart Metering Human Rights claims might include: Right to life, Prohibition of torture, Right to liberty and security, Prohibition of discrimination and Protection of property. With proper forethought such claims might be minimised.

Challenges over perceived breaches of Human Rights could prove extremely costly, and stall rollouts, unless issues are addressed and precautions taken to optimise specification and operation.

Health Matters

Considerable concern is already being voiced by some over the alleged detrimental health effects of some (but not all – *present author's comment*) Smart Meter regimes.

Anecdotal evidence suggests that RF/microwave radiation from Smart Meters may cause: stress, difficulty concentrating, dizziness, fatigue, headaches, heart palpitations, irritability, short-term memory loss, nausea, difficulty sleeping and tinnitus.

Exposure to raised field levels may be a contributory factor to other ailments including: cancers, depression, diabetes, infertility and obesity. A pilot study indicates that raised exposures might also be linked with increased risk of autism.

If raised RF/microwave exposures cause the dramatic rise in infertility that some predict, labour forces may decline to a level where countries are unable to adequately support the ill and elderly.

The possible cost to the economy in terms of lost health and productivity from some types wireless Smart Meters and related technologies (in their present form) may be substantial, and could greatly outweigh any cost savings.

The 'biological friendliness' of Smart Metering systems should be rigorously assessed to reduce public concern and ensure the correct systems are used.

Environmental Sustainability

Experts state that Smart Meters may not necessarily bring environmental benefits unless policies relating to them are properly thought through and optimised.

The unintended consequences of some rollouts could add so much to the real costs of the programs to national economies that they may make them financially unviable even if they achieve their stated goals.

It is vital to factor in unforeseen circumstances and concerns as they arise so that strategies can be suitably amended. As noted in the Seletun Resolution, the Burden of Proof for the safety of radiation-emitting technologies should fall on Producers and Providers not Consumers.

The Rio Declaration

Claims may be brought that Principles 1 (health), 4 (environmental protection), 7 (conservation and protection of the ecosystem), 9 (sustainable development through improved scientific understanding), 13 (liability and compensation), 15 (precautionary approach), 16 (the polluter pays principle) and 17 (the need for Environmental Impact Assessment) may be breached through some programs as they currently stand.

The European Commission

The European Commission states 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 is in the interests of all parties that disproportionate risks be minimised particularly when 'no risk'/'low risk' technologies can be adopted.

Environmental Concerns

Vegetation

Anecdotal evidence indicates that emissions from some wireless Smart Meters can cause severe die off of local vegetation. This concurs with the findings of related RF/microwave research. A brief listing is given:

Amphibians

Environmental RF/microwave emissions have been shown to effect the biological development of amphibians in comparison to shielded controls in the same environment.

In one study 90% mortality was shown for exposed frogs' eggs and tadpoles compared to only 4.2% mortality in shielded controls.

Birds

Fewer male House Sparrows have been found in areas with raised exposures caused by RF/microwaves in the 1 MHz – 3 GHz range (wireless Smart Meters and smart appliances operate within this frequency range).

Insects

Some RF/microwave regimes have been shown to drastically reduce insect numbers, including that of insect pollinators. Such exposures can adversely affect Nature's food chain and may partially explain reduced numbers of some bat and bird species.

Existing technological solutions for Smart Meters and smart grids can be used to avoid at least some of these apparent negative environmental effects. New technologies can also be developed to create more 'ecologically friendly' systems.

Security of Supply

Vulnerability to Solar Flares

According to NASA the Sun is entering a particularly vicious solar maximum, similar to that in which the most powerful solar storm ever recorded took place. Experts state that the effects of such events on smart grids over the next few years could be devastating.

It is predicted that the next storm of similar magnitude could take place in 2012-2014 and may cause widespread devastation due to our increased reliance on sensitive electronics that can be damaged by natural electromagnetic pulse (EMP) events.

One US expert states "… *given our current state of unpreparedness, within 12 months of an EMP event, about two-thirds of the U.S. total population… would perish from starvation, disease and societal collapse*." No figures appear available for other countries.

As Smart Meters are more vulnerable to stray high-energy electrical fields that can be caused by EMP than the units they replace, a delayed rollout till after 2014 (*when the risk of solar EMP subsides*) may be worth considering. The design of more robust units should also be actively considered.

Practicality, Security, War, Terrorist or Cyber-Attack

Large scale EMP Events

In addition to the risk of natural electromagnetic pulse (EMP) events, there is also the possibility of large-scale manmade EMP events caused by terrorists or rogue nations.

Measures to reduce risk to infrastructures from EMP are already being put in place by governments worldwide. It is important that the design of smart grids addresses this issue.

Source Region EMP

These are caused by nuclear detonation, such as an air-burst EMP cruise missile. A single event could cause irreparable damage to most electronics within a 30 km (18.6 mile) area. Smart Meters (at present) appear more vulnerable to such damage than the units they replace.

Non-Nuclear EMP (NNEMP)

NNEMP can be created by extremely powerful portable radio transmitters (which can be mobile and coordinated). Their effects would be similar to solar threats and HEMP but usually more localised unless a coordinated attack is undertaken. Technical solutions are being developed to address such threats.

If EMP vulnerabilities remain unaddressed they present increased invitations for attacking smart grids.

NNEMP present a comparable risk scenario likelihood to that of Cyber Attack.

Power surges

A recent sustained power surge in the USA, where 80 Smart Meters caught fire, further indicates that Smart Meters may be more susceptible to EMP than the conventional type of meters they replaced which were unaffected by the event.

Measures should be taken to ensure Smart Meters are robust enough to withstand such surges.

Preventing EMP catastrophes

As smart grids create more potential points of failure than traditional grids, cost effective protective measures should be considered early in the brief.

Resolute action is required to prevent smart grid EMP catastrophes and could create numerous opportunities for investment.

Smart grids, Smart Meter systems and related technology should be hardened where practical to prevent adverse effects from EMP.
At present there are no procedures to perform 'black start' (*restoring power stations to operation without requiring use of using the external power grid*) under severe damage scenarios.

Cyber security

Consumers and utilities' infrastructures risk becoming more vulnerable to cyber-attack due to the two-way communication and increased security vulnerabilities of smart grids compared to existing systems.

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 about security shortfalls.

Manipulation of smart grid data

Electricity theft is a cause of great concern to utilities and already there are devices existing that allow Smart Meters to be altered remotely to register less energy consumption than actually used.

There are also risks that some hackers could be virtual traders seeking to benefit financially through intercepting and manipulating smart grid data to place safe bets on manipulated energy demands.

Other foreseen possibilities include attempted attacks to take out sensitive facilities and criminals studying usage patterns to determine when homes can best be burgled.

An additional challenge for present smart technologies is ensuring that their built-in security remains viable throughout their 10-20 year design lifespan.

Blackout attacks

Network security experts state that once hackers gain access to the smart grid they may gain control "*of thousands, even millions, of [smart] meters and shut them off simultaneously*."

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*."

The installation of remote off-switches for Smart Meters, as presently advocated by some Governments, would further increase such risks.

The need for 'opt outs' and wired alternatives

Legal rulings

In Maine, USA, a "*landmark*" legal ruling now permits individuals to fully 'opt out' of the Smart Metering program and retain their existing analogue meters.

The ruling was given as a result of unresolved concerns on health, privacy and cyber-security issues.

Why 'opt outs' don't always work

In situations where individuals are in close proximity to other consumers' wireless Smart Meters, they will still be exposed to the radiation they are seeking to avoid even if they 'opt out'.

PG&E in California offer customers the opportunity to *partially* 'opt out' – with their old meters being replaced with Smart Meters that have their wireless function turned off.

There are claims that allowing individuals to partially 'opt out' may not be enough to address health concerns, as it appears that the units can continue to emit high-frequency radio signals from their Switching-Mode Power Supply (SMPS) units after being disabled.

The apparent effectiveness of wired fibre-optic Smart Meters and technologies to help reduce the likelihood of health concerns has yet to be assessed.

Smart Meters, HAN & smart appliances

Smart Meters

Alternatives to wireless Smart Meters are required for a number of reasons. One of these is that materials used to construct many buildings shield, at least in part, the emissions from such units. The use of wired fibre-optic Smart Meters would avoid such problems.

Home Area Networks (HAN)

Whilst not being universally adopted by utilities – *almost 3/4 of all utilities have either no plans for using HAN or have yet to make a decision* - HAN will form an important part of the Smart Metering system in the UK and some other countries.

At present all current proposals for HAN in the UK are for wireless networks. The wired option is used to create wired HAN networks in several European countries including Germany.

Public health concerns, the Council of Europe's recommendation that electromagnetic emissions should be "as low as reasonably achievable" and the recent IARC classification of RF/microwaves as being a Class 2B carcinogen should all be considered when deciding which type of system to adopt (WHO/IARC 2011).

It would appear prudent to consider the use of fibre-optics for consumers' HAN and Smart Meters to make them more desirable to end-users.

Smart Appliances

Smart appliances allow communication between consumers' Home Area Networks (HAN) and utility HAN. To date communication has generally been undertaken wirelessly, though potentially safer wired alternatives exist.

At present some manufacturers allow communications solely through RF/microwave connections.

Pushing the adoption of smart appliances at the present time may be a case of too much too soon and could damage the viability of the Smart Metering industry.

"Orders are already being lost with a number of products because some individuals are refusing to have smart appliances and devices (that emit RF/microwaves throughout the day) installed in their homes and workplaces.

Trade Unions may further influence the degree to which such devices are adopted in the workplace.

"*… 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*,"
UK Trades Union Congress.

Consumer confidence

As noted above, some consumers have started to question how many smart appliances actually benefit them by being 'smart', and are stating that they are unhappy with the idea of having a large number of RF/microwave emitters within their homes.

Wireless transmissions from such systems should be able to be disabled and wired smart interfaces be built in as standard.

Public health and Human Rights issues also have to be taken into consideration with regard to the design and operation of smart appliances.

Will Smart Meters save money?

As the World faces a prolonged period of austerity, and redundancies increase at an alarming rate, it is necessary to ensure that the correct Smart Metering options are chosen to avoid placing further burden on those facing hardship.

"*Very big and complex projects of this sort always cost more than anticipated.*"

Whilst real-time displays of usage can be of benefit, there is little evidence that Smart Meters usage results in an overall reduction in energy demand - *savings are not necessarily guaranteed*.

Concerns are being expressed that the cost to end-users may actually exceed the benefits created during the units' lifetimes. Alternative ways to save energy, such as furthering the creation of more efficient building designs and appliances, should also be considered.

Already there are calls that Smart Meters should only be provided to those who request and can pay for them. More consumer-friendly 'opt in' and 'opt out' options are also required.

It appears necessary to robustly re-access the market and the financial viability of different types of Smart Metering regimes in the light of research findings and consumer feedback.

Proper education

There is a real need to educate the general public on ways to reduce their energy usage.

It is vital that the market is better understood so that products and services can be properly developed and specified for the end user.

Research indicates that manually operating appliances when the price is low is the consumers' favoured way of optimising energy consumption.

Smart Meters and Economic Instruments

'Polluter pays principle'

It has been suggested that 'polluter pays principle' should be applied to electromagnetic pollution.

"*National Authorities should endeavour to promote … the use of economic instruments, taking into account the approach that the polluter, should in principle, bear the cost of pollution with due regard to the public interest …*"
Principle 16 of the Rio Declaration - the 'polluter pays principle.'

The EU's environmental policy incorporates the precautionary principle and that "the polluter should pay".

It is in the interests of all parties that the most environmentally friendly solutions for Smart Metering can be adopted.

Providing incentives for investments in innovation and improved environmental technology for smart grids and related technologies can allow targets to be met and environmental and financial benefits to be created.

National Security

The possible unforeseen costs of some Smart Meter regimes to national security and national economies have to be taken into account and contingencies planned.

It is vital that Governments and States make fully informed decisions on the advantages and disadvantages of different Smart Meter options and the need to optimise grid structures.

Cost of securing critical grid infrastructures

There is a very real risk that, unless adequate precautions are taken, smart grids may be more readily damaged by space weather and malicious manmade events than their predecessors.

Governments worldwide are taking space weather and the threat of such manmade events very seriously.

Alongside hardening grids, the option exists of delaying further rollouts of Smart Meters until the main risk period from space weather subsides. This would allow further time for security measures to be better developed.

The security risks to the new systems from hacking are yet to be resolved. Ensuring that Smart Meters cannot be disconnected

remotely would help reduce the risk of blackouts caused by hackers and rogue states.

Future proofing investments

For Smart Meters to meet the international Electric Infrastructure Security Council (EIS) requirements and be a financial success they need to be "*future proofed'* and made more desirable to the end user. One way to help achieve this may be through providing mainly fibre-optic systems. This would reduce health and security issues and make smart grid more attractive for external investors.

Possible costs of Smart Meters on health & productivity

The potential cost and savings of different metering systems have to be transparently balanced against their potential effects on health and productivity.

Anecdotal evidence already indicates that some types of Smart Meter and related technologies may adversely affect these. These matters need to be robustly addressed. It is proposed that 'biologically friendly' solutions should be adopted.

Environmental costs

The possible effects of emissions from some smart grid technologies on the environment too have to be considered.

Taking into account the 'polluter pays principle', it is vital to ensure that Smart Meters and related technologies are 'biologically friendly'.

Cost benefits of Human Rights recognition

The possible costs of human rights challenges to various Smart Meter configurations should be addressed before further rollouts are undertaken. Failure to do so has already stalled their installation in the Netherlands (metering.com 2009).

Cost benefit analysis

Independent Cost Benefit Analyses (CBA) should be undertaken which incorporate Life Cycle Costings (LCCs) for the different types of metering system being considered. The CBAs should also take into account health and productivity issues, as determined by multifactoral Environmental Impact Assessments (EIA) and Health Impact Assessments (HIA).

Creating financial opportunities

Once CBAs are taken into consideration, the results obtained may indicate that there are few opportunities to create true financial gains unless radical changes are considered, including creating more purportedly 'biologically friendly' and endorsing other ways to save energy.

One way of achieving financial viability may be through investing in fibre-optic smart grid networks and other novel forms of 'biologically friendly' technology.

The higher initial costs of fibre-optic Smart Meters compared to some other systems could additionally be mitigated through greater national productivity and wellbeing being achieved than might otherwise be the case with widespread use of wireless units (in their present format).

'The introduction of smart grids using fibre-optic technology has already been shown to be financially viable and to improve business investment over other types of system.

It is important to secure a meaningful sustainable growth strategy for the smart grid by opening up its revenue streams. Innovation and increased discourse are key.

Conclusion

It is imperative that national security, human rights issues, public safety and the economic well-being of countries are taken into account with regard to Smart Meters when considering the types of systems to adopt and the timing of their rollout. At present 'future proof' fibre-optic Smart Meter systems appear to be the best option for large-scale rollouts.

For Smart Metering and smart grids to be financially sustainable and excel, there is a need for the adoption of 'open innovation' approaches based on collaboration and co-creation that respect security issues, human rights, public health, the environment, the need for beneficial best practice and timely innovation.

Public Perception

Image source: http://stopsmartmeters.org/

At present many of the general public are not 'buying in' to the concept of Smart Metering.

Wireless Smart Meters

California, USA

"*The [California State Public Utility] Commission has received more than 8,000 complaints about PG&E Smart Meters. Statewide, the Commission has received more than 2,000 complaints in the past two months (August 15 - October 15, 2010). Many of the complaints include health, safety and environmental concerns*" (Maurer 2010).

In California several local governments have passed ordinances criminalising new Smart Meter installations. Four of seven counties (Lake County, Marin County, Mendocino County and Santa Cruz County), and eight of the thirty-four cities and towns (Capitola, Fairfax, Lakeport, Rio Dell, Ross, Seaside and Watsonville) have done so to date (SSM.org 2011).
The Tribal Community of Pomo Indians in California has also banned their use within its tribal boundaries.

The remaining counties there have also taken steps to address concerns on Smart Meter installations:

- In San Francisco its City Attorney, Dennis J. Herrera, filed a petition against the California Public Utilities Commission (CPUC) in June 2010 to block the installation of more Smart Meters until state regulators conclude their investigation into them. Herrera's prime concern is the accuracy of readings provided by the meters.

- In February 2011, Humbolt County requested that alternative options are identified for customers who decline the installation of Smart Meters by 1st January, 2012.

- In March 2011 The Board of Supervisors of San Luis Obispo County agreed to issue a letter to the CPUC calling for a delay in the installation of wireless Smart Meters in that county until questions about the technology's safety, alleged threat to privacy and cost-effectiveness are answered.

Safety

A number of Californians admit that they have safety concerns over EMF emissions from Smart Meter units. There is presently much confusion and disagreement over the magnitude of the signals created by such units and the appropriateness of safety benchmarks adopted.

As examples of this difference of opinion:

1) There is the official stance from one of the utilities: "*Both the federal government and the international community have deemed the low-level RF on which PG&E's SmartMeters™ rely to be completely safe*" PG&E (2011).

2) Compared with that of others: "*The installation of wireless 'smart meters' in California can produce significantly high levels of radiofrequency radiation (RF) depending on many factors (location of meter(s) in relation to occupied or usable space, duty cycle or frequency of RF transmissions, reflection and re-radiation of RF, multiple meters at one location, collector meters, etc)…*

Violations of FCC safety limits for uncontrolled public access are identified at distances within 6" [15.2 cm] of the meter. Exposure to the face is possible at this distance, in violation of the time-weighted average safety limits …" Sage Associates (2011).

The need for further independent testing appears warranted.

Video footage (TIR 2011) additionally indicates that RF/microwave emissions from some Smart Meters may be in excess of what was originally suggested by CCST (2011). For further commentaries on that document refer to Sage Associates (2011).

Some residents state they would be comfortable with a wired Smart Meter, whilst others wish their analogue meters to be retained or reinstated.

In November 2010, the Division of Ratepayer Advocates (DRA) of the CPUC filed documentation arguing that it has a responsibility to ensure wireless Smart Meters do not endanger public health.

The DRA state "*Unless the public's concerns can be put to rest, there is a very great risk that Smart Meter deployment will turn out to be a $2.2 billion mistake that ratepayers can ill afford*".

Consumer survey on wireless Smart Meters

An independent survey of 443 individuals evaluated by Survey Design & Analysis (SDA 2011) indicated the following:

- 35% of respondents said they had received increased bills after having the new meters installed.

- 26% of respondents stated they had experienced electronic interference with their radios, mobile phones or cordless phones (15%) and interference with their security systems (11%) since installation of the Smart Meters. 8% said they had experienced burnt out appliances (including TVs, stereos and computers) since the meter installations. Two individuals stated that the meters had caused interference with a medical implant device.

- 49% of respondents claimed they or a member of their household were electrosensitive. The top health issues of 318 respondents since the installation of wireless Smart Meters were: sleep problems (49%), stress, anxiety and irritability (43%), headaches (40%), ringing in the ears (38%) and heart problems (26%).

Statistical testing had revealed the top health symptoms were positively associated with Electrosensitivity and the presence of wireless Smart Meters. The majority of respondents (78%) are from California and share the same utilities provider. Which features of the system might have contributed to the apparent health problems registered remains to be determined. *Refer also to Appendix 1.*

94% of the respondents stated that they wished to retain or have their analogue meters reinstated, with 92% of them stating that they should not have to pay more to do so (SDA 2011).

Optimising public opinion

It appears essential to suitably address public concerns for Smart Meters to have a chance of real success in reducing energy usage. *Refer also to Appendix 2.*

Public perception to Smart Meters appears more favourable in Chattanooga, Tennessee, which uses fibreoptics for its Smart Meters (ICF 2011) - *Refer also to section on 'Smart Alternatives'*.

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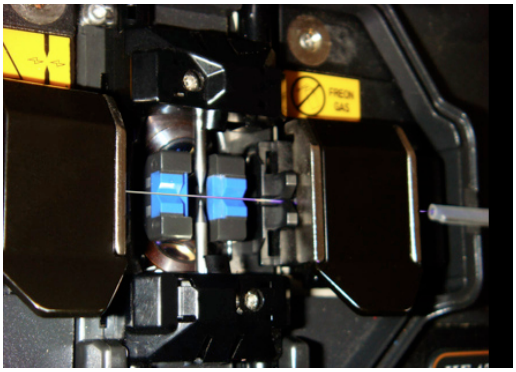
Smart Alternatives



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Smart Grids

The classification of RF/microwave radiation as a Class 2B carcinogen (WHO/IARC 2011) taken alongside the recommendation the Parliamentary Assembly of the Council of Europe (PACE 2011) that electromagnetic emissions should be "*as low as reasonably achievable*" (ALARA) – *a call similar to that of the BioInitiative Working Group* (2007) - create strategic challenges for smart grid infrastructures.

"*Wireless is not necessary - just cheaper and easier to implement*", Powerwatch (2010).

Not all smart grids are wireless. Some utilities companies have already opted for fibre-optic cabling for their primary communication needs. Others have opted for Power Line Communications (PLC), or use it as a backup channel or for simple installations they consider do not merit the installation costs of fibre-optics.

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 presently installing 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 will contribute to this?*

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 biologically friendly and 'future proofed' than wireless options.

" …when you add a demand for reliability and resiliency (as well as a technology that doesn't conduct electricity) to the trends already highlighted, fiber offers a exemplary conduit for the intelligence, two-way communications, and control and monitoring capabilities smart grid applications demand." (Hardy 2010).

Fibre-optics is the smarter environmentally friendly alternative to adopt for general rollouts to gain public acceptance and attract investment.

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Power Line Communications (PLC/'Linky'/BPL)

This is also known as Broadband over Power Line (BPL), 'Linky', Power Line Access (PLA) and Power Line Telecommunication / Technology / Transmission (PLT).

PLC frequencies

• 20-200 kHz frequencies used for home-control PLC devices.
• 100-200 kHz low-frequency carriers on high voltage power lines.
• 15-500 kHz low speed narrow-band. Utility usage including meter reading used for telemetry on high voltage power lines. May be used for meters, domestic appliances and switches.
• 9-500 kHz medium speed narrow-band. Used for home automation. Typically utilise carrier wave in 20-200 kHz range on household wiring. Can be used for automatic meter reading (AMR).
• ≥1 MHz high-frequency. HLAN and broadband over power lines (BPL). PLC modems transmit in the 1.6-80 MHz region. System expected to operate in the 10-30 MHz region.
• ≥100 MHz ultra-high-frequency (E-Line technology). It can operate anywhere in the 20 MHz – 20 GHz region.

Utility companies use PLC operating in the 24-500 kHz range (Wikipedia 2011).

PLC Effects on shortwave broadcasting

Whilst low speed PLC (below 150 kHz) present no apparent problems - *in terms of causing radiowave interference with broadcasting* - High speed Power Line Communications (HS-PLCs) can and do reduce the effective deployment range of broadcasting to different countries unless transmitter power output levels are substantially increased (Marshall 2010).

"*There is strong evidence that the wide deployment of high-speed [PLC] will seriously impact radio communication. If we allow this to happen we sacrifice a proven long-distance universally accessible technology of considerable commercial and social importance for what can only be described as a short-term gain in convenience for local data networks*." Richard Marshall*

*Managing Director and Principal Consultant of the RF and EMC-related electronic design, consultancy & training firm Richard Marshall Limited.

Effects on power usage for broadcasting

The increased use of High speed Power Line Communication (HS-PLC) for Smart Meters may create unforeseen demands in the energy usage of shortwave broadcasters worldwide.

Marshall (2010) predicts that in order to match these additional power requirements worldwide "*Each year this would require the installation of a further electrical generation resource equivalent to some 30,000 wind turbines*!"

Aircraft communications are particularly at risk of receiving interference from PLC (Marshall 2010).

PLC Effects on radio astronomy

In addition to space satellites, radio astronomy laboratories on Earth investigate solar emissions from the Sun and other planets. Their effective operation is vital in predicting possible disturbances that may seriously compromise the integrity of electrical grids and other infrastructures unless sufficient warning is given. The sensitivity of the measurements taken by these laboratories is in large part determined by their 'radio-noise' environment in the High Frequency range.

Ohishi et al. (2003) calculated that to protect HF radio astronomy antenna from interference caused by a *single* PLC system, it is necessary to have a separation distance from it of 424 km. Far larger separations will be required if PLC are widely deployed.

PLC Effects on Military Communications and Intelligence

NATO in its report on the effects of HF interference on Communications and Intelligence (COMINT) suggested that (whilst having no authority itself to implement regulatory measures) it would be highly desirable for limits on PLC emissions to be harmonised throughout NATO countries. It stated it would be willing to work with national and international regulatory authorities to do so (NATO 2007).

Deployment of PLC internationally

PLC are being used in whole or part of the following countries: Argentina, Austria, Bosnia & Herzogovinia, Brazil, China, Columbia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Italy, India, Mexico, Netherlands, Norway, Portugal, Puerto Rico, Russia, Serbia, Sweden, Spain and the USA. (Echelon 2011, SMPM 2011, ResearchAndMarkets 2010).

PLC in France

Électricité Réseau Distribution France (ERDF) manages the public distribution of electricity to over 95% of the French mainland. It is in charge of the French Smart Meter rollout through its PLC 'Linky' project (ERDF 2011, 2010). Linky is a "slave" system that receives and executes orders, and transmits reports and validated readings to minicomputers in transformer substations, which then inform the distributor's supervision centre.

It uses powerline carrier technology (using a low-voltage electric network) to exchange data and orders between wired Smart Meters and the substations' minicomputers. Its extended communication network allows those minicomputers to talk with the central information system using the telecommunications network.

According to Fontana (2010), ERDF took into account the Canadian and US experience with wireless Smart Meters when deciding to opt for wired units. They are apparently "*very conscious*" of electromagnetic problems. The effectiveness of their proposed measures has yet to be assessed.

Over 35 million wired Smart Meters are to be installed in France.

Unlike Canada and the USA, meters in France are usually located inside homes, as is the general case in the UK.

It appears that PLC will not be used *en masse* for smart grids in the UK. This is primarily due to the present risk of PLC causing significant disruption to communications equipment.

UK perspective on PLC

Resistance to PLC use in the UK has come from the BBC, Civil Aviation Authority, Electromagnetic Compatibility Industry Association and The Radio Society of Great Britain, which are all extremely concerned over the possible damage PLC "would cause" to radio broadcasting and the electromagnetic environment (EMCIA 2011, Ray 2010, RSGB 2011). A report commissioned by Ofcom additionally found that PLC devices tested failed to satisfy essential requirements of the Electromagnetic EMC directive (Smith 2008).

Effects on flora and fauna

The biological and environmental effects of radiofrequencies created by PLC do not appear to have been assessed in detail by those using or seeking to deploy it. This is an important omission that should be rectified at the earliest possible opportunity - Refer to section on '*Environmental Concerns*'.

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Smart Meter Interference

4-60 kHz

Radio frequency interference can be created by the Switched-Mode Power Supply (SMPS) units in Smart Meters even when their wireless transmitters are disabled unless suitable precautions are taken. This interference, or 'dirty electricity' as some call it, can be carried indoors from the SMPS onto mains wiring.

"*Extensive measurements have demonstrated that all of the meters measured so far, including ABB, GE, and Landis Gyr, emit noise on the customer's electric wiring in the form of high frequency voltage spikes, typically with an amplitude of 2 volts, but a frequency anywhere from 4,000 Hertz, up to 60,000 Hz. The actual frequency of the phenomena is influenced by the devices that are plugged into the customer's power. Some houses are much worse than others, and this observation has been confirmed by PG&E installers that have talked to us,*" - quote by engineer (Brangan & Heddle 2011a).

Refer also to the section on 'PLC, Switched-Mode Power Supply and Health'.

900-928 MHz

California, USA

The emissions from PG&E's wireless electric Smart Meters (which operate in the 902-928 MHz range – *which is unlicensed in North America*) have been implicated as interfering with: baby monitors, remote car starters, cordless phones, DirecTV systems, garage door openers, motion detectors, patio speakers, wireless headphones, wireless microphones and security systems – *even in the middle of the night*.

Such problems were first noted in 2009, and can occur when the Smart Meters transmit information wirelessly back to the utility (OTLB 2011, Rockstroh 2010).

Ontario, Canada

In Ontario, the utility company Chatham-Kent Hydro has installed wireless Smart Meters that operate over the same frequency range (902-928 MHz) used by PG&E.

The choice to use these unlicensed frequencies appears to have been taken as a cost saving measure in an attempt to benefit their customers who had to fund the rollout.

It is, however, now being claimed that the money originally saved by this decision (*the project was coming in at a third of the cost of those by other utilities*) could be lost as a result of severe concerns related to technical aspects of the rollout – namely that the units cause illegal interference on the bandwidths used.

In order for the wireless Smart meters to qualify for licence-exempt use in that frequency range, their transmission power must not exceed 50 mV/m at a distance of (9 feet 10 inches) 3 metres (corresponding to a 0.00075 watts output power). As noted by C-K ARC (2010), as the Smart Meters transmit at significantly higher power levels (0.5 watts of RF/microwave energy), they have to operate using a frequency-hopping scheme under Annex 8 of RSS-210 - which unfortunately causes interference with other devices.

"*… it is ILLEGAL to cause this interference in the first place. Industry Canada requires all equipment operating under RSS-210 to cause no interference to other users, including licence-exempt users*," C-K ARC (2010).

Though Industry Canada does not get involved with cases of interference, this is still a matter of law enforceable in Civil Courts and a matter of concern to those in the Smart Meter industry.

Businesses or individuals who have their investment in wireless equipment rendered useless as a result of permanent interference have recourse to legal action, with the likelihood that, due to the large number of parties affected "*a group of cases could be certified for Class Action*," (C-K ARC 2010).

The EMF Safety Network online survey (SDA 2011) indicated that 8% of respondents had experienced burned out appliances or damaged electronics after installation of Smart Meters.

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The general adoption of fibre-optic systems may provide a simple solution to reduce risk of bandwidth interference and a number of possible legal actions.

Electrical safety and Smart Meters

Image source: Kaskurgichan (2011).

There have been a number of reports of Smart Meters exploding, catching fire, overheating, smoking or smouldering due to poor installation (Admin 2011, Clark 2010, CBS 2010, CPC 2011, Davis 2011, HMH 2011, MrHillDo 2011). It appears vital that properly trained electricians are employed to undertake installations.

"As soon as he pulled the meter we could see what had happened. The receiving clips for the meter were burnt. … [The utility service worker] then said "… you're lucky it didn't start a fire."

… He then proceeded to tell me that they were having nothing but problems with the contractor who was installing the meters …

He then went on, telling me that the burnt area was more than likely due to the contractors not being able to fit the new Smartmeter into place, so they widened the receiving clip and shoved it into place. By them widening the clips, they caused an area of no contact which then caused arcing every time we used any appliance with 220v." Captain Ross, California Fire Department (Admin 2011).

Electrical hazards and fire risks

There have been a number of incidents of electrical hazards and fire risks reported worldwide related to Smart Meter installations both outside and inside buildings. A selection of these is presented.

The above photograph *"is the aftermath of one of those new smart meters not being properly installed. The guy who installed it did not know what he was doing and caused the main electric line to the box to become lose and over time it ended up touching the electric meter/box casing causing a fire and a huge firework festival on the side of our house. If I was not home we would have lost the house and our 3 dogs. ..."* Kaskurgichan (2011).

Florida, USA

A claim has been made by a Florida woman that a brand new Smart Meter "*caught fire and caused [excess] current to pass thru my house and fry my beautiful new kitchen*." $31,993 of damage was caused to appliances and electronic devices in the home which had also recently been rewired.

It is being contested whether the utility company is liable for the damage as "*the Florida legislature has given FPL special protection by declaring that they do not have to pay for damage caused by their negligent mistakes. Only gross negligence and this is done to keep FPL's costs down so they can keep everyone's power bills from going up*." Howard Finkelstein (HMH 2011).

The following comments were posted online about that incident: (Boater39) "… *we had a fire last week … Afterwards, I went to investigate and it was the electric meter that burned up. ... I have an electrical background, and from my professional experience, whatever caused the meter to burn up was a dead short carrying a very large amount of current. Based on the damage, the problem was AT THE METER – not at the customer equipment attached to the meter. (like I said, I have professional experience). At the time I found it strange, until I saw this report on TV…."* (HMH 2011).

Texas, USA

There have been a number of complaints about outages and house fires related to Smart Meter installations in Texas (Carey 2011, CPC 2011, CBS 2010). One of these is detailed below:

"*Charles Phillips saw smoke coming from the transformer in his backyard … When he went out to … he saw a [utility] contractor at his meter box with a fire extinguisher.*
"He told me it had caught on fire," Phillips said. "He had talked to his boss. Evidently, he told him to put it out, which is what he did." But that was just the beginning. Inside Phillip's home, two TVs were fried, his air conditioner and garage door opener stopped working, and all of the wires and cables hooked up to his electronics were melted from the jolt his electronics took when a fire sparked after the installer removed his old meter. Phillips was left with a total of about $2,500 in damages." (Davis 2011).

'"*I felt that they should have some type of liability*," said Phillips about CenterPoint Energy. But both CenterPoint and the subcontractor installing the smart meters across Houston said the damage is not their fault or their responsibility.' (Davis 2011).

The utility stated that such *problems exist predominantly in older homes where the wiring is incorrect or a strain has been put on the wiring running into the Smart Meter enclosure.*

Christchurch, New Zealand

A spate of meter fires occurred in Christchurch in 2010 with, in one instance, firefighters being called out to three Smart Meter malfunctions within five days.

In one case a consumer woke up at 4.30 in the morning to find his Smart Meter on fire, the following day a registered electrician who lived in the same area pulled into his driveway to find his meter box on fire and emitting copious amounts of smoke.

Station Officer Murray Jamieson of the NZ Fire Service stated, "*It was very dangerous, … the whole thing burnt out completely, last night's one was a melt down and it was significantly dangerous*," (Clark 2010).

Possible causes

Bad fitting - there is not likely to be a significant increase in current indoors from Smart Meters unless they are badly fitted.

There is the possibility that the extra current generated through fitting errors may cause the live/'hot' wires in the building to carry more current than they were designed to, which can cause overheating. This in turn can also overload the 'neutral' wiring (*particularly if it is thinner than the live/'hot' wiring as is often the case in North America*).

This situation may result in damage to appliances and items of electrical equipment and create potential fire hazards - *the greater the current carried the greater the danger, particularly with older wiring.*

The degree of risk of damage to electrical items and fires varies from country to country depending on building codes and also from building to building (depending on how and when it was wired).

In North America, risk of damage from these greater currents can often be exacerbated as a result of neutral wires often being sized smaller than hot/live wires (Spitaels 2011).

Best practice

Arc-fault circuit interrupters (AFCI) are circuit breakers designed to prevent fires by detecting non-intentional electrical arcs and

disconnecting the power supply before the arcing starts a fire. They are required in US building codes for new build construction and renovation work.

Ground Fault Interrupters (GFI) - *or Residual Current Devices (RCD) as they are known in the UK* - are circuit breakers that protect from individuals from electrical shock by interrupting a household circuit when there is a difference in the currents in the hot/live wire and the neutral wire.

Wireless Smart Meters have been shown to trip both AFCI and GFI/RCD (Admin 2011, Rockstroh 2010).

Building wiring

Powercor in Australia acknowledges the safety risks related to wiring stating, "*A defect notice is issued when a wiring safety issue is identified. The defect may be identified before or during the smart meter installation or during the testing that we must do before reconnecting the electricity supply. If you are given a defect notice, you will need a registered electrical contractor to rectify the defect and issue a Certificate of Electrical Safety*" (SMFE 2011).

As a matter of best practice, neutral wires should never be undersized in buildings where high levels of harmonics and radiofrequencies (*as can be caused accidentally by some Smart Meters*) are likely to be carried on wiring.

As noted by Spitaels (2011), "*In modern facilities the neutral wiring should always be specified to be the same capacity as the power wiring (or larger). This is in contrast the electrical codes which may permit undersizing the neutral wire*." [Emphasis added by present author].

Safety certification

Underwriters Laboratories Inc. (UL) deals with matters of product safety and undertakes certification of Smart Meters worldwide. In February 2011, the Capitola City Council in California discovered that wireless Smart Meters being installed there did not have the UL certification required under the state electrical code for all domestic electrical equipment and appliances (OTLB 2011).

Such matters need to be addressed, as ensuring the safety of 'smart' technology is paramount both for reasons of public safety and consumer confidence - certification, such as that already undertaken by Underwriters Laboratories Inc. (UL) appears essential.

In addition to UL certification being available for Smart Meters, there is now certification issued under the authority of the US FCC that requires that all persons be kept ***at least*** 8 inches (20cm) from wireless Smart Meters (CCS 2011). The more rigorous exposure guidelines of some other countries, such as Russia and China, would require far greater distances.

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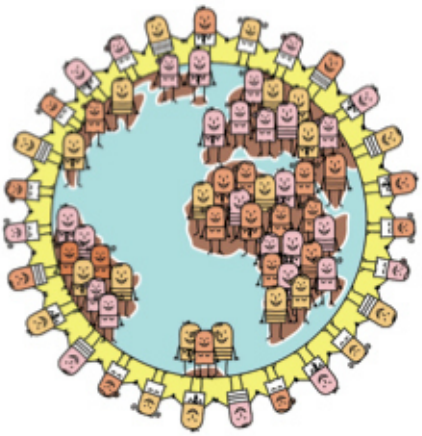
Smart Meters and Human Rights



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Overview

There is increasing talk worldwide of individuals coming together to pursue Human Rights claims related to Smart Meters. 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.

The extent to which Smart Metering projects are being embarked on worldwide can be viewed at the following link:
http://maps.google.co.uk/maps/ms?ie=UTF8&source=embed&oe=UTF8&msa=0&msid=208141621543957618113.0000011362ac6d7d21187

In order for Smart Metering to have a proper chance of success, it is vital that potential Human Rights issues are properly addressed.

Europe

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).

Their 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.

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United Kingdom

UK - Human Rights Act 1998

This Act is based on the European Convention of Human Rights. For this reason, many of the pointers that could have been included in the review of the European Convention are covered here instead.

Human rights are required to be part of all UK policy making (DCA 2006). This Act is one of the most important statutes ever passed in the UK (Hoffman & Rowe 2010).

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 (Cherry 2000); claims might be brought that increasing involuntary exposures to such regimes may be against individuals' 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. *Refer also to Appendix 3.*

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 (KCRA 2011), it appears that some systems may be a cause of real risk to life if installed 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 evidence already exists indicating that RF/microwave emissions from Smart Meters may seriously damage the environment (OTLB 2011). Refer also to section on '*Environmental Concerns*'.

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.

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.

Adverse effects created by exposure to some types of Smart Meters – *if proven true* - may prove very expensive to the UK economy (if such types of unit are widely adopted).

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.

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).

- Privacy. The UK government presently wishes access to all UK metering information, with gas and electricity meter readings to be taken from every UK household every half hour. However, this is inconsistent with EU privacy law and, as mentioned previously, has already been successfully contested in the Netherlands (Anderson & Fuloria 2010).

- It is recognised that the enjoyment and quality of domestic life may be damaged by particular types of interference, such as various forms of environmental pollution - *electromagnetic pollution may be in this category*.

It appears that claims that "*economic benefits outweigh the rights of those affected*" could be disputed related to:

- health matters (*as noted elsewhere within this publication*).

- the right for individuals to be able to enjoy their property in the manner to which they have become accustomed. 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, 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).

Some may claim that the installation of wireless Smart Meters and/or 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).

They may also claim that the unwarranted introduction of such pollution may reduce the capital value of their homes (*some individuals in the USA 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).

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 this present document.

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.

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.

It appears important to ensure that the technologies used for the Smart Meter rollouts in the UK, and elsewhere, do not adversely discriminate against those with conditions that may be exacerbated by exposures to inappropriate electromagnetic field regimes.

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 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.

There may also be claims that individuals' "peaceful enjoyment' may be disturbed over privacy issues, including: data hijacking from Smart Meters that may allow thieves to determine the types of electronic equipment they possess (as a result of their unique electronic signatures) and when they are not in occupancy.

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 plants (through creating inappropriate field regimes that may instigate their die-off) – Refer to section on '*Environmental Concerns*'.

The possible effects of exposures on other animals too have to be considered, along with any claims of violation of human rights that may be made as a result of these.

The Council of Europe (CE 2011) draft resolution has already recorded concerns over "*the potentially* [emphasis by present author] *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. Possible effects emissions from wireless Smart Meters and powerline communications (PLC) have yet to be undertaken.

The effects on individuals' livelihoods of proposed metering schemes should also be seriously taken into consideration so that optimum solutions can be obtained "*in accordance with the general interest …*"

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

Image source: FreeDigitalPhotos.net staff, ttp://www.freedigitalphotos.net">Image: FreeDigitalPhotos.net</p>

African [Banjul] Charter on Human & Peoples' Rights

The African [Banjul] Charter on Human and Peoples' Rights is an important legal instrument for Africa that was adopted in 1981. It entered into force in 1986 (African Charter 1986).

Part I: Rights and Duties
Chapter I: Human and Peoples' Rights
Article 1

"*The Member States of the Organization of African Unity parties to the present Charter shall recognize the rights, duties and freedoms enshrined in this Chapter and shall undertake to adopt legislative or other measures to give effect to them*."

Article 4

"*Human beings are inviolable. Every human being shall be entitled to respect for his life and the integrity of his person. No one may be arbitrarily deprived of this right*."

As RF/microwave radiation is categorised as a Class 2B carcinogen (WHO/IARC 2011), respect for life and integrity of person may be infringed by <u>some</u> Smart Meter regimes *(Smart Metering alternatives are available that may avoid this risk – present author's comment).*

In particular, the potential detrimental health effects already noted abroad with Some Smart Meters (EMFSN 2011, KCRA 2011, Milham 2011), right to life issues - as related to the effects of increased RF/microwave exposures (Cherry 2000), and privacy issues that could damage integrity (Quinn 2009, Cuipers & Koops 2008), might be pursued by African citizens unless suitable best practice measures are taken.

Article 5

"*Every individual shall have the right to the respect of the dignity inherent in a human being … All forms of … degradation of man particularly … cruel, inhuman or degrading punishment and treatment shall be prohibited*."

The symptoms exhibited by some individuals exposed to RF/microwave regimes from some types of Smart Meters, and related technologies, can make them feel degraded as a human being.

It may be worthwhile for utilities and those developing smart technologies to investigate the use of more potentially 'biologically-friendly' options, such as fibre-optics, to prevent potential claims that they may be breaching this right.

Article 6

"*Every individual shall have the right to liberty and to the security of his person. No one may be deprived of his freedom except for reasons and conditions previously laid down by law. …"*

The liberty and security of those who are electrohypersensitive (EHS) may be compromised by some Smart metering regimes which can inadvertently inhibit/prevent individuals going where they wish, even within their own homes (EMFSN 2011), in order to avoid electromagnetic exposure from such devices.

Article 12

1. "*Every individual shall have the right to freedom of movement and residence within the borders of a State provided he abides by the law*."

Freedom of movement and residence may be compromised by emissions from some types of Smart Meters and related smart technologies, as discussed above in the commentary for Article 6.

The threat of exposure to such emissions can, in some instances, prevent vulnerable members of the public from going where they wish within their own country without the risk of becoming unwell as a result of inappropriate EMF exposure.

Article 13

3. "*Every individual shall have the right of access to public property and services in strict equality of all persons before the law*."

Inappropriate RF/microwave regimes can prohibit EHS individuals from accessing public property. It is important to ensure that Smart Metering, smart appliances and related technologies avoid contributing to this potential problem in Africa.

Article 15

"*Every individual shall have the right to work under equitable and satisfactory conditions, …*"

The field regimes created by some Smart Meters and related smart technologies in the workplace may compromise the right to work of vulnerable EHS individuals by creating unsatisfactory work conditions, or conditions where they cannot work without becoming unwell.

Article 16

1. "*Every individual shall have the right to enjoy the best attainable state of physical and mental health*."
2. "*States parties to the present Charter shall take the necessary measures to protect the health of their people …*"

As indicated by anecdotal evidence from overseas (EMFSN 2011), the physical and mental health of a number of individuals may become compromised by some Smart Meter regimes.

As it is the duty of African States parties to "*take necessary measures to protect the health of their people,*" it would appear wise to check the scientific validity of the claims made related to health effects, and ensure that options used for smart meter rollouts and related smart technologies are 'biologically friendly'.

Article 18

1. "*The family shall be the natural unit and basis of society. It shall be protected by the State which shall take care of its physical health and moral*."
3. "*The State shall ensure the elimination of every discrimination against women and also ensure the protection of the rights of the woman and the child as stipulated in international declarations and conventions.*"
4. "*The aged and the disabled shall also have the right to special measures of protection in keeping with their physical or moral needs*."

Claims might be brought that as some RF/microwave regimes are linked with increase risk of infertility, miscarriage and damage to human offspring (Cherry 2000); there is a possibility that emissions

from some types of Smart Meters and related devices may cause similar damage, thereby hindering individuals' right to found a family.

Claims might also be brought that if some types of Smart Meter regimes are adopted there may be risk of increased ill health to individuals.

Anecdotal evidence already exists from abroad concerning the risk of Smart Meters to health (EMFSN 2011). It is the State's duty to protect against such risks if proven real, particularly for those considered most vulnerable to such regimes.

Article 20

1. "*All peoples shall have the right to existence. …*"

Cherry (2000) indicates that some human embryos/fetuses may be (inadvertently – *present author's comment*) deprived of life as a result of inappropriate RF/microwave regimes raising the risk of miscarriage.

There also appears a very real risk that some Smart Meter regimes may shorten individuals' lives (plus reduce the quality of their lives and length of time they are able to work productively).

Article 23

1. "*All peoples shall have the right to national and international peace and security*. … "

It is predicted by NASA that the Sun is entering a particularly vicious solar maximum over the period 2012-2014 (Moskowitz 2011, NASA 2010). Upcoming solar flares could severely disrupt national grids and infrastructures unless suitable precautions are taken (Birnbach 2011).

"*As Smart Meters are more vulnerable to stray high-energy electrical fields that can be caused by EMP than the units they replace. A delayed rollout till after 2014 (when the risk of solar EMP subsides) may be worth considering for this reason alone. The design of more robust units should also be considered*." – Dr Isaac Jamieson.

It is already predicted that for the USA, under current states of preparedness, such an event might cause two-thirds of its population to die as a result of starvation and societal collapse (Cogan 2011). It appears that no assessments have been undertaken to date for Africa on the effects of such an event.

Article 24

"*All peoples shall have the right to a general satisfactory environment favorable to their development*."

Some installations have been indicated as creating unsatisfactory environmental conditions for individuals' development both in health terms (EMFSN 2011, Sage Associates 2011), and in terms of the security of their environment, as there may be increased risk of burglary (SGIP 2010) if third parties obtain data on the types of electrical equipment individuals hold and building occupancy patterns.

Article 25

"*States parties to the present Charter shall have the duty to promote and ensure through teaching, education and publication, the respect of the rights and freedoms contained in the present Charter and to see to it that these freedoms and rights as well as corresponding obligations and duties are understood*."

It may prove prudent, as part of the promotion of the need to respect the rights and freedoms contained within the Charter being discussed, for the needs of those thought particularly vulnerable and/or likely to be adversely affected by electromagnetic pollution (such pregnant women, young children, the elderly and those with EHS) to become better known.

Article 26

"*States parties to the present Charter shall … allow the establishment and improvement of appropriate national institutions entrusted with the promotion and protection of the rights and freedoms guaranteed by the present Charter*."

It is suggested that in order to further promote and protect the rights and freedoms guaranteed by the present Charter there should be the establishment and improvement of appropriate national institutions to better evaluate the benefits and risks of smart grid employments so that the best choices can be made for the good of all.

Chapter II: Duties

Article 27

"*… The rights and freedoms of each individual shall be exercised with due regard to the rights of others, collective security, morality and common interest*."

Smart grid security issues have to be properly addressed – Refer to section on *'Security of Supply'* in this present document.

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The Nations of the Americas

The American Convention on Human Rights

The American Convention on Human Rights is a legally binding instrument as concluded under international law adopted by the nations of the Americas (OAS 2011).

24 Member States of the Organization of American States (OAS) have ratified the American Convention on Human Rights 'Pact of San José, Costa Rica'. They are: Argentina, Barbados, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominica, Dominican Republic, Ecuador, El Salvador, Grenada, Guatemala, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Suriname, Uruguay, and Venezuela. The treaty has not been ratified by the USA, Canada and several Caribbean nations.

Part I: State Obligations and Rights Protected, Chapter 1: General Obligations

Article 1. Obligation to Respect Rights

1. "*The States Parties to this Convention undertake to respect the rights and freedoms recognized herein and to ensure to all persons subject to their jurisdiction the free and full exercise of those rights and freedoms, without any discrimination …*"

The widespread introduction of RF/microwave emitting Smart Meters (and related wireless emitting technology) may be discriminatory against individuals who may be detrimentally affected by them.

Article 4. Right to Life

1. "*Every person has the right to have his life respected. This right shall be protected by law and, in general, from the moment of conception. No one shall be arbitrarily deprived of his life*."

Since research indicates that some RF/microwave regimes may increase risk of infertility, miscarriage and cause damage to human offspring (Cherry 2000), and RF/microwave radiation is now classified as a Class 2B carcinogen (WHO/IARC 2011), claims might be brought that raising involuntary exposures may be against individuals' right to life. Refer also to section on '*Health Matters'*.

Claims might also be brought that individuals may be arbitrarily deprived of their lives through health conditions exacerbated or brought on as a result of the involuntary exposures they receive – *refer also to section on 'Health Matters' in present document.*

Article 5. Right to Humane Treatment

1. "*Every person has the right to have his physical, mental, and moral integrity respected*."
2. "*No one shall be subjected to torture or to cruel, inhuman, or degrading punishment or treatment. …* "
3. "*Punishment shall not be extended to any person other than the criminal*."

Some Smart Meter regimes are indicated as being potentially inhumane to susceptible individuals (KCRA 2011).

Article 7. Right to Personal Liberty

1. "*Every person has the right to personal liberty and security*."

Insights into individuals' living patterns and relationships, gained through Smart Meters and related devices (if data is not suitably anonymised), may impinge on their freedom of liberty to do as they please within their own homes and therefore be in breach of their Human Rights (Anderson & Fuloria 2010, metering.com 2009).

2. "*No one shall be deprived of his physical liberty except for the reasons and under the conditions established beforehand by the constitution of the State Party concerned or by a law established pursuant thereto*."

The physical liberties of some individuals may be violated if EMF emissions from the units prevent them from being able to go where they wish, even within their own homes, without feeling unwell and/or having their health compromised.

6. "*Anyone who is deprived of his liberty shall be entitled to recourse to a competent court*, …"

It appears highly likely that individuals who consider that they are deprived of their liberty to go where they wish will seek recourse.

Article 11. Right to Privacy

1. "*Everyone has the right to have his honor respected and his dignity recognized*."

Some individuals may have their dignity severely compromised as a result of some types of Smart Meter exposure making them feel unwell - Refer to section on *'Smart Meter Health Impacts Testimonials*'.

2. "*No one may be the object of arbitrary or abusive interference with his private life, his family, his home, or his correspondence, or of unlawful attacks on his honor or reputation*."

There are concerns that unless data from Smart Meters is suitably anonymised, it may provide sensitive data to third parties allowing them to cause unwarranted interference.

3. "*Everyone has the right to the protection of the law against such interference or attacks*."

Protection against interference and the right to privacy may be compromised, unless suitable precautions are undertaken by providers. At present many cyber-security experts have grave reservations over the level of security provided by Smart Meters – Refer to section on '*Cyber Security'*.

Article 17. Rights of the Family

1. "*The family is the natural and fundamental group unit of society and is entitled to protection by society and the state*."
2. "*The right of men and women of marriageable age to marry and to raise a family shall be recognized, if they meet the conditions required by domestic laws*, …"

1. Claims of negligence may be brought if the Smart Meter technologies that are adopted are indicated as placing the family at increased risk of ill health, identity theft, etc.
2. The right to raise a family may be compromised if emissions from some Smart Meters and related technology are proven to reduce human fertility and increase risk of miscarriage.

Article 19. Rights of the Child

"*Every minor child has the right to the measures of protection required by his condition as a minor on the part of his family, society, and the state*."

The rights of the unborn child may be compromised through increased chance of miscarriage due to exposure to increased levels of RF/microwave radiation from some Smart Meter technologies - increased exposure RF/microwave radiation is linked to incidence of ill health after birth (De Iuliis et al. 2009).

Article 21. Right to Property

1. "*Everyone has the right to the use and enjoyment of his property. The law may subordinate such use and enjoyment to the interest of society*."

EMF emissions from wireless Smart Meters are documented as preventing some individuals using and enjoying parts of their properties on health grounds (EMFSN 2011, Havas 2011, KCRA 2011). Wireless smart appliances and devices may additionally compromise their use and enjoyment. It is suggested that it is not in society's interest to subordinate such use and enjoyment.

2. "*No one shall be deprived of his property except upon payment of just compensation …* "

Compensation claims may be brought by individuals.

Article 22. Freedom of Movement and Residence

1. "*Every person lawfully in the territory of a State Party has the right to move about in it, and to reside in it subject to the provisions of the law*."

The freedom of movement and residence of some individuals, particularly those who are electrohypersensitive (EHS), may be severely compromised if/where wireless regimes are introduced. (There are already incidences of people being forced to move home and/or sleep elsewhere to try and escape from the emissions of wireless Smart Meters).

Article 24. Right to Equal Protection

"*All persons are equal before the law. Consequently, they are entitled, without discrimination, to equal protection of the law*."

Those whose rights may be seen to be compromised by some Smart Meter regimes may seek recourse through law.

It is important to take such matters on board when considering the choice of systems to adopt.

Chapter 3: Economic, Social and Cultural Rights

Article 26. Progressive Development

"*The States Parties undertake to adopt measures, both internally and through international cooperation, especially those of an economic and technical nature, with a view to achieving progressively, by legislation or other appropriate means, the full realization of the rights implicit in the economic, social, educational, scientific, and cultural standards set forth in the Charter of the Organization of American States as amended by the Protocol of Buenos Aires*."

Progressive development may be hindered by:

- Smart Meter regimes that hinder economic development through increasing health-related problems and security risks.
- Inappropriate wireless Smart Meter regimes that restrict some individuals' freedom of movement both at home and outdoors.

Article 29. Restrictions Regarding Interpretation

"*No provision of this Convention shall be interpreted as:*
1. permitting any State Party, group, or person to suppress the enjoyment or exercise of the rights and freedoms recognized in this Convention or to restrict them to a greater extent than is provided for herein; .."

It appears highly likely that claims will be brought unless suitable action is taken.

Article 32. Relationship between Duties and Rights

1. "*Every person has responsibilities to his family, his community, and mankind*."

It is important to ensure that these responsibilities are met with regard to creating appropriate Smart Meter provisions that reduce the likelihood of Human Rights being violated.

Protocol of San Salvador

This is an additional protocol of the American Convention on Human Rights. It was created to bring inter-American Human Rights to a higher level through protecting second-generation rights in economic, social and cultural spheres. It came into effect on 16th November 1999 and has been ratified by 14 nations.

The countries which have adopted it are: Argentina, Bolivia, Brazil, Columbia, Costa Rica, Ecuador, El Savador, Guetamala, Mexico, Nicaragua, Panama, Paraguay, Peru, Suriname and Uruguay. Some of these countries (Argentina, Brazil, Columbia and Mexico) also have Smart Meter installations.

Under the 'Protocol of San Salvador' (CIDH 2011) the following additional articles might be referred to on matters related to Smart Meters based on the essential rights of humankind:

Article 3: Obligation of nondiscrimination

"*The State Parties to this Protocol undertake to guarantee the exercise of the rights set forth herein without discrimination of any kind …*"

Claims may be made that the creation of field regimes inappropriate to those suffering from EHS, or other health ailments, may be a form of discrimination, particularly when practical alternatives that do not create such regimes are available.

Article 6: Right to Work

1. "*Everyone has the right to work, which includes the opportunity to secure the means for living a dignified and decent existence …*"

The right to work of individuals may be compromised by Smart Meter field regimes that compromise their health.

Article 7: Just, Equitable, and Satisfactory Conditions of Work

"*… the States Parties undertake to guarantee in their internal legislation, particularly with respect to*:"

a. "*Remuneration which guarantees, as a minimum, to all workers dignified and decent living conditions for them and their families …*"

"*Dignified and decent*" living conditions may be compromised by emissions from some Smart Meters and related appliances (EMFSN 2011).

In particular claims may be brought by some that their introduction may result / has resulted in reduced quality of home life and restrictions on which rooms in a dwelling may be used by vulnerable individuals.

e. "*Safety and hygiene at work; …*"

Claims may be brought that raised field regimes caused by the introduction of Smart Meters and related technologies in the workplace may compromise best practice as related to safety and hygiene at work and compromise health, wellbeing and productivity, particularly as RF/microwave radiation has now been classified as a Class 2B carcinogen (WHO/IARC 2011).

Article 10: Right to Health

1. "*Everyone shall have the right to health, understood to mean the enjoyment of the highest level of physical, mental and social well-being*."

Some Smart Meter regimes may compromise health. Others may, in comparison, help maintain it. Specifying the right type of system will help reduce likelihood of ill health and claims.

2. "*In order to ensure the exercise of the right to health, the States Parties agree to recognize health as a public good and, particularly, to adopt the following measures to ensure that right:"*
d. "*Prevention and treatment of endemic, occupational and other diseases;"*
e. "*Education of the population on the prevention and treatment of health problems, and*"
f. "*Satisfaction of the health needs of the highest risk groups …*"

As the right to health is a public good, it may be said that the States Parties have a duty to adopt measures to prevent diseases that may otherwise be exacerbated by some Smart Meter regimes - Refer also to section on '*Health Matters*'.

State Parties may also be required to educate the public of the possible health risk of exposure to field regimes from some Smart Meters and related items of technology.

Article 11: Right to a Healthy Environment

1. "*Everyone shall have the right to live in a healthy environment and to have access to basic public services."*

Claims may be brought that the right to live in a healthy environment is being violated in instances where unhealthy Smart Metering regimes are created.

2. "*The States Parties shall promote the protection, preservation, and improvement of the environment*."

State Parties might be held liable if they adopt Smart Meter regimes that can be proven to be harmful to the environment.

Article 14: Right to the Benefits of Culture

1. "*The States Parties to this Protocol recognize the right of everyone*:"
a. "*To take part in the cultural and artistic life of the community*;"

Individuals may claim that their Right to the Benefit of Culture is compromised if field regimes prevent them from taking part in the life of the community.

b. "*To enjoy the benefits of scientific and technological progress*;"

Properly undertaken, everyone has the right to enjoy benefits of scientific and technological progress. It is necessary to ensure that the correct Smart Meter systems are specified to help achieve this.

4. "*The States Parties to this Protocol recognize the benefits to be derived from the encouragement and development of international cooperation and relations in the fields of science, arts and culture, and accordingly agree to foster greater international cooperation in these fields*."

There are many benefits that can be created through international cooperation. One of these is the creation of safe, secure and environmentally friendly smart grids. To achieve this successfully a larger range of stakeholders may be required - *Refer to Appendices 5 and 6.*

Article 15: Right to the Formation and the Protection of Families

1. "*The family is the natural and fundamental element of society and ought to be protected by the State, which should see to the improvement of its … material conditions*."
2. "*Everyone has the right to form a family, which shall be exercised in accordance with the provisions of the pertinent domestic legislation*."
3. "*The States Parties hereby undertake to accord adequate protection to the family unit and in particular*:"
c. "*To adopt special measures for the protection of adolescents in order to ensure the full development of their physical, intellectual and moral capacities*; …"

Individuals may claim that the State's duty to protect their 'Right to the Formation and the Protection of Families' may be compromised by some Smart Meter regimes that may reduce their ability to form and protect their family.

Article 16: Rights of Children

"*Every child, whatever his parentage, has the right to the protection that his status as a minor requires from his family, society and the State. …* "

Some may claim that as the right to protection for children is from the moment of conception, electromagnetic field regimes that compromise this may breach children's Human Rights.

Article 17: Protection of the Elderly

"*Everyone has the right to special protection in old age. With this in view the States Parties agree to take progressively the necessary steps to make this right a reality and, particularly, to:*
a. Provide suitable facilities, …"

States Parties may be required to revise their Smart Meter provisions for the elderly if they wish to avoid potential breaches of Human Rights related to conditions (*including Alzheimer's Disease and cancers*) that may be aggravated by inappropriate field exposures.

Article 18: Protection of the Handicapped

"*Everyone affected by a diminution of … capacities is entitled to receive special attention designed to help him achieve the greatest possible development of his personality. The States Parties agree to adopt such measures as may be necessary for this purpose and, especially, to*:"
a. "*Undertake programs specifically aimed at providing the handicapped with the … environment needed for attaining this goal …*"
c. "*Include the consideration of solutions to specific requirements arising from needs of this group as a priority component of their urban development plans; …*"

Low field Smart Meter regimes might become a priority component of urban development plans, to protect those who are vulnerable by providing them with the specific environment they require to allow the greatest possible development of their personality.

Article 19: Means of Protection

1. "*Pursuant to the provisions of this article … the States Parties to this Protocol undertake to submit periodic reports on the progressive measures they have taken to ensure due respect for the rights set forth in this Protocol*."

The creation of secure low field Smart Meter regimes may prove an appropriate progressive protective measure.

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Chile, South America

Political Constitution of the Republic of Chile

Human Rights, as set out within the individual constitutions of South American countries, may also come into play with regard to Smart Meter rollouts.

In December 2009, the Appeal Court in Rancagua, Chile, confirmed by unanimous decision the demolition of Entel PCS' mobile phone mast for the protection of the public in the O'Higgins district of Santa Cruz affected by its radiation (El Mercurio 2009).

That decision was made on the grounds that the structure violated the constitutional rights and obligations of the Political Constitution of the Republic of Chile (PCRC 1980), namely that the State guarantees to all persons:

Article 19:

1. "*The right to life and to the physical and psychological integrity of the individual' - this law also 'protects the life of those about to be born.*" …

8. "*The right to live in an environment free from contamination. It is the duty of the State to watch over the protection of this right and the preservation of nature*."
"*The law may establish specific restrictions on the exercise of certain rights or freedoms in order to protect the environment*." …

9. 'The right to protection of health.'
"*The State protects the free and egalitarian access to actions for the promotion, protection and recovery of the health and rehabilitation of the individual."*
"The coordination and control of activities related to health shall likewise rest with the State." …

One of the specific factors that led to the Appeal Court's decision was a report from the Instituto de Salud Pública de Chile (Institute of Public Health of Chile) acknowledging human health can be damaged by RF/microwave emissions from by mobile phone masts.

As wireless Smart Meters emit similar radiation, their introduction might also be prohibited under such legislation.

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United States of America

United States Constitution

This document was created in 1787 and ratified in 1788 (DPC (1788). It is the second oldest constitution in the World still in use.

The Fourth Amendment – Search and Seizure

"*The right of the people to be secure in their persons, houses, papers, and effects, against unreasonable searches and seizures, shall not be violated, and no Warrants shall issue, but upon probable cause, supported by Oath or affirmation, and particularly describing the place to be searched, and the persons or things to be seized*."

There are already numerous concerns about privacy issues related to Smart Metering in the USA – Refer also to section on '*Data provision & privacy/security issues'* and Appendix 7.

Below are extracts of transcripts from the Supreme Court of the United States related to the Fourth Amendment and privacy that may be brought into play related to privacy claims brought against Smart Meters:

"*The makers of our Constitution undertook ... to protect Americans in their beliefs, their thoughts, their emotions, and their sensations. They conferred, as against the Government, the right to be let alone - the most comprehensive of rights and the right most valued by civilized men. To protect that right, every unjustifiable intrusion by the Government upon the privacy of the individual, whatever the means employed, must be deemed a violation of the Fourth Amendment*." O v US (1928).

"*[A] Fourth Amendment search occurs when the government violates a subjective expectation of privacy that society recognizes as reasonable*," Judge Harlan (K v US 2001).

"*The Fourth Amendment's protection of the home has never been tied to measurement of the quality or quantity of information obtained. … In the home, our cases show, all details are intimate details, because the entire area is held safe from prying government eyes,"* (K v US 2001).

"*At the very core*" of the Fourth Amendment "*stands the right of a man to retreat into his own home and there be free from unreasonable governmental intrusion*" (S v US 1961).

"*The Fourth Amendment is to be construed in the light of what was deemed an unreasonable search and seizure when it was adopted, and in a manner which will conserve public interests as well as the interests and rights of individual citizens*" C v US (1925).

"... it is the duty of the courts to be watchful for the constitutional rights of the citizen, and against any stealthy encroachments thereon," B v US (1927).

Right To Privacy

The US Constitution does not expressly state the right to privacy (Walenta 2011). However, US Supreme Court decisions have determined that the right to privacy is a basic Human Right, and as a result of this it is protected by virtue of the 9th Amendment: "*The enumeration in the Constitution of certain rights shall not be construed to deny or disparage others retained by the people*."

"*… most justices do believe that the Ninth Amendment has binding authority, and they use it to protect implicit rights hinted at but not explicated elsewhere in the Constitution. Implicit rights include … the right to privacy …*" Head (2011).

"*… In addition, it is said that a right to privacy is inherent in many of the amendments in the Bill of Rights, such as the 3rd, the 4th's search and seizure limits, and the 5th's self-incrimination limit*," (Walenta 2011).

"I believe that data mining is inherently dangerous to one's privacy and potentially dangerous to one's liberty on many levels depending on the intentions of the third party obtaining the information.

The smart meter applications and mesh networking systems penetration into one's privacy goes beyond the uses and misuse of data and defiling the sacredness of the home, … it compromises the exact status of one's life the minute it is turned on and alters the physical destiny of that person forever." Aders (2010).

The Fourteenth Amendment – Citizenship Rights
Section 1.

"… No State shall make or enforce any law which shall abridge the privileges or immunities of citizens of the United States; nor shall any State deprive any person of life, liberty, or property, without due process of law; nor deny to any person within its jurisdiction the equal protection of the laws."

a) Life

The IARC now classify RF/microwave radiation as a Class 2B carcinogen (WHO/IARC 2011), indicating to many that increased exposures (as may be caused by some Smart Metering regimes) may risk increasing individuals' chances of dying from cancer, thereby threatening their right to life and length of life.

The detrimental health conditions that may be exacerbated or induced by some types of Smart Metering regimes (EMFSN 2011, KCRA 2011, Milham 2011) might also be claimed to harm individuals' right to life.

Additional claims about individuals' right to life being compromised might be brought as a result of increased exposure to some RF/microwave regimes appearing to increase risk of miscarriage, damage to human offspring and infertility (Cherry 2000).

b) Liberty

The physical liberty of those who react adversely to exposures from some types of Smart metering regimes may be inadvertently compromised if such regimes inhibit/prevent them going where they wish outdoors and indoors, even within their own homes (EMFSN 2011), without the risk of becoming unwell and/or having their health compromised.

Insights into individuals' living patterns and relationships gained by third parties (*if Smart Meter and related technology data are not suitably anonymised*) may impinge on individuals' freedom of liberty to do as they please within their own homes (Aders 2010, Anderson & Fuloria 2010, metering.com 2009).

c) Property

There is the possibility that Individuals may claim that the installation of RF/microwave emitting Smart Meters and/or related smart technology abridges their privileges, as the radiation from them may interfere with their right to peacefully enjoy their possessions.

Individuals may be deprived of their right to enjoy their property (or parts of their property) in the manner to which they have become accustomed, due to RF/microwave emissions from such equipment (EMFSN 2011). It is suggested that it is not in society's interest to subordinate such use and enjoyment.

Additionally, claims may be made that the unwarranted introduction of such pollution from smart grid technologies may reduce the capital value of individuals' homes/property (some individuals are already being forced to relocate in an attempt to escape exposures and others may be less likely to want to move in thereby potentially reducing property value).

Some Smart Meter regimes may cause individuals to be deprived of other property that they own. This may include animals, insects (such as bees) and plants (including plant crops – that may be either directly or indirectly effected such as by loss of insect pollinators) – Refer to section on '*Environmental Concerns*'.

The effects on individuals' livelihoods of proposed metering schemes should also be seriously taken into consideration so that optimum solutions can be obtained for the good of all.

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Constitutions in individual States

The individual states in the USA, and elsewhere, can also have their own constitutional guidelines that may provide further levels of protection.

As an example:

California Constitution

Article 1: Declaration of Rights

Section 1.

"*All people are by nature free and independent and have inalienable rights. Among these are enjoying and defending life and liberty, acquiring, possessing, and protecting property, and pursuing and obtaining safety, happiness, and privacy*."

Commentary on this constitution as related to Smart Meters can be found in (Koehle 2010).

References

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The Universal Declaration of Human Rights

Eleanor Roosevelt with the Universal Declaration of Human Rights.
Image source: UN Photo

This declaration was the first international declaration of the human rights and fundamental freedoms to which all human beings are intrinsically entitled. It was initially adopted in 1948.

The General Assembly of the United Nations has proclaimed this Universal Declaration of Human Rights to be "*a common standard of achievement for all peoples and all nations*…" to promote "*social progress and better standards of life in larger freedom*."

Article 2.
"*Everyone is entitled to all the rights and freedoms set forth in this Declaration*, … "

Article 3.
"*Everyone has the right to life, liberty and security of person*."

As previously stated elsewhere in this review, "*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 (Cherry 2000); claims might be brought that increasing involuntary exposures to such regimes may be against individuals' right to life*."

'Security of person' is legally defined as "*The legal and uninterrupted enjoyment by a man of his life, his body, his health and his reputation*." Claims may be brought by some that enjoyment of life and health may be seriously compromised by the RF/microwave regimes created by some Smart Meters and related technologies.

Claims might also be brought that some individuals may have their reputations damaged as a result of how they are forced to behave as a result of exposures, or potential exposures to RF/microwave radiation from such units. Claims might also be brought that they find that having to behave in this way is degrading and damaging to their security of person.

Additionally, with regard to privacy issues, it could be claimed that lifestyle information determined by third parties from analysis of energy usage divulged by Smart Meters (if data is not suitably protected and/or anonymised) may potentially damage individuals' reputations and security of person. *Refer also to Appendix 7 for one opponent's views*.

Article 5.

"*No one shall be subjected to torture or to cruel, inhuman or degrading treatment or punishment*."

As documented earlier when discussing the UK - Human Rights Act 1998, the "*… feelings of fear, anguish and inferiority, capable of humiliating and debasing… and possibly breaking… physical or moral resistance*" that can be caused by degrading treatment (IUK 1980) appear very similar to descriptions of how EHS individuals can feel when exposed to RF/microwave emissions as created by Smart Meter units (EMFSN 2011). This suggests that deliberately exposing vulnerable individuals to such regimes may be against their basic Human Rights.

Article 7.

"*All are equal before the law and are entitled without any discrimination to equal protection of the law. All are entitled to equal protection against any discrimination in violation of this Declaration and against any incitement to such discrimination*."

Claims might be brought that if providers ignore the special needs of individuals who are, or believe they are, vulnerable to exposure to the EMF radiation emitted by some Smart Meter and related devices, they may be guilty of discrimination.

Claims might also be brought that those who deliberately ignore and dismiss relevant scientific evidence of potential risks may be guilty of inciting others to unwittingly discriminate against such individuals.

Article 8.

"*Everyone has the right to an effective remedy by the competent national tribunals for acts violating the fundamental rights granted him by the constitution or by law*."

As everyone has the right to an effective remedy for acts violating fundamental rights, there appears a very real possibility that those who violate such rights may be required to pay for their rectification.

Article 12.

"*No one shall be subjected to arbitrary interference with his privacy, family, home or correspondence, nor to attacks upon his honour and reputation. Everyone has the right to the protection of the law against such interference or attacks*."

There are significant concerns being expressed worldwide that some Smart Metering regimes may compromise this basic Human Right (FIPR 2010, OTLB 2010, Cuipers & Koops 2008).

This policy has already been successfully contested in the Netherlands (Anderson & Fuloria 2010), causing the previously mandatory introduction of Smart Metering there to be replaced by a voluntary 'opt in' scheme.

Article 13.

1. "*Everyone has the right to freedom of movement and residence within the borders of each state. …*"

The freedom of movement of individuals vulnerable to the effects of RF/microwave emissions may be compromised by the presence of some Smart Meter regimes. This has already been documented after some rollouts, and can even restrict some individuals to which rooms within their own homes they can occupy (EMFSN 2011, KCRA 2011).

Article 16.

1. "*Men and women of full age, without any limitation due to race, nationality or religion, have the right to marry and to found a family. …*"

Scientific research has demonstrated that increased exposures to RF/microwave can reduce human fertility and increase risk of miscarriage, thereby hindering individuals' rights to found families (Cherry 2000).

Claims of breaches of Human Rights may be brought if similar risks are indicated with particular types of Smart Meters and related technology. (Opting for technologies such as fibre-optics would appear to reduce such risks and likelihood of claims – present author's comment).

3. "*The family is the natural and fundamental group unit of society and is entitled to protection by society and the State*."

There is a risk that States (and utility companies) may be declared negligent if they rush through the adoption of Smart Meter technologies that are indicated as potentially placing the family unit at increased risk of ill health, infertility, burglary, identity theft and other privacy violations.

Article 17.

… 2. "*No one shall be arbitrarily deprived of his property*."

The term 'property' can be legally defined as including real estate, land, growing plants and animals. If particular Smart Metering regimes are shown to cause losses to any of these, claims may be made that that this basic Human Right is being denied.

RF/microwaves have already been shown to be capable of causing damage to plants and animals at levels below internationally accepted guidelines and at levels below that which RF/microwave emitting Smart Meters operate.

Anecdotal evidence has also been presented which indicates that some Smart Meter regimes may harm plants and animals – *Refer to section on 'Environmental Concerns' in present document.*

Article 21.

… 2. "*Everyone has the right of equal access to public service in his country. …*"

Inappropriate RF/microwave regimes from certain types of Smart Meters and related technology may prohibit some vulnerable individuals from directly accessing public services if these units are present.

Article 23.

1. "*Everyone has the right to work, to free choice of employment, to just and favourable conditions of work …*"

It has been suggested that the EMF emissions from some Smart Meters and related smart technologies in the workplace may

compromise the right to work of vulnerable individuals who may react adversely to such exposures. It might therefore be claimed that such conditions are neither just nor favourable to such individuals and may compromise their free choice of employment.

Article 25.

1. "*Everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, including … housing …*"

Anecdotal evidence already indicates that the standard of living of many individuals, as related to health, wellbeing and earning ability, is presently being compromised by a number of Smart Meter rollouts (EMFSN 2011, KCRA 2011).

Standards of living, as related to useable space within individuals' homes, may also become compromised, as vulnerable individuals are no longer able to occupy some areas of their homes (and gardens) for prolonged periods due to emissions from some types of Smart Meters and related technology (EMFSN 2011, KCRA 2011).

2. "*Motherhood and childhood are entitled to special care and assistance. …*"

As RF/microwave radiation is classified as a Class 2B carcinogen (WHO/IARC 2011), and has been linked with increased incidence of miscarriage and damage to human offspring (Cherry 2000); it would appear wise to limit the exposure of mothers and children to additional sources of such emissions, or at to least prove that the type of emissions created by Smart Meters and related technology cause no such risk.

Article 27.

1. "*Everyone has the right freely to participate in the cultural life of the community, to enjoy the arts and to share in scientific advancement and its benefits. …*"

Individuals may be prohibited from fully participating in the cultural life of the community if their health is compromised as a result of unwarranted exposures to Smart Meter EMF regimes that damage their health.

In order to help allow vulnerable individuals to share in scientific advancement it is necessary to develop/specify Smart Metering regimes that are scientifically proven, truly beneficial and biologically friendly.

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Additional Human Rights guidelines to those mentioned in this document also exist.

Health Matters

Image source: Bluestone 360°

Health effects and guidance

"*Wireless communication is now being implemented in our daily life in a very fast way. At the same time, it is becoming more and more obvious that the exposure to electromagnetic fields not only may induce acute thermal effects to living organisms, but also non-thermal effects, the latter often after longer exposures. This has been demonstrated in a very large number of studies and includes cellular DNA-damage, disruptions and alterations of cellular functions like increases in intracellular stimulatory pathways and calcium handling, disruption of tissue structures like the blood-brain barrier, impact on vessel and immune functions, and loss of fertility,*" Johansson (2011). – *Refer also to Appendix 8*.

It is essential that the possible health effects of electromagnetic fields from Smart Meters, and related technologies, are properly addressed so that appropriate technology is used in rollouts.

The International Agency for Research on Cancer (IARC) has recently reclassified RF/microwave radiation as being possibly carcinogenic to humans (WHO/IARC 2011).

As a result of concerns, some insurers (*including Lloyds of London*) are now withholding coverage for risks linked with such radiation (Ryle 1999).

The Parliamentary Assembly of the Council of Europe now calls for all reasonable measures to be taken to reduce exposure to electromagnetic fields (PACE 2011).

Whilst not all RF/microwave regimes are potentially harmful (*as an example: very low levels of frequency-specific amplitude-modulated EMFs are indicated as beneficial for treating advanced carcinoma (Costa et al. 2011*)); many manufacturers of RF/microwave emitting devices now ensure that their devices carry warnings.

As an example, one mobile phone manual states that studies "*have suggested that low levels of RF could accelerate the development of cancer in laboratory animals. In one study, mice genetically altered to be predisposed to developing one type of cancer developed more than twice as many cancers when they were exposed to RF energy compared to controls*," (Motorola 2011).

"*I want to be very clear. Industry has not said once - once - that … [RF/microwave radiation is] safe. The federal government and various interagency working groups have said it is safe*."
K. Dane Snowden, Vice President, External & State Affairs, CTIA-The Wireless Association®* (Safeschool 2010).

The possible effects that RF/microwave exposures from Smart Meters and related technologies may have on health should be taken very seriously.

Adverse health effects are already being claimed after some Smart Meter rollouts (EMFSN 2011, KCRA 2011). Among conditions that may be exacerbated are: Autism, Alzheimer's disease, Cancer, Diabetes, DNA damage, Electrohypersensitivity, Fatigue/sleep deprivation, Fertility and Obesity.

The following are 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).

UK perspective

In 2011 the UK's Department of Energy and Climate Change (DECC) confirmed it is involved in discussions with the Department of Health (DH) over potential safety concerns related to the proposed mass installation of Smart Meters in the UK.

The DECC states it aims to continue discussions with the DH as concerns escalate over research linking exposure from Smart Meter technologies with adverse health effects, including increased cancer risk, and that it "*will keep under review any evidence related to the effects of radiofrequency signals on the health of individuals,*" (Evans 2011). UK industry is also addressing these concerns:

"*The [UK] Smart Metering System shall be installed and maintained in a manner that protects public safety*."
Prospectus requirement - The UK Smart Metering Design Group (SMDG 2011).

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Health Impacts

Possible low cost indicators

Dark Field Microcospy

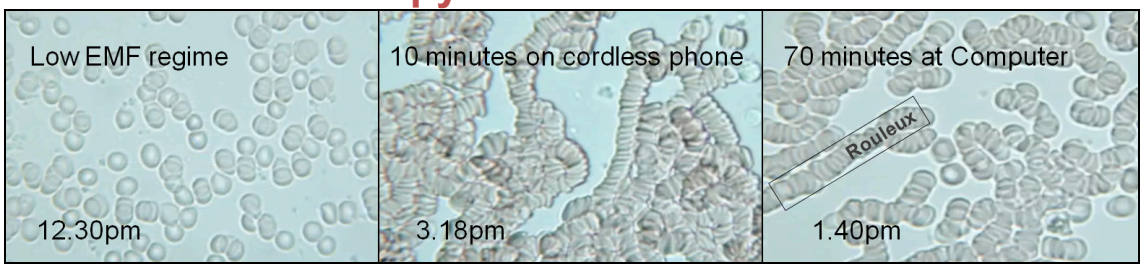

Image source: Havas (2010), http://www.youtube/watch?v=L7E36zGHxRw

Dark field microscopy indicates that some field regimes may cause clumping of red blood cells similar to that found with diabetics, individuals with heart conditions, and cancer patients (Havas 2010).

Rouleaux formation, as shown above (*where blood cells stack together*) is often a precursor to many serious diseases and can occur when blood is exposed to some RF/microwave regimes and intensities.

It may be useful to assess the effects of different Smart Meter regimes on blood parameters using this technique.

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 (NUO 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 (NUO 2011).

It appears likely that the results of such procedures (as documented above), if undertaken for Smart Meters, would provide valid evidence acceptable in court as to their suitability.

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NUO (2011), EMFs and changes in the Complete Blood Count, Next-up Organisation, http://www.next-up.org/pdf/EMFs_and_changes_in_the_Complete_Blood_Count.pdf

Employing Smart Meter technologies that are proven to be 'biologically friendly' would greatly help allay public fears and further increase their likelihood of their success.

Health symptoms, RF/microwave radiation and dose response

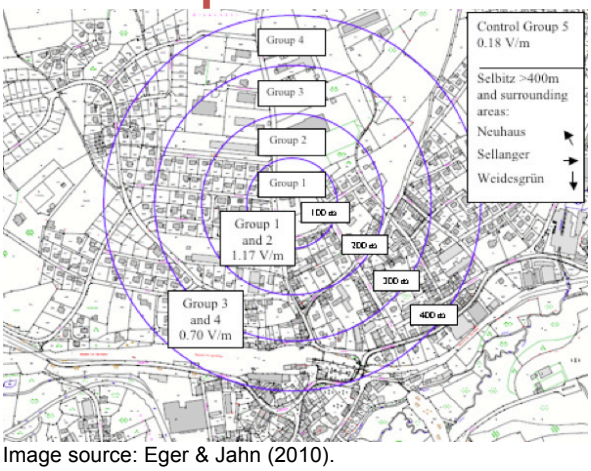

Image source: Eger & Jahn (2010).

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.

Eger & Jahn's 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.*

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Smart Meter exposures

Image source: http://stopsmartmeters.org/2011/08/11/smart-meters-not-green-not-safe-not-legal/

Moldan (2009) noted pulsed microwaves emitted by a single Smart Meter resulted in a power-density of 0.05 μW/cm² at 1 m (3.28 ft). This increased to 0.2 μW/cm² 0.5 m (1.64 ft) from the unit and 5.5 μW/cm² 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 μW/cm^2 (in the 902-928 MHz range) 30.5 cm (1 ft) from a single wireless Smart Meter for electricity. At a similar distance, they recorded a power-density of 0.00166 μW/cm^2 for a single gas Smart Meter operating in the 450-470 MHz range. Units can also operate in the 2.4 GHz range. In that work, power densities of 1.0 μW/cm^2 and 0.1 μW/cm^2 were measured at distances of 91.4 cm (3 ft) and 304.8 cm (10 ft) from the signal (CCST 2011).

Higher power densities will occur nearer individual wireless Smart Meters and when multiple units (as shown above) and other RF/microwave emitting items are in use. Reflections can also occur, causing potential hotspots and increasing local radiation levels (SA 2011). 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 0.05-0.1 μW/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 smart technology that are relaying information 24/7. Exposures from other RF/microwave emitting equipment would also contribute to the apparent risk cited.

Studies matrix of power densities similar to those caused by *single* wireless Smart Meter

Power Density	Reported Biological Effects	References
0.000000001 $\mu W/cm^2$	Altered EEG in humans' brain waves & behaviour	Bise (1978)
0.002 $\mu W/cm^2$	Abnormal blood pressure, digestive problems, fatigue, joint & limb pain, nervousness, sleep disorders & weakness	Altpeter et al., (1995, 1997)
0.06 $\mu W/cm^2$	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 $\mu W/cm^2$	EEG brain waves altered under exposure to cell phone signal	von Klitzing (1995)
0.6 $\mu W/cm^2$	Cardiac arrhythmias & sometimes cardiac arrest (frogs)	Frey (1986)
1.0 $\mu W/cm^2$	Headache, dizziness, irritability, fatigue, weakness, insomnia, chest pain, difficulty breathing, indigestion (humans – occupational exposure)	Simonenko et al., (1998)
0.168 - 1.053 $\mu W/cm^2$	Decrease in newborns & irreversible infertility in mice after 5 generations	Magras & Zenos (1997)
5.0 $\mu W/cm^2$	Biochemical and histological changes in brain, heart, kidney & liver tissue	Belokrinitskiy, V.S. (1982)
8 $\mu W/cm^2$	Association between increased incidences of childhood leukaemia & mortality through RF fields	Hocking et al., (1996)

"... the possibility of harm from exposures [to low levels of radio frequency radiation] insufficient to cause important heating of tissues cannot yet be ruled out with confidence."
Sir William Stewart

Reducing RF/microwave exposure, particularly at night when the body is sleeping, might greatly reduce risk of serious illness.

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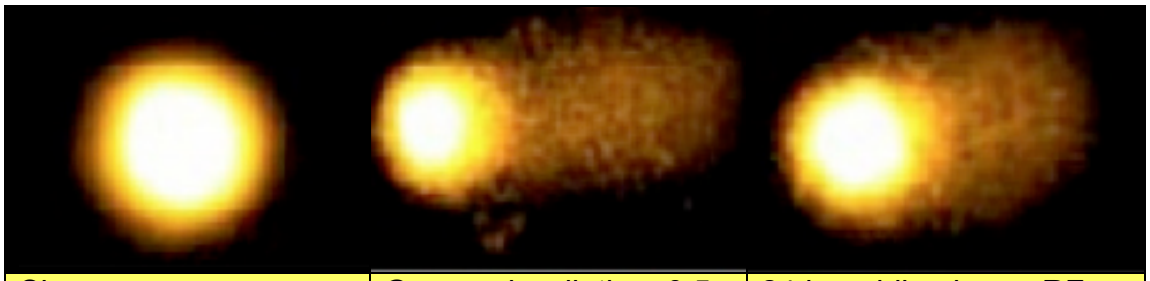
Possible Health Risks

Introduction



Sham	Gamma-irradiation, 0.5 Gy (1,600 chest x-rays)	24 h mobile phone, RF-EMF, 1800 MHz at SAR = 1.3 W/kg. ICNIRP/WHO = 2 W/kg

Comet Assay - a typical picture after RF-EMF-exposition of HL60 leukaemia cells
Image source: Adlkofer (2004).

> *"… 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).

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).

It would appear prudent to undertake similar tests with 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).

> As no official data is available on the health effects of exposures to radiation from Smart Meters and related devices; reference is made to research undertaken on other devices emitting RF/microwave radiation at similar intensities.

> 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).

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Autism

Image source: http://www.dreamstime.com/royalty-free-stock-photography-autism-kid-looking-far-away-image20515227

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 (Knapp et al. 2007). The number of individuals diagnosed with autism is 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 an additional factor may also be at work – electromagnetic pollution. Whilst there are likely to be a number of 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 national economies.

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 disproved or properly verified, is provided by an unpublished pilot study by Dr Dietrich Klinghardt MD, PhD. It intriguingly links higher levels of microwave radiation [0.011-0.171 μW/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 μW/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 do increase autism risk, and if so how new generations of 'bio-friendly' technology can mitigate, or even reverse, such risk.

Such precautions are in line with 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).

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Alzheimer's disease

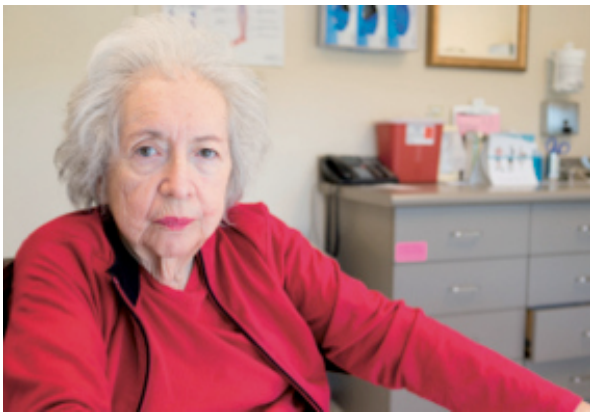

Image source: http://www.dreamstime.com/stock-photo-elderly-woman-with-alzheimer-image21269060

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).

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 appears important to reduce ELF and RF/microwave magnetic field exposures "*through equipment design changes and [proper] environmental placement of electrical equipment …*" Davanipour & Sobel (2009).

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).

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 nonthermal microwave exposures produced clinical Alzheimer's disease - lack of funding prevented his findings being followed up at that time (Becker 1990).

Increased risk of Alzheimer's disease and other neurodegenerative disorders is also linked to the 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, as can be caused by exposure to RF/microwave radiation, 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).

There are other electromagnetic factors that may affect the risk of succumbing to dementia. These, however, are out with the brief of this current document – *present author's comments*.

Interestingly, research by Arendash et al. (2010) indicates that unmodulated microwaves might be able to mitigate the effects of Alzheimer's. However, as the health effects of both these and modulated microwaves (as experienced when using mobile phones) have yet to be adequately researched, caution is required.

The cost of Alzheimer's and other dementias to the UK economy is presently £23 billion per year (ARUK 2011).

The number of individuals in the UK with dementia is presently predicted to rise as the population ages. Reducing RF/microwave exposure may be a novel way to help reduce the number of future sufferers. This may in part be achieved through optimising the design of Smart Meters, and related technologies, to help reduce/optimise individuals' exposures.

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"*The worldwide costs of dementia will exceed 1% of global GDP in 2010, at US$604 billion. … The costs of caring for people with dementia are likely to rise even faster than the prevalence*…" ADI (2010).

Dementia is one of the World's most costly illnesses. Interventive measures that reduce risk are likely to save Governments substantial outgoings.

Cancer

Image source: jscreationzs, http://www.freedigitalphotos.net/images/view_photog.php?photogid=1152

Cancer rates are rising in the UK. The annual cost of cancer to England (not the whole UK – *present author's 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).

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). In the USA, it is estimated that around 41 percent of citizens will be diagnosed with cancer at some time in their lives and approximately 21 percent die from it (US DHSS 2010).

"*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. This data provides compelling evidence that balancing the world's global health agenda to address cancer will not only save millions of lives, but also billions of dollars*," ACS (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 may be prudent to opt for Smart Meter options that avoid creating EMF regimes that may increase this risk.

Whilst there is growing anecdotal evidence on the effects of RF/microwave emissions from Smart Meters on health, no proper research appears to have been undertaken to date. As this is the case, examples are given of other studies assessing the possible effects of similar types of radiation on animals and individuals as related to cancers.

Whilst a large number of studies (such as those shown below) indicate a link between inappropriate exposures to some EMF regimes and negative health effects; it is important to recognise that not all studies do so, and that beneficial field regimes can also be created (Jamieson et al. 2010).

Eger et al. (2004) found increased risk of malignant tumours in individuals exposed to 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 (Eger et al. 2004).

(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).

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.

An association has also been noted between increased incidences of childhood leukaemia & mortality through RF fields at power densities of 8 $\mu W/cm^2$ (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.

The need for additional research particularly under field regimes individuals might receive in standard domestic environments when Smart Meters and smart appliances are installed appears necessary.

"*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).

For additional details on studies which indicate that long-term *low intensity* RF/microwave exposures may provoke cancer growth please refer to the review document by Yakymenko et al. (2011).

"*… just as there are many opportunities for harmful environmental exposures, ample opportunities also exist to intervene in, ameliorate, and prevent environmental health hazards. Governments, industry, the academic and medical communities, and individuals all have untapped power to protect the health of current and future generations … and reduce the national burden of cancer.*" US President's Cancer Panel (US DHSS 2010).

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In 2008 the total economic impact of premature death and disability from cancer worldwide was $895 billion. This figure is equivalent to 1.5 % of the World's Gross Domestic Product (GDP) and does not incorporate direct medical costs (ACS 2010).

Tests assessing the potential biological effects of exposures to different types of 'smart' technology regimes to prove that they are safe may prove prudent, as this could lead to the development of safer RF/microwave technologies if risks are determined to be real.

Diabetes

Image source: Ambro / FreeDigitalPhotos.net, http://www.freedigitalphotos.net/images/view_photog.php?photogid=1499

Diabetes related care costs the UK upwards of £5 billion annually (Currie et al. 1997).

The cost of diabetes drugs and treatment have risen 40% in the last five years, and since 1996 the number of diagnosed individuals has increased from 1.4 million to 2.6 million.

It is predicted that, unless matters are taken in hand, over four million people will have diabetes by 2025 (Diabetes UK 2010).

'Dirty electricity' - high frequency transients created by a variety of electrical devices (including some Smart Meters) and sometimes carried on mains electricity - may be a contributory factor to diabetes and other health conditions (Milham 2011, Havas 2006).

The switching-mode power supply (SMPS) units in Smart Meters can often create such transients, and it has been suggested may in part be responsible for the detrimental health effects observed with Smart Meter installations even when wireless transmission is disabled (Brangan & Heddle 2011) – Refer also to the section '*PLC, Smart Meters and health' elsewhere in this review*.

The effects of exposure to RF/microwaves regimes from wireless Smart Meters on diabetics have yet to be assessed.

Havas (2006) determined that Type 1 diabetics required less insulin and Type 2 diabetics registered lower blood sugar levels when in electromagnetically clean environments.

Poor sleep is also a contributory factor to diabetes – *see related notes on Fatigue/sleep deprivation*:

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"*The prevalence of diabetes has reached epidemic proportions. … Diabetes is one of the major causes of premature illness and death worldwide. Non-communicable diseases including diabetes account for 60% of all deaths worldwide*." World Diabetes Foundation (2010).

Electrohypersensitivity

Source: http://en.fotolia.com/id/25156314

This is known by a variety of terms including 'Electrosensitivity' (ES), 'Electrohypersensitivity' (EHS), 'Electromagnetic Hypersensitivity' (EHS) and 'Idiopathic Environmental Intolerance with Attribution to Electromagnetic Fields' (IEI-EMF). The WHO began investigating it after Dr Gro Harlem Brundtland, their Director General (and 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.

Peer-reviewed studies (not directly investigating EHS) indicate increased occurrence of a number of these symptoms in areas where raised exposures to RF/microwaves exist. A partial listing is given below:

Depression: Eger & Jahn (2010) found a highly significant dose-response relationship between the RF/microwave field strengths encountered at residential locations and depression ($p < 0.001$). In their study, the mean radiation exposure level of the highest exposure group (1.2 V/m) was substantially higher than that recorded in other work.

Santini et al. (2002) found an increase in depression for people living within 100 m of a base station, as opposed to in lower field regimes. Women were particularly affected ($p < 0.05$). Increased

incidence of depression also noted under similar circumstances by Bortkiewicz et al. (2004).

The cost to the UK economy of depression in terms of lost earning is now over £9bn a year. This represents an increase of £4bn since 1999, and a rise of half a billion over the last year (RSHCL 2010).

Dizziness: Eger & Jahn (2010) noted a highly significant dose-response relationship between the RF/microwave field strengths measured at residential locations and dizziness when comparing high field and low field exposure groups – *mean exposures levels of 1.17 V/m compared to 0.70 V/m* ($p < 0.001$).

Santini et al. (2002) found an increase in individuals complaining of dizziness when they were living within 100 m of a base station, as opposed to living further away ($p < 0.05$), whilst Simonenko et al., (1998) noted increased incidence of dizziness occurred in individuals at occupational exposures of 1.0 μW/cm^2.

Headaches: 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) documented a significant link ($p < 0.017$) between headaches and exposures to power densities >0.05 μW/cm^2 (maximum 0.41 μW/cm^2) compared to ≤0.01 μW/cm^2.

Simonenko et al. (1998) recorded increased incidence of headaches at 1.0 μW/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.

Headache disorders cost the UK around £7 billion a year in absenteeism and reduced productivity (Thomas 2009).

Irritability: Santini et al. (2002) noted an increase in individuals complaining of irritability when living within 100 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 noted that increased complaints of irritability in individuals close to base stations. Simonenko et al., (1998) found occupational exposures of 1.0 μW/cm^2 were associated with increased irritability.

Memory deficits: Increased incidence of concentration difficulties was found in the vicinity of base stations by Bortkiewicz et al.] could also be affected. Poorer memory retention was found by Santini et al. (2002) for individuals living within 100 m of a base station ($p < 0.05$).

Simonenko et al. (1998) reported incidence of difficulty breathing, dizziness, chest pain, fatigue, headache, indigestion, insomnia, irritability & weakness) at occupational exposures of 1.0 μW/cm^2.

Incidence of EHS

A 2001 Swiss survey by Röösli et al. (2004), investigating symptoms of ill-health ascribed to EMF exposure, revealed that individuals most often related their symptoms to exposure to RF/microwave radiation from mobile phone base stations (74%), followed by use of mobile phones (36%), cordless phones (29%) and exposure to power lines (27%). The most common mitigative measure taken by the respondents was to avoid exposures.

Removing or disconnecting field sources indoors was judged to be particularly effective in reducing/preventing symptoms.

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

National variations: Figures on individuals who may be EHS vary greatly between countries. This may be in part due to differences in educational awareness, survey definitions, environmental factors and variations in the field regimes individuals are exposed to.

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.

A German study involving 30,047 participants, found that 10.3% attributed personal adverse health effects they had to exposure to RF/microwave emissions from mobile phone base stations (Blettner et al. 2009).

EHS has become officially fully omm. nted 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 verdict issued on 23rd May awarded the college professor, who has been permanently incapacitated, a permanent disability pension at 100% of his base salary rate.

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Refer also to Appendix 8 – Seletun Resolution

Fatigue/sleep deprivation

Image source: Michal Marcol, http://www.freedigitalphotos.net/images/view_photog.php?photogid=371

Exposure to some RF/microwave radiation regimes are linked with fatigue and insomnia (Eger & Jahn 2010, Hutter et al. 2006, Bortkiewicz et al. 2004).

Simonenko et al. (1998) noted occupational exposures of 0.1 $\mu W/cm^2$ could cause both fatigue and insomnia in humans, whilst Santini et al. (2002) found a significant increase in individuals complaining of fatigue within 300 m of a base station and sleep disturbances within 200 m of a base station ($p < 0.05$).

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.

The present annual cost to the UK economy of chronic sleep deprivation is estimated at £1.6 billion (Bupa 2010).

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.

Fatigue/sleep deprivation and accidents: 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 (DfT 2011).

"*The only real cure for sleepiness is proper sleep.*"
UK Department for Transport (DfT 2005).

The extent to which EMF emissions by some types of Smart Meters and related technologies may result in increased fatigue and insomnia has yet to be fully determined. One survey indicated that 49.1% of their respondents reported sleep problems in either themselves or members of their household after the installation of wireless Smart Meters (SDA 2011). *Refer also to Appendix 1.*

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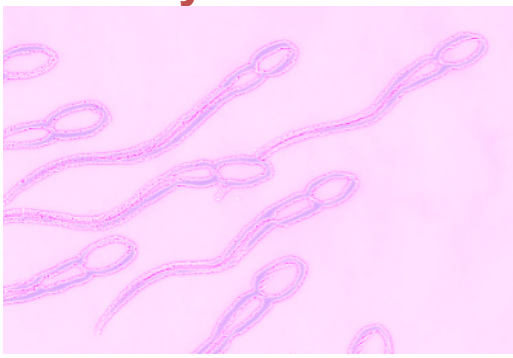
Infertility



Animals

Research by Magras & Zenos (1997) recorded irreversible infertility in mice after 3 generations at exposures of 1.053 μW/cm^2 from a RF tower – measurements were taken in the 80–900 MHz range. Lower exposures of 0.168 μW/cm^2 (further away from the tower) were linked with total infertility in mice after 5 generations.

As mentioned elsewhere in this document, PG&E (2011) have recorded a power-density of 8.8 μW/cm^2 (in the 902-928 MHz range) 30.5 cm from a single wireless Smart Meter. Wireless Smart Meters can also operate in the 450-470 MHz and 2.4 GHz range.

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 μm^2 versus controls 18.8 $\pm$ 1.4 μm^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 spermiogramms (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*."

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

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 smart metering regimes do not impact negatively on health.

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It has also been indicated that RF/microwave radiation at levels encountered in the environment may affect fertility of insects, birds and amphibians – Refer to section on '*Environmental Concerns*'.

Learning ability

The hippocampus

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.

Some wireless electric Smart Meters operate in the 902-928 MHz range.

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.

900 – 1800 MHz exposures

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) (Nittby et al. 2008).

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. (Narayanan et al. (2009).

2.4 GHz exposures

Some 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 leaning ability or other biological functions.

Research undertaken by Wang & Lai & (2000) indicated that exposure to some 2.45 GHz RF/microwave regimes may affect memory.

In that work, the long-term memory and navigational skills of rats appeared negatively influenced by one hour of exposure to 2.45 GHz radiation (pulse width 2ms, 500 pulses/s, average power density of 2,000 $\mu W/cm^2$) as compared to the unexposed control group. Whilst some studies by others failed to replicate this work (MMF 2005), the need for caution is indicated.

A later study by Li et al. (2008), found exposing rats to a 2.45 GHz pulsed RF/microwave field at an average power density of 1,000 $\mu W/cm^2$ for 3 hours daily for up to 30 days resulted in significant deficits in spatial learning and memory performance in the exposed rats.

Concentration, memory or learning problems

Though no official human testing has been undertaken related to Smart Meters, a survey on their impacts found that for 34.6% of recipients (n = 318), either they or individuals in their homes experienced worsened concentration, memory or learning problems since Smart Meter installations (SDA 2011). Refer also to Appendices 3 and 4 related to *'Health promotion'* and '*Educational buildings and Smart Meters*'.

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Obesity

Image source: Michelle Meiklejohn, http://www.freedigitalphotos.net/images/view_photog.php?photogid=901

Obesity is on the rise worldwide. It is estimated that the annual cost of obesity in the USA may be over $75 billion (Finkelstein et al. 2004).

In 1980, 36% of the UK population was categorised as being overweight or obese. By 2004 this figure had risen to 63%, with a third being categorised as obese. Almost two of every three individuals in the UK are overweight or obese (WHO 2005). If this is not addressed, 60% of men, 50% of women and 25% of children in the UK could be obese by 2050 (DH 2011).

Obesity increases risk of many serious ailments:
Cardiovascular disease, Cancer, Diabetes, High blood pressure, Osteoarthritis, Psychological problems / Mental Disorders, Urinary incontinence & Sleep disorders (NIH 2011).

Obesity places a significant burden on health services worldwide. At present it is estimated that the UK's National Health Service (NHS) has direct costs of £4.2 billion annually caused by obesity, and that this figure is likely to double by 2050. Reducing obesity is a priority of the UK Government (DH 2011).

Poor quality sleep, as can be created by exposure to inappropriate RF/microwave regimes – *Refer to related item on 'Fatigue/sleep deprivation' in current document* – is a contributory factor to obesity.

Sleep debt can increase fatigue levels making individuals less prone to exercise. It can also increase levels of the hormone grehlin thereby stimulating appetite (Taheri et al. 2004).

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The EMF Safety Network Smart Meter survey (SDA 2011) indicated 49.1% of respondents (n = 318) experienced sleep problems after Smart meter installations. The need to replicate that study appears evident.

Smart Meter Health Impacts Testimonials

Image source: Grant Cochrane, http://www.freedigitalphotos.net/images/view_photog.php?photogid=2365

Smart Meter Health Impacts – comments

EMFSN (2011), Smart Meter Health Complaints, EMF Safety Network, http://emfsafetynetwork.org/?page_id=2292

Excerpts

The following comments about how the new wireless utility Smart Meters have [apparently – *present author's comment*] affected people's health were sent to the EMF Safety Network, or publicly posted. 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 omm. nt 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 distrubution and the adjacent neighbor's meters are on my side of their houses, putting me in direct line of currect 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 (EMFSN 2011) – *present author's comment.*

Reference

EMFSN (2011), Smart Meter Health Complaints, EMF Safety Network, http://emfsafetynetwork.org/?page_id=2292

Health Impacts from Smart Meters – the CCST report

The California Council on Science and Technology (CCST 2011) agreed to gather and assess the evidence available on the impacts of RF/microwaves from Smart Meters on health.

The CCST assessed two particular questions:

1. "Whether FCC [US Federal Communications Commission] standards for Smart Meters are sufficiently protective of public health taking into account current exposure levels to radiofrequency and electromagnetic fields."

2. "Whether additional technology specific standards are needed for Smart Meters and other devices that are commonly found in and around homes, to ensure adequate protection from adverse health effects."

For the first question the CCST found that "*The FCC standard provides an adequate factor of safety against thermally induced health impacts of smart meters and other electronic devices in the same range of RF emissions.*"

The CCST also noted that "*in some of the studies reviewed, contributors have raised emerging questions from some in the medical and biological fields about the potential for biological impacts other than the thermal impact that the FCC guidelines address*."

> *"Non-thermal effects ..., including cumulative or prolonged exposure to lower levels of RF emissions, are not well understood. Some studies have suggested non-thermal effects may include fatigue, headache, irritability, or even cancer,…"* (CCST 2011).

The CCST suggests additional research and monitoring are required to help better document and understand non-thermal effects.

Comments

United States Environmental Protection Agency

In 2002 the United States Environmental Protection Agency (US EPA), in correspondence with the President of the EMR Network stated that the FCC guidelines had been "*recommended by the EPA with certain reservations*."

The US EPA stated that since its comments were submitted to the

FCC in 1993:
- the amount of scientific research documenting effects associated with both acute and chronic low-level exposure to RF/microwave radiation had risen.
- health and safety agencies have still to develop policies relating to risk from long-term, *non-thermal* exposures.

The US EPA also declared that:
- exposures complying with the FCC's guidelines are usually presented as "*safe*" by many RF/microwave operators and service providers in spite of uncertainties over possible risks from intermittent non-thermal exposures.

- The FCC guidelines are considered to protective against effects arising from thermal mechanisms but *not all* possible mechanisms.

- the generalisation by many that FCC guidelines protect humans from harm by any or all mechanisms is unjustified. US EPA (2002).

Maret (2011), commenting on the CCST Report, mentions that the biological effects of low-level, non-thermal EMFs have been investigated for over 30 years.

He provides the following quote from Professor Arthur Pilla, PhD (*Professor of Biomedical Engineering, Columbia University and Director of the Bioelectrochemistry Laboratory, Mount Sinai School Of Medicine, New York*) taken from the Handbook of Biological and Medical Aspects of Electromagnetic Fields (Third Edition):

"*The biophysical lore … and lingering to this day is that, unless the amplitude and frequencies of an applied electric field were sufficient to trigger an excitable membrane (e.g. heart pacemaker), produce tissue heating or move an ion along a field gradient, there could be no effect. …. However, this position had to be changed as the evidence for weak (non-thermal) EMF bioeffects became overwhelming,*" (Pilla, 2006).

This latter point is in agreement with the thoughts of Associate Professor Magda Havas, as documented in the written report CCST asked her to submit to it on Smart Meters (Havas 2011). With regard to the 'Thermal vs. Non-thermal Debate', citing Inglis (1970), she also notes that (non-thermal) biological effects can take place at levels far below the FCC thermal guidelines.

Maret (2011) goes further on this topic, stating that there is a large body of scientific literature describing several key mechanisms for non-thermal effects. He cites early reports by Frey (1993), Hyland (2000) and Lai (2000) on the potential health effects on non-thermal EMFs, then mentions that many relevant scientific findings are covered by the BioInitiative Working Group (2007), and that last year the European Journal of Oncology published an entire monograph outlining non-thermal effects of EMFs (Giuliani & Soffritti 2010).

Key mechanisms that he mentions for the action of weak EMFs are:

- changes in the blood-brain barrier of test-animals after microwave exposure
- change of calcium ion leading to changes in cells' metabolic processes
- removal of calcium ions bound to cellular membranes, leading to their weakened structure and changed cellular functioning
- leakage of calcium ions into neurons creating spurious action potentials
- defined cellular stress response, including production of heat shock proteins (HSP), which are triggered electromagnetically at non-thermal levels (that need far less energy than when triggered by heat)
- fragmentation of DNA in cells as shown through Comet assay
- activation of specific genes through exposure to non-thermal EMFs leading to gene transcription to form RNA, the first stage in the synthesis of proteins.

All the biological effects Dr Maret lists are found to exist at far lower levels than the current FCC standards which wireless Smart Meters are designed to comply with.

Havas (2011) notes that the FCC standard was originally based "*on the amount of radiation that would heat an adult male in the US military exposed to radar*," and that other countries, such as China, Poland, Russia and Switzerland, have substantially lower 'biologically-based' guidelines (i.e. 10 $\mu W/cm^2$ instead of 1,000 $\mu W/cm^2$ as advocated by the FCC).

<u>Unlike</u> the FCC standard, those guidelines take into account children, pregnant women, the elderly, and those with debilitating conditions.

For the second question, "Whether additional technology specific standards are needed for Smart Meters and other devices that are

commonly found in and around homes, to ensure adequate protection from adverse health effects," the CCST found the following:

"*At this time there is no clear evidence that additional standards are needed to protect the public from smart meters or other common household electronic devices.*" (CCST 2011).

The CCST notes, however, that there is a need to further identify gaps in research and research priorities relating to potential biological or adverse health effects from RF/microwave emissions, particularly as related to non-thermal mechanisms not presently covered by FCC guidelines (NRC 2008) – *a point with which the present author agrees.*

Comments

In answer to the second question, Havas (2011) wrote that she considered additional standards are required for Smart Meters (in addition to DECT baby monitors, cordless phones, wireless routers "*and all of the other devices that emit radio frequency radiation*").

She further commented that she has received correspondence from individuals who have experienced ill health after wireless Smart Meters were installed, "… *many are unable to use the room closest to the smart meter. … Sickness contributes to time off work and away from school, growing medical costs and a general poorer quality of life.*" Such responses from the general public indicate a need for the precautionary principle to be applied.

"… *Children are particularly vulnerable as are pregnant women and those with compromised immune systems.*" Havas (2011).

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"*...there is no federally developed national standard for safe levels of exposure to radiofrequency (RF) energy, ...*"
US Federal Communications Commission (FCC 2011).

Commentary on Safety Guidelines

Council of Europe / Conseil de L'Europe

The potential dangers of electromagnetic fields and their effect on the environment

Resolution 1815 adopted by the Council of Europe's parliamentary assembly on 27 May 2011.

Excerpts

… While electrical and electromagnetic fields in certain frequency bands have fully beneficial effects which are applied in medicine, other non-ionising frequencies … appear to have more or less potentially harmful, non-thermal, biological effects on plants, insects and animals, as well as the human body when exposed to levels that are below the official threshold values.

Waiting for high levels of scientific and clinical proof before taking action to prevent well-known risks can lead to very high health and economic costs, as was the case with asbestos, leaded petrol and tobacco.

The Parliamentary Assembly has repeatedly stressed the importance of states' commitment to preserving the environment and environmental health, … [including] Recommendation 1885 (2009) on drafting an additional protocol to the European Convention on Human Rights concerning the right to a healthy environment and Recommendation 1430 (1999) on access to information, public participation in environmental decision-making and access to justice – implementation of the Aarhus Convention [which amongst other things acknowledges that we owe an obligation to future generations – *present author's comment*]…

… As regards standards or threshold values for emissions of electromagnetic fields of all types and frequencies, the Assembly recommends that the ALARA or "as low as reasonably achievable" principle is applied, covering both the so-called thermal effects and the athermic or biological effects of electromagnetic emissions or radiation.

Present author's note: The following text is from the draft resolution earlier adopted unanimously by the CE committee on the Environment, Agriculture and Local and Regional Affairs. It is missing from the final document (shown on previous page), as there was a wish to gain the widest possible support in the assembly (BMJ 2011). It appears highly valid.

Excerpts excluded from final version

… According to the [European Environment Agency] EEA, there are sufficient signs or levels of scientific evidence of harmful biological effects to invoke the application of the precautionary principle and of effective, urgent preventive measures.

… In connection with the proven or potential risks of electromagnetic fields, it should also be noted that after a Lloyd's report, insurance companies tended to withhold coverage for risks linked with electromagnetic fields under civil liability policies, in the same way as, for example, genetically modified organisms or asbestos, which is hardly reassuring …

… the rapporteur wonders whether it might not be expedient and innovative to try and develop new wireless communication technologies … but more energy-efficient and above all less problematic in terms of the environment and health than the present microwave-based wireless communication.

Such systems … are reportedly being developed in the United States and Japan and could largely replace the present technologies. Should such changes in transmission and communication systems [or others – *present author's comment*] prove realistic, it would then be a case of technological and economic innovations not to be missed or obstructed.

The precautionary principle and the right to a healthy environment, particularly on behalf of children and future generations, must be key factors in all economic, technological and social development of society.

Refer also to the Seletun Resolution in Appendix 8.

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PLC/'Linky'/BPL, Smart Meters and health

Power Line Communications (PLCs) - *also known as 'Linky' in France and Broadband over Power Lines (BPL) in the USA* - transform electric grids into smart grids through turning them into communications networks by placing RF-modulated carrier signals onto grid wiring. A variety of PLC systems use different frequency bands depending on the characteristics of the wiring they operate on – Refer to section on '*Power Line Communications*'.

The effects of PLC on health have yet to be properly assessed. Some electrohypersensitive (EHS) individuals appear to react adversely to PLC signals as indicated by the following anonymous testimonial:

"*Jack (not his real name) has been sensitive to wireless transmitters for well over a decade. …*

In the spring of 2011, [he and his girlfriend] traveled to their rented house … When he arrived, he could immediately feel something had changed. It was as if a cell tower had been erected nearby, but he could not find one. It was unlikely to be the neighbors, since they lived on a large lot and he could still feel it when he drove some distance away. It seemed to be everywhere. …

After asking around, they found out that the local utility had swapped out all of the electrical meters over the winter. The new smart meters communicate with the utility's computers by [PLC]. … The signal is not very powerful, but the antennas are huge and everywhere. … The pulses bother him even fifty feet (15 meters) from the house, with the power line 150 feet (50 meters) on the other side of the house." Anon (2011).

Radio-frequency emissions can also be created by the Switched-Mode Power Supply (SMPS) of Smart Meters.

Tests have indicated that some Smart Meters, even when their transmitters are disabled, can create radio-frequency voltage spikes on consumers' indoor electric wiring due to their SMPS. This occurs over the frequency range of 4-60 kHz, typically with a 2 volts amplitude (Brangan & Heddle 2011).

It has been suggested by some, including (Milham 2011), that the detrimental health effects which have been noted with some wireless Smart Meters – even *before* their wireless function is enabled – may be because of the addition of this 'dirty electricity' onto mains wiring [placebo effects too can come into play – *present author's comment*]. Further research is required to determine the possible extent of any such problems, if they do indeed exist, and if they do, how they may be remedied.

As little work has been undertaken on the possible biological effects of PLC and Smart Meter emissions in the radiofrequency range, reference is made to past research cover similar frequencies to those they can create.

Whilst the SMPS of some Smart Meters can create frequencies of 4-60 kHz on indoor wiring (Brangan & Heddle 2011), PLC typically operate at frequencies between 9-500 kHz and at frequencies of ≥1 MHz (Wikipedia 2011).

Literature review covering different frequencies

4-500 kHz frequencies

"*Acute biological effects have been established for exposure to ELF electric and magnetic fields in the frequency range up to 100 kHz that may have adverse consequences on health*," WHO (2007).

1-100 kHz (natural atmospherics/sferics)

These are naturally occurring electromagnetic impulses of short duration (500μs) normally in the 1-100 kHz range, with a frequency maximum normally around 10 kHz. They are of low-intensity (<0.1μT).

Reiter's work revealed significant positive correlations between sferics impulse rates and humans' pain levels from brain injuries, operation scars and wounds, plus incidences of asthma, angina pectoris and migraine. Increased reaction times, accident-rates, incidents of crime and suicides were also noted during natural enhanced sferics activity (Reiter 1974, 1954).

Research by Fischer & Grossmann (1990) revealed the following probabilities for increased 10 kHz activity: general troubles, insomnia, increased accident frequency or muscular spasms (p <0.001), hypertension, suicide or thrombosis (p <0.05). Biases towards positive correlations were found with migraine, colic, depression and heart attacks.

Natural sferics activity can also influence platelet adhesiveness and risk of thrombosis (whilst increased adhesiveness is not a risk issue for thrombosis by itself, when there is reduced blood flow, heart failure, or blood vessel walls are already damaged, increased adhesiveness may greatly increase its risk of occurring).

Ranscht-Froemsdorf & Rinck (1972) revealed that variations in susceptibility to thrombosis (and haemorrhage) could occur under simulated natural electro-climates, whilst Jacobi et al. (1973) demonstrated that a rapid transformation in weather accompanied by sferics with field-strengths of 0.02-0.4 V/m, could significantly alter the degree of platelet adhesiveness that was measured (p <0.001).

Ruhenstroth-Bauer et al. (1984), found a significant positive correlation between incidence of increased 28 kHz sferics and the epileptic seizures of human sufferers (Spearman's rank correlation-coefficient for entire group of 0.30, p <0.0001), and a negative correlation with incidence of 10 kHz sferics and seizures (negative correlation = -0.20, p <0.0032).

A significant positive association between sferics activity in the 28 kHz range and onset of myocardial infarction in humans (r = 0.15) was made by Ruhenstroth-Bauer et al. (1985). Cheng (1985) commenting on that work, and additionally citing GMCCG (1984), stated that similar findings had been made in China indicating that this was a universal phenomenon.

4-100 kHz (manmade)

The controversial work of Havas (2006), Milham (2010) and Milham & Morgan (2008) is also of interest with regard to the possible health effects of PLC and Smart Meter SMPS emissions, as the 'dirty electricity' (*electromagnetic energy that deviates from a pure mains-frequency sine wave and contains both harmonic and transient components*) they document in their research carries similar radio frequency radiation transients.

The RF filters used to reduce exposure to 'dirty electricity' in the research by Havas (2006) do so over the 4-100 kHz range, and have been claimed to reduce the risk and occurrence of a number of health and behavioural problems.

They have no effect in reducing exposure to frequencies below that frequency range which can also be biologically active.

≥1 MHz high-frequency (manmade)

A pilot study instituted by Commander Russell M. Jaffe in 1978 (who was Senior Staff Physician at the US National Institutes of Health at that time) indicated that whilst exposures to frequencies in the 0.1-100 MHz range appeared to weaken human muscle strength, proper shielding restored both tone and strength (Ott 1982). As PLC and the SMPS Smart Meters can create interference in this range it may prove wise to undertake similar experimentation.

≥100 MHz ultra-high-frequency (manmade)

Von Klitzing (1993) demonstrated that 15min exposure to 150 MHz signals of low amplitude (1 μW/cm^2) pulsed with frequencies corresponding to 8-10 Hz human brainwaves increased human alpha-rhythms.

Future research

Independent research, using properly validated research methods, is urgently required to determine to what, if any, effects PLC and Smart Meter SMPS may have on national health, wellbeing and prosperity.

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Environmental Concerns

The Environment and Sustainable Development

"*Smart Meters do not necessarily bring environmental benefits. Like many new technologies, their rollout requires replacing an entire, fully functional, existing system. Their lifespan is expected to be short, at only 15 to 20 years (rather than over 30 years for traditional meters) and they use electricity to run – which requires extra generation to supply. The overreaching conclusion of the study is that the policies governing smart meters, are decisive in limiting or maximizing the positive impacts of this technology*." VaasaETT Global Energy Think Tank (Stromback & Dromacque 2010).

Unintended consequences and sustainable development

The law of unintended consequences is amongst the most powerful in creation. It has yet to be adequately addressed with regard to the effects that Smart Meters, smart grids and related technologies may have on sustainable development.

"The law of unintended consequences provides the basis for many criticisms of government programs. As the critics see it, unintended consequences can add so much to the costs of some programs that they make the programs unwise even if they achieve their stated goals. The law of unintended consequences is at work always and everywhere," Norton (2008).

The more that is known of the possible knock-on effects of Smart Meters and related technologies being rolled out across the world, and measures that can be taken to mitigate potential problems the smoother such rollouts are likely to be.

In-depth official Environmental Impact Assessments (EIA) that cover all of the areas discussed in this document have yet to be undertaken.

The Rio Declaration – as related to smart grids

There are many factors that need to be assessed for the development of the new electricity age to be omm. nte to be in accord with the spirit of the 1992 United Nations Rio Declaration on Environment and Development (UNEP 1992). As examples:

Principle 1

"*Human beings are at the centre of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature*."

As documented in the section on Human Rights, for some human beings at least, this principle may be compromised through the creation of inappropriate Smart Meter regimes that impact negatively on their health and potential productivity.

Principle 4

"*In order to achieve sustainable development, environmental protection shall constitute an integral part of the development process and cannot be considered in isolation from it*."

It appears that some, though not all, Smart Meter systems may *in their present form* damage have the potential to damage flora and fauna. This matter needs to be urgently addressed.

Additionally, environmental protection should extend to ensuring smart grids are adequately protected against natural and manmade EMP, as failure to do so could have huge negative repercussions.

Principle 7

"*States shall cooperate in a spirit of global partnership to conserve, protect and restore the health and integrity of the Earth's ecosystem. …*"

Transparent, properly funded, *unbiased* research is urgently required on the possible effects of Smart Meters and related technologies on the health and integrity of the Earth's ecosystem.

Principle 9

"*States should cooperate to strengthen endogenous capacity-building for sustainable development by improving scientific understanding through exchanges of scientific and technological knowledge, and by enhancing the development, adaptation, diffusion and transfer of technologies, including new and innovative technologies*."

If a true spirit of cooperation and global partnership can be achieved, *that takes onboard the advice of relevant specialists often excluded from such developments*, this goal can be omm. nt with smart technologies to an even greater extent.

'Open innovation' approaches based on collaboration and co-creation may prove particularly worthwhile in creating environmentally cost effective solutions.

Principle 13

"*States shall develop national law regarding liability and compensation for the victims of pollution and other environmental damage. States shall also cooperate in an expeditious and more determined manner to develop further international law regarding liability and compensation for adverse effects of environmental damage caused by activities within their jurisdiction or control to areas beyond their jurisdiction*."

Unless suitable mitigative and low-cost best practice measures are developed/undertaken related to Smart Meters and related technologies; there may be numerous liability and compensation claims lodged by victims related to 'electromagnetic pollution' and other environmental damage claims related to the rollouts.

Principle 15

"*In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."*

It appears that there may be a number of benefits in applying cost-effective precautionary measures in the design and operation of Smart Meters and related technology to reduce the likelihood of serious or irreversible environmental damage. Full EIAs which take into account the comments of those who could address such matters, appear warranted.

Low cost low risk alternatives and strategies should be applied wherever practical.

Principle 16

"*National authorities should endeavour to promote the internalization of environmental costs and the use of economic instruments, taking into account the approach that the polluter should, in principle, bear the cost of pollution, with due regard to the*

public interest and without distorting international trade and investment."

This 'polluter pays' principle – *which Marshall (2010) suggests should be applied to electromagnetic pollution* – is very important as it may be one of the key deciding factors related to which formats of smart technologies are adopted and how existing smart systems should be modernized to address problems.

It is in everyone's interest that the most environmentally friendly cost-effective smart technologies and infrastructures are chosen.

Principle 17

"*Environmental impact assessment [EIA], as a national instrument, shall be undertaken for proposed activities that are likely to have a significant adverse impact on the environment and are subject to a decision of a competent national authority*."

It appears that some Smart Meter and smart grid EMF regimes may in their present forms risk causing serious or irreversible damage to the environment. It is suggested that comprehensive EIA on Smart Meters and related technology (covering the matters raised in this present document) should be carried out by States at the earliest possible opportunity to address these issues.

Terrific inroads are being made with regard to the development of intelligent grids – *there is much still to be achieved*. Smart Meters do not benefit the environment without proper regulation (Stromback & Dromacque 2010).

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The European Commission

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 that some RF/microwave regimes may cause environmental damage. *Refer to section on 'Possible environmental effects'.*

Risk assessment

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 can 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 countries, and could lead to numerous innovative solutions and technological breakthroughs that may benefit the worldwide Smart Meter rollout and the next generations of electronic technology.

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Many countries are committed to enhancing their 'green infrastructure'. One such way of doing so is ensuring Smart Meters and related technologies are biologically and 'environmentally friendly' and that their development and operation adhere to the 'precautionary principle'.

Possible environmental effects 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. 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 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 which 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).

The use of wired Smart Meters, or retention of existing meters until such problems as appear to exist are solved, would appear prudent. *Smart Meters need not be wireless and can be safe and smart.*

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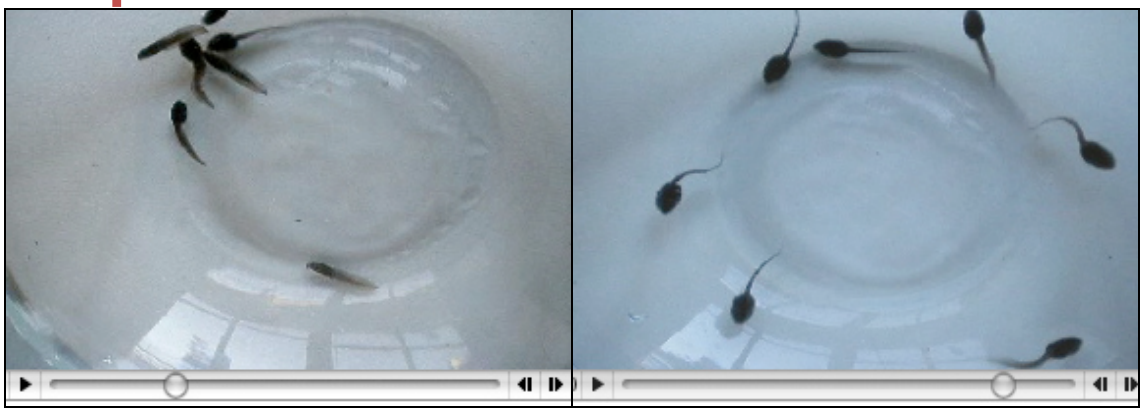
Amphibians



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.

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 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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Research indicates that both natural and artificial electromagnetic phenomena can cause positive and negative effects on the environment. One of the key challenges in Smart Meter development will be to ensure that they are biologically friendly.

Birds

Image source: Arvind Balaraman, http://www.freedigitalphotos.net/images/view_photog.php?photogid=1058

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 ($p = 0.0001$).

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 was also noted under the higher field regimes.

Whilst the need for caution is apparent, further research, particularly as related to the increased field levels that the presence of wireless Smart Meters, or power line communications (PLC), might cause (unless systems are upgraded) 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.

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 μW/cm^2 and was still evident until 1 μW/cm^2.

Honey bees (*Apis mellifera*)

These and other insect pollinators are vital for many agricultural crops. 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). How such fields may be made more biologically friendly has been alluded to.

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. 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 assessed.

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 $\mu W/cm^2$.

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.

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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"Systematic assessment of the health impact of a rapidly changing environment - particularly in areas of technology, work, energy production and urbanization - is essential." WHO (1986). *Refer also to Appendix 3 'Health Promotion'.*

SmartReach, the UK consortium created to address the UK Government mandate on Smart Meter installation is "*committed to helping protect the environment and to making a meaningful contribution to the development of a thriving low–carbon economy*." It is comprised of three companies: BT, Arqiva and Detica. http://smartreach.com/

Security of Supply

Image source: smokedsalmon / FreeDigitalPhotos.net,
http://www.freedigitalphotos.net/images/view_photog.php?photogid=2038

"*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.

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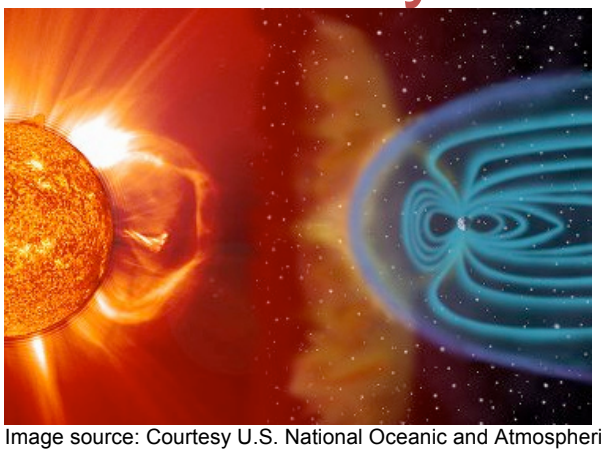

Image source: Courtesy U.S. National Oceanic and Atmospheric Administration (NOAA).

Solar super storms

According to NASA, 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).

Solar storms can greatly compromise the integrity of electrical grids and damage electrical equipment and satellites.

The effects that the electromagnetic pulses (EMP) of a solar super storm would have on Smart Meters, smart grids and smart technologies have yet to be fully assessed. Such storms are already a major threat to less vulnerable grid systems (Birnbach 2011).

The US and UK are now 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 (Connor 2011).

1859 & likelihood of similar events

During the 1859 event, the most powerful solar storm ever recorded, caused the telegraph systems in North America and Europe to short out 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 that is more easily damaged.

Marusek (2007) claims that such a storm could cause long-term blackouts in the USA, Canada, Europe, China, Central Asia, Russia, Argentina, Chile and New Zealand.

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 [as used for some smart grid communications – present author's comment] and car navigations, air travel, the banking system, our computers, everything that is electronic. It will cause major problems for the world.*"

On 7th June 2011 the largest ever observed coronal mass ejection from the Sun took place (Mosher 2011).

According to Antti Pulkkinen, head of NASA's "Solar Shield" satellite-based detection system, such events could cause a "*major space weather event*" if they were orientated towards the Earth (Behr & ClimateWire 2011).

It is predicted by some scientists that the Sun's 11-year cycle will now hit its maximum in late 2013 or early 2014. Phillip Chamberlin of NASA's Solar Dynamics Observatory said that there could be very energetic solar storms "*every couple of months instead of years*," at that time (Mosher 2011). It appears imperative to have smart grids protected against such events.

Such an event would cause individuals to be without electricity for hours or days. In the worse case scenario, large areas of the Earth would be without electricity for longer periods, possibly several months. Countries with "*fragile*" grid infrastructures are likely to be affected most.

It is predicted that upcoming solar flares could greatly endanger national security and take down key services such as electricity grids, electronics and communications for prolonged periods.

It is predicted that the next solar super storm could occur in 2012-2014. The 1859 super solar storm took place during a solar cycle of about the same size that NASA is predicting for 2013 (NASA 2009).

The present design of many high-tech devices (including Smart Meters) makes them more vulnerable to the effects of space weather than the units and technologies they replace. Transformer designs could also be improved (Birnbach 2011, EMPrimus 2011).

Solar storm of 1989

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 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 in future solar storms.*

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: the blackout of the province of Québec in Canada (*due to a voltage depression over a 90-second period 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. 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 would be greater for smart grids as present grid designs have unknowingly increased GIC risks and their potential impacts (Kappenman 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). It appears more cost-effective to create robust smart grids now than to have to do so in retrospect. Solar events are not particularly rare.

Smart Meters are more vulnerable to solar storms than the meters they replace, as the chips for their integrated circuits are easily damaged by solar EMPs/geomagnetically induced currents (GICs).

Research indicates that large GICs are also possible at low-latitudes, as well as at high latitudes (Kappenman 2011).

It appears that smart grids will need to be protected against solar EMP to comply with the International Infrastructure Security Roadmap.

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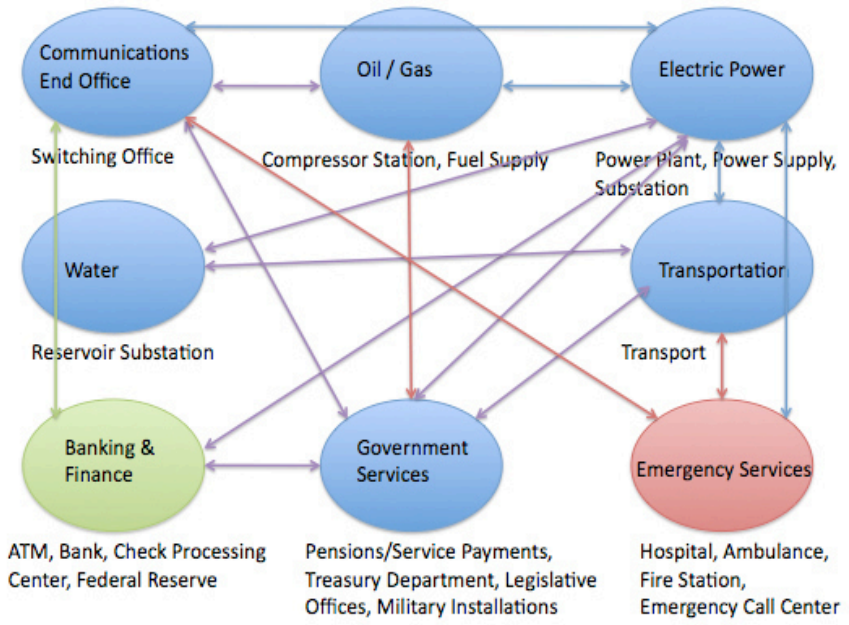
Sensitivity to geomagnetic storms



The economy is sensitive to geomagnetic storms due to a network of interdependencies. [Adapted from original graphic by US Department of Homeland Security].

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*."

"*There is limited time to upgrade national electric grids to avoid solar flare-induced, global scale burn out*." Arbuthnot et al. (2010).

The consequences of such an event could be very high, as its effects could cascade through other systems dependent, either directly or indirectly on electricity. It is therefore vital that smart grids and Smart Meters are robust and able to withstand such threats.

Distribution of drinkable water could be compromised, 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 effects of a solar super storm, as predicted for 2012/2013, could take many years to correct and severely damage national economies unless appropriate measures are taken in time.

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's National Risk Register (NRR 2010) has contingency plans to cope with a complete national outage and regional outage of electrical supplies. It states that "*In the event of a national outage (which has never occurred), and provided there had been no damage to the system, the objective would be to restore supplies throughout Great Britain within three days*." Some question whether such measures are adequate.

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 earlier this year 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, UK Government's chief scientific adviser (Brewster 2011).

Similar concerns were raised by UK Defence Secretary, The Right Honourable Liam Fox MP, in 2010 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).

It is estimated that the cost of what Professor Sir John Beddington call a potential "*global Katrina*", caused by the increased solar storm activity could be up to $2 trillion (£1.2 trillion) as a result of various technologies being knocked out unless suitable precautionary measures are undertaken.

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, a delayed rollout till after 2014 might be worth considering for this reason alone.

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, Jane Lubchenco, head of the National Oceanic and Atmospheric Administration (NOAA), is on record as having said at the 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*.

"*What's at stake are the advanced technologies that underlie virtually every aspect of our lives*." Tom Bogdan, Director of the US Space Weather Prediction Center. He also mentioned that forthcoming individual solar events could be particularly powerful (Lovett 2011).

These 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 increase the impact of solar storms above those discussed in the report above – *present author's comments.*

Need for robust smart 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 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 might 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, "*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 smart grid systems worldwide – *as related to space weather* – 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 too has to be taken into consideration – *these too should be hardened*. X-class flares, which are on the increase till 2013 (Moskowitz 2011a), can cause their orbital decay.

Some locations where 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].

At the very least, as a precautionary measure, it is suggested that consideration should be given to retaining existing electromechanical rotating-disk meters (which are more resilient to space weather than present Smart Meters) till after the solar maxima of 2012/2014 when risk begins to subside. Grids should be appropriately upgraded as finances allow and ideally hardened to increase their resilience.

> "*[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*."
> Professor Sir John Beddington, the UK Government's chief scientific adviser (Moskowitz 2011a).

Shielding just 10% of critical infrastructure could reduce anticipated damage from EMP events considerably (The Sage Policy Group, 2007). The present author suggests that as a basic minimum at least 20% should be protected before the main risk periods in 2012-2013 - ideally protection levels should be 'As High As Reasonably Achievable' (AHARA).

> Precautions taken to protect smart grids and technology from natural EMP events will also help protect them from EMP events by terrorists/rogue nations.

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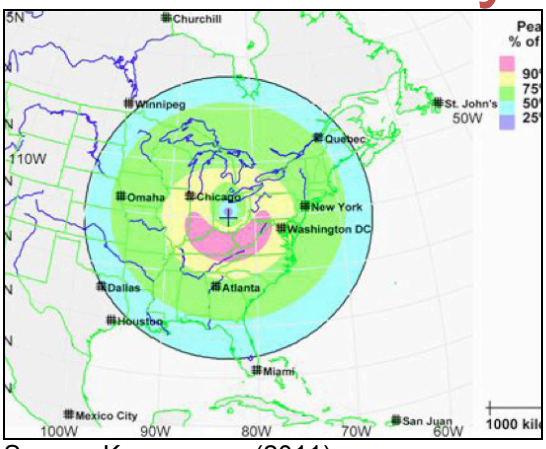
Practicality, Security, War, Terrorist or Cyber-Attack



Source: Kappenman (2011).

High-Altitude Electromagnetic Pulse (HEMP)

This term 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).

It is often seen as impracticable to protect wireless systems (such as used in Smart Meter systems? – *present author's 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."*

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 U.S. total population… would perish from starvation, disease and societal collapse*."
No figures appear available for the UK or Europe.

"*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 …*"
William R. Graham, Chairman of the US Commission to Assess the Threat to the United States from Electromagnetic Pulse Attack.

It appears sensible to at least delay the rollout of Smart Meter technology till after the passing of the forthcoming solar maxima. This might also allow time for additional system improvements to be undertaken.

Source Region Electromagnetic Pulse (SREMP)

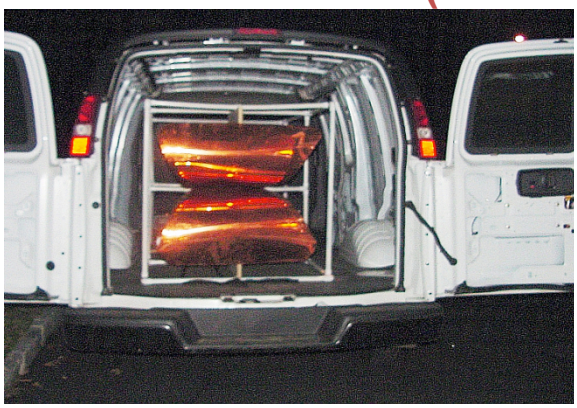
These are caused as a result of nuclear detonation, such as can be created by an air-burst EMP cruise missile, interacting with the Earth's and its adjacent atmosphere.

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.

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.

UK Smart Meters are also being designed so they can be disconnected remotely (Anderson & Fuloria 2010). This may be a major design flaw. As a matter of best practice such meters should be designed to fail in a "supply on" mode (Powerwatch 2010).

Non-Nuclear EMP (NNEMP)



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. The effects of

NNEMP/IEMI 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).

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).

If EMP vulnerabilities remain unaddressed they present increased invitations for attack (Graham et al. 2011).

NNEMP/IEMI present a comparable risk scenario likelihood to that of Cyber Attack (Kappenman 2011).

Power surges

A recent sustained power surge in California appears to further indicate the increased susceptibility of Smart Meters to EMP over 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 analog 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 analog 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).

It is now intended that Paolo Alto city officials will undertake additional research and investigative work to ensure Smart Meter shortfalls and glitches are resolved before investing further in them.

Measures should be taken to ensure that Smart Meters are robust enough to withstand such events. In the meantime, till such matters are addressed, delaying their rollout till after solar maxima subside in 2014 may prove beneficial – *present author's comment.*

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Preventing EMP catastrophes

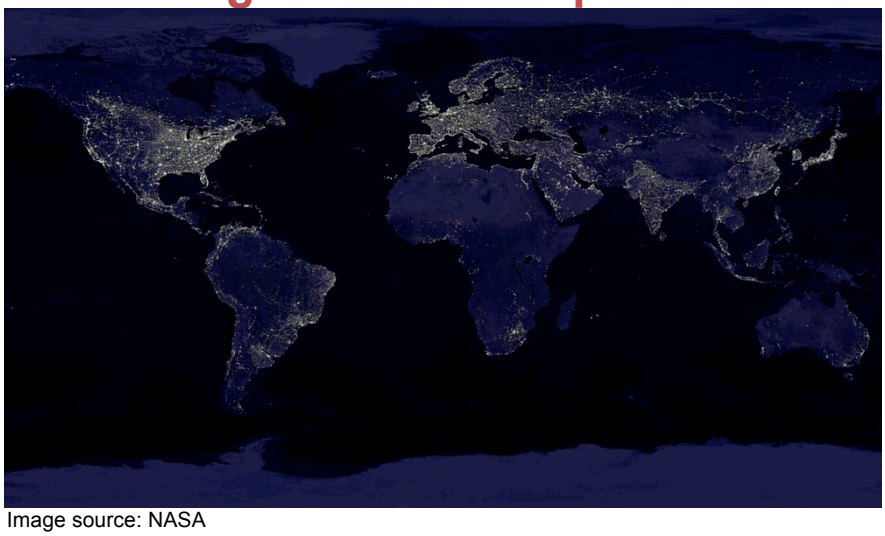

Image source: NASA

Smart grids create more potential points of failure than traditional grids. Ideally, protection should be considered early in the brief. Cost effectiveness is essential (EMPrimus 2011, Koepke 2010).

It is possible with robust planning to prevent EMP catastrophes. Action is required sooner rather than later for smart grids and smart devices, 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).

Smart grids, Smart Meter systems and related technology should be hardened where practical to prevent adverse effects from EMP.

"*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.

The corresponding estimate for the U.S. would be approximately $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).

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

Recommendations (partial listing) – *various authors*

- Adhere to the Electric Infrastructure Security Council (EIS) International Infrastructure Security Roadmap (EIS 2011).
- Determine grid and network level vulnerabilities & prioritise actions.
- Improved forecasting required 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 Meters, smart grids and related technologies against EMP risk.* *(This creates a new level of safety – much like fitting seat belts in automobiles).*
- Delay rollout of additional Smart Meters till after main period of solar risk if unhardened.
- Develop regional and national smart grid restoration plans.
- Provide Government endorsement & tax incentives for required work.
- Undertake "controlled" power cuts when necessary to protect grid.
- Identify & address regulatory gaps that preclude effective mitigation.

*If budget does not stretch to automatically protecting Smart Meters in this way, allow individuals to purchase upgrades that allow them to be hardened.

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*.

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Cyber security

"Just as securing and managing the physical defence of the country is a unique challenge, so is protecting the UK's critical infrastructure from threats of cyber terrorism. … Traditional security technologies are in no way up to the challenge."
Mark Darvill, Director of security firm AEP Networks (AEPN 2010).

Similar concerns are being voiced abroad. Experts at the IEEE Smart Grid Comm 2010 conference warned that consumers and utilities' infrastructures are becoming more vulnerable to cyber-attack due to 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).

It is recognised by the US Government Accountability Office (US GAO) and the US Department of Energy (US DOE) that the present transition to smart grids is leaving electric grids open to increased cybersecurity weaknesses that risk damaging their efficient operation (Mills & LaMonica 2010, US GAO 2011).

Built in security

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). 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*).

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 (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).

Blackout attacks

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).

As a result of the remote off-switches currently specified for some countries' Smart Meters, 'blackout attacks' could be carried out by rogue nations, terrorists or criminals unless appropriate countermeasures are taken. One of these is the option that Smart Meters are designed to fail in the 'on' mode - *human rights laws in Europe stop defaulters simply being disconnected* (Anderson & Fuloria 2010).

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).

"*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*."
UK Defence Secretary, the Rt. Hon. Dr. Liam Fox MP (Fox 2010).

The development of appropriate solutions to realistic threats to security of supply should be carried out before large-scale UK 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).

The installation of remote off-switches for Smart Meters would further increase risk to the consumer.

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Smart Meter Data

Every electrical appliance has its own energy fingerprint readable by Smart Meters. Those accessing such information have indications of the appliances individuals have and how often they use them.

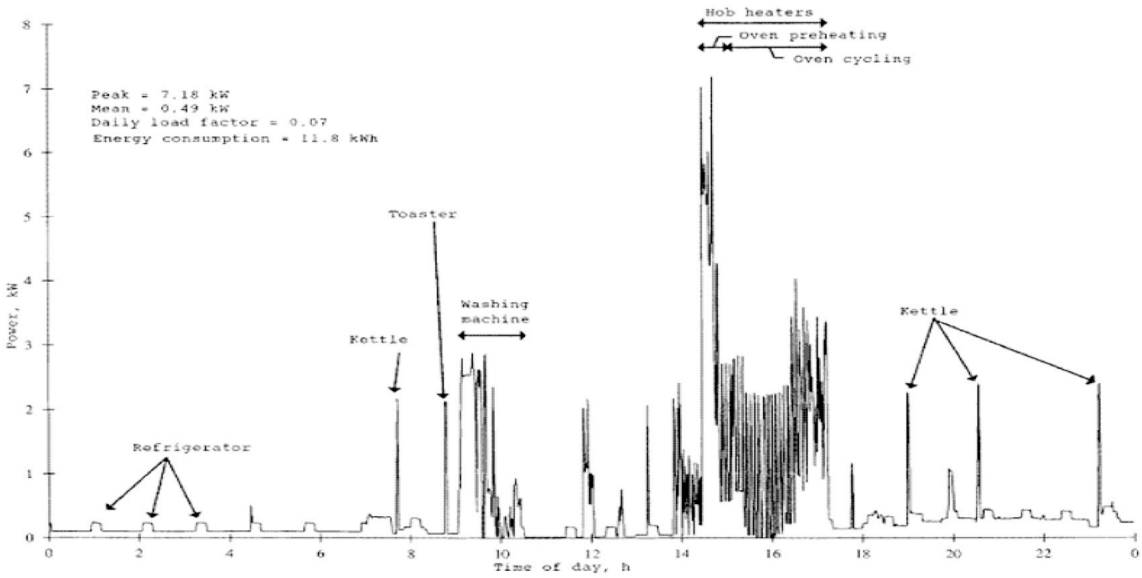

Image source: Newborough & Augood (1999).

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 (such as sleep problems*), 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)

*Emissions from some wireless Smart Meters have been reported to be linked to health and sleep problems (EMF SN 2011) – *present author's comment*.

Data provision & privacy/security issues

"*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).*

**Refer also to Appendix 7*.

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. …
Martin Pollock of Siemens Energy, quoted by Wynn (2010).

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).

Unlike conventional meters that measure total energy use through day and night tariffs (and are normally read four times every year), Smart Meters allow energy use to be read with far finer granularity (typically every half-hour). There is much debate as to what level of information should be provided by Smart Meters and to whom it should be provided.

" *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*." Quinn (2009).

A court in the Netherlands (Cuipers & Koops 2008) has already determined that the mandatory collection of non-essential fine-grained Smart Meter data is against Article 8(1) of the European Convention of Human Rights (which the UK is signed up to).

That ruling has led to mandatory Smart Meter installation being halted in the Netherlands (metering.com 2009). It is important to address such potential legal issues as early as possible and ensure that necessary safeguards are put in place.

"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*", as it is their degree of positive acceptance, support and involvement with Smart Meters and related technology that will determine the level of success smart metering achieves.

"*Data protection issues play a very important and even decisive role in the successful implementation of smart metering*," Knyrim & Trieb (2011).

As noted by Berliri & Maxwell (2010):

- 'Privacy by Design' creates opportunities rather than threats for smart grids – *it instills consumer confidence.*
- Consumers concepts of privacy are altering; soon statutory provisions may be inadequate. Privacy should be embedded into the technology.
- There may be competitive advantages for those able to offer the highest levels of privacy protection.

Robust privacy measures and policies are required to cover data usage and distribution if consumers are to be brought onboard and potential security shortfalls addressed.

Smart grid privacy measures			
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	

Source: Sooriyabandara & Kalogridis (2011).

Undertaking robust measures to anonymise Smart Metering data and remove recognisable appliance load signatures can help to address privacy concerns (Efthymiou & Kalogridis 2010, Kalogridis et al. 2010). Such measures may include: Privacy Enhanced Home Energy Management using Elec Privacy algorithms (*to disguise the signatures of electronic equipment*) and Escrow: Data Anonymisation.

Privacy Initiatives

Ontario, Canada

The province of Ontario in Canada is a world leader in embedded privacy protections for smart grids (PBD 2010). Adopting its guidelines may help prevent many claims on Human Rights privacy issues that might otherwise stall or halt rollouts.

1. Proactive not Reactive; Preventative not Remedial
"*Smart Grid systems should feature privacy principles in their overall project governance framework and proactively embed privacy requirements into their designs …*"

2. Privacy as the Default
"*Smart Grid systems must ensure that privacy is the default — the "no action required" mode of protecting one's privacy — its presence is ensured*."

3. Privacy Embedded into Design
"*Smart Grid systems must make privacy a core functionality in the design and architecture of Smart Grid systems and practices — an essential design feature*."

4. Full Functionality — Positive-Sum, not Zero-Sum
"*Smart Grid systems must avoid any unnecessary trade-offs between privacy and legitimate objectives of Smart Grid projects*."

5. End-to-End Lifecycle Protection
"*Smart Grid systems must build in privacy end-to-end, throughout the entire life cycle of any personal information collected*."

6. Visibility and Transparency
"Smart Grid systems must be visible and transparent to consumers - engaging in accountable business practices - to ensure that new Smart Grid systems operate according to stated objectives."

7. Respect for User Privacy
"Smart Grid systems must be designed with respect for consumer privacy, as a core foundational requirement."

That document states that the above principles should be applied to: accountable business practices; Information Technology (IT) systems; and physical design and networked infrastructure for smart grids (PBD 2010).

"… 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).

Another concern related to 'Privacy by Design' is that present smart grid systems have a life expectancy of 10-20 years, during which time any in-built security they may have risks becoming compromised or outdated.

United Kingdom

The UK is adopting an approach to privacy drawn on international best practice measures and the advice of privacy experts (DECC 2011).

In September 2011, it was announced that the UK Government has established a central data and communications company to administer access to smart grid data to help allay consumer privacy concerns over Smart Metering. The UK Government will also oversee its security (smartmeters 2011).

California, USA

In July 2011, California voted to adopt it's own comprehensive set of privacy and security rules for the three utility companies that provide the majority of Californians with electricity (King 2011).

If consumers wish, they will be able to allow third parties to receive their backhauled Smart Meter data directly from the utilities, as opposed to directly from the Smart Meters in order to support services including demand response, energy advice and energy efficiency. It is important to note that the CPUC declared that "*The utilities … will bear no new liability for the actions of third parties which acquire information via this [mechanism]*."

The CPUC also stated that they will not exercise jurisdiction over third parties who directly receive energy usage data from installed devices that receive data via the HAN interface (King 2011).

It is likely that the Californian and UK initiatives will be a success if they fully take into account Human Rights' privacy issues and the need to anonymise electrical metering data to gain public trust.

Texas, USA

In Texas all meter data on electricity shall belong to the customer (BSM (2011). Texas Utilities Code 39.107(b) states:

"*All meter data, including all data generated, provided, or otherwise made available, by advanced meters and meter information networks, shall belong to a customer, including data used to calculate charges for service, historical load data, and any other proprietary customer information. …*"

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The need for 'opt outs' and wired alternatives

Image source: http://2.bp.blogspot.com/-k7RtVOx5FmY/Tki0ChvyW9I/AAAAAAAADV4/4QCQUmzWY5Y/s1600/smart-meter-free-zone-signs-on-meters.jpg

Legal rulings

In Maine, USA, a "landmark" legal ruling has been made to allow individuals to 'opt out' of the Smart Metering program and retain their existing analogue meters (SKT&A 2011). This was the first time a US state had demanded that an electric utility must allow utility customers the choice to opt out. It is claimed that the decision "*will benefit utility customers throughout the country*."

Alan Stone of law firm Skelton, Taintor & Abbott successfully proved in the "landmark" ruling that as a result of unresolved concerns on health, privacy and cyber-security issues related to the installation of wireless meters on their homes, customers should be allowed a choice over whether such meters are installed.

The Central Maine Power Company had "*argued vigorously that customers should not be allowed to opt out*", which the Maine Public Utilities Commission found unreasonable and unjust (SKT&A 2011).

Energy users in Maine have two 'opt out' options: they either retain their existing analogue meter or receive a Smart Meter and have its transmitter turned off. They pay extra for either option (SOP 2011).

PG&E in California presently offer customers the opportunity to partially 'opt out', with a charge being made by PG&E to deactivate individuals' Smart Meters along with an additional monthly charge (LaMonica 2011). The California Public Utilities Commission President Michael Peevey has additionally now told members of the public that the utility "*will provide for you to go back to the analog meter if that's your choice*," (OTLB 2011a).

Milham (2011) suggests allowing individuals to only partially 'opt out' may not be enough to address health concerns, as the switching-mode power supply (SMPS) of some Smart Meters can continue to emit high-frequency radio signals (which have been indicated in some studies as being potentially injurious to health) 24/7. Further action is urgently required. Measures can be taken to avoid such problems.

"*I have had a number of cases where symptoms continued after the [smart] meter's transmitters were disabled, but disappeared when an analog meter was reinstalled. I think it prudent to offer customers the option of retaining their old utility meter or to have another reinstalled*." Milham (2011).

Additional legal claims may be following the 'victory' by Alan Stone, as a US attorney has provided guidelines available online detailing how individuals can file small claims suits over Smart Meters (Koehle 2010). There is a need to resolve such problems.

The cost of 'opt outs' - United States

Consumers in Maine, USA, are to be charged a one-time fee of $40.00 fee and a monthly charge of $12.00 for retaining their existing meter. If they opt for choosing to have a non-transmitting Smart Meter they will be liable for an initial fee of $20.00 and a monthly charge of $10.50 (SOP 2011).

The above charges are markedly lower than those that PG&E wishes to charge its customers who wish to 'opt out'. They propose that consumers pay $270 up front and a $14 monthly fee, or $135 up front and a $20 monthly charge for the option of having Smart Meters that have had their wireless transmission deactivated (Chediak 2011, LaMonica 2011). PG&E does not presently wish to let consumers keep their old meters.

At present, PG&E estimates that approximately 145,800 customers may chose to have their Smart Meters disabled at a potential cost of $84.4 million (Chediak 2011).

Consumer reaction to PG&E: "… *a smart meter costs between 3 and 10 times as much as a traditional meter depending on options and communications choices; installation costs 2-3 times the cost of a traditional meter; traditional meter reading fees are around $1 per month. … IF PG&E wanted to be fair they would let you opt out ahead of the meter installation, lower your rate to the pre-program level and then charge a monthly meter reading fee equal to the actual costs of the read*," Damianio (2011).

Why 'opt outs' don't always work

112 Smart Meters in apartment complex

Source: OTLB (2011).

112 wireless Smart Meters have been installed in the large apartment complex shown above. If the individual who lives immediately above them opts out she is still exposed to microwaves from the remaining 111 units (OTLB 2011).

"*In the US, if too many people opt out, the utility companies have vowed to put a repeater in neighborhoods, possibly on utility poles right outside some people's windows, to boost the signal. REPEATERS emit even more intense radio frequency radiation, so these are also unacceptable*," CST (2011). The use of fibre-optics for smart grids as championed in Chattanooga (Baker 2011) would avoid such logistical problems.

Additional claims (Milham 2011, Brangan & Heddle 2011, Wilner 2011), with regard to possible health effects from RF emitted by the switching-mode power supply (SMPS) also have to be taken into account.

If SMPS and RF/microwave issues are not properly addressed, 'opt outs' linked to health concerns may prove at least partially ineffective, as individuals may still be being exposed to unwanted radiation, which may be in violation of WHO health promotion initiatives – *Refer to Appendix 3*.

As noted by Wilner (2011), if concerned customers pay more for an 'opt out' installation yet derive no material benefit, it "*would be a violation of CPUC Code Section 451 which describes any utility rate that is unjust and/or unreasonable as unlawful*."

If consumer concerns are addressed, 'opt outs' and the risks they cause to the credibility of the rollouts, may be dramatically reduced, particularly if the technology can be made more attractive.

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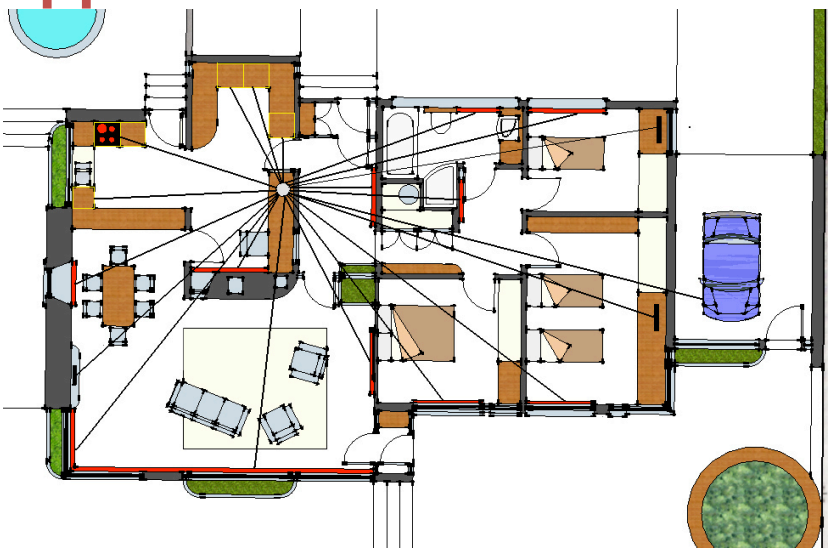
Smart Meters, HAN & smart appliances



Smart Meters

Alternatives to wireless Smart Meters and related technologies may be required for a number of reasons.

One of these is that, as many individuals who claim to be electrohypersensitive (EHS) - *or simply do not wish to be exposed to raised levels of manmade electromagnetic fields* - have shielded their homes against RF/microwave signals; wireless Smart Meters located within such dwellings (as most meters are in the UK) would be unable to connect to utility Home Area Networks (HAN) outdoors.

Another reason alternatives are required is that many materials used to construct standard dwellings (and many commercial buildings) shield, at least in part, emissions from such units.

Powerwatch (2010) proposes that this might be addressed by utilities offering to locate such meters outside the house. However, individuals could still be exposed to RF/microwave emissions from such units when directly outside their own property and could still result in them being able to use parts of their property as they used to. The use of wired Smart Meters (*such as used by EPB in Chattanooga (Baker 2011*)), would avoid such problems. Refer also to section on '*Human Rights and Smart Meters'*.

As a matter of best practice, filters should used to reduce high frequency transients and harmonics from Smart meters that may otherwise create 'dirty electricity' which have been indicated in some studies as negatively impacting on health (Milham 2010, Havas 2006). Refer also to section on '*Smart Meter Interference'.*

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).

According to 'The Worldwide Smart Grid Market in 2011: A Reality Check and Five Year Outlook Through 2015', "*Nearly 3/4 of all utilities either have no plans for home area networking, or have not yet made a decision. Only 2% have already committed to a business venture, with another 12% considering such a move*," (Berst 2011). It is proposed that the use of fibre-optics and RF/microwave regimes that are proven to be 'bio-friendly' could reverse this trend.

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), provide further incentive to develop and adhere to best practice measures when developing HAN systems.

HAN design and specification

The Smart Meter HAN interface can be activated to both receive or transmit signals to smart appliances by either the utility company or the smart appliances themselves transmitting data. This can only take place, however, after the utility permits HAN communication by issuing a security password that only it controls.

Wireless HAN

At present all the current proposals for HAN in the UK are for wireless networks - though 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).

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 say 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).

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.

Wired HAN

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. They 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 are used as the final connection.

Fibre-optic HAN

HAN are now considered essential by many consumers, with growing numbers of people wishing them to be preinstalled in new homes. This can now be achieved in every room using plastic optical fibre (POF) 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 would appear prudent to consider its use for consumers' HAN and Smart Meters to make them more desirable to end-users.

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Smart Appliances

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.

Zypryme (2010) predicts that the global market for smart appliances will be as follows in 2015*:

Clothes washers - $3,542,000,000 (€2,608,000,000)
Refrigerators - $2,693,000,000 (€1,983,000,000)
Clothes dryers - $2,236,000,000 (€1,646,000,000)
Dishwashers – $1,354,000,000 (€997,000,000)
Freezers - $1,166,000,000 (€858,500,000)
Other smart appliances - $4,184,000,000 (€3,080,000,000)
* Projected figures given in US dollars.

A number of commentators and consumers 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).

It is important to assess the market accurately for appliance manufacturers who may wish to invest in it and not create unnecessary risks by 'talking up' the market or specifying the wrong type of systems.

It is presently predicted that in 2015 there will be a combined global market for 'smart' clothes washers, clothes dryers and dishwashers of $7,132,000,000. (€5,251,000,000)

The predicted combined global market for 'smart' refrigerators and freezers in 2015 will be $3,859,000,000. (€2,841,000,000)

Hunn (2011) suggests that as refrigerators and freezers are operational throughout the day, they are less suited to be smart than the appliances just discussed. Whilst this is debatable, the point he makes about the need for appliances to decrease their energy consumption still further through innovative design is highly valid. As he notes, the cheaper appliances of a number of companies advocating the use of smart technology presently have poor energy performance.

"*Consumer agreements may focus on utilities controlling only particular appliances such as freezers, air conditioners or luxury items such as swimming pools*," Wynn (2010).

Health and communication issues

Smart appliances allow communication between consumers' Home Area Networks (HAN) and utility HAN.

At present some 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.

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 during their operation at a typical time interval of 10 seconds down to 1 second if required. Slower configurations can also be created.

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 appear not to have been considered.

Orders are already being lost with a number of items because some individuals are refusing 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.

As mentioned in an earlier section, Schreier et al. (2006) noted that approximately 5% of the Swiss population may be electrohypersensitive (EHS) - the percentage of EHS individuals may be roughly similar in other countries. This is a large sector of the customer base to risk alienating. Creating wired options would help reduce such risk.

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 the call for the removal of such devices in the workplace where 'safer' practical alternatives are available.

Consumer confidence

"*With growth like this it is easy to overlook the needs of the consumer.*" Jason S. Rodrigues, CEO & Director of Research, Zpryme Research & Consulting, LLC (Zypryme 2010).

Some consumers have started to question how many smart appliances actually benefit them by being 'smart', and are stating that they are unhappy with the idea of having a large number of RF/microwave emitters within their homes, particularly when they will often have to be in close proximity to them (Sage 2011).

Increased exposure to RF/microwave emissions 24/7 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 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 such systems should be able to be disabled and wired smart interfaces built in as standard.

For the success of smart appliances and devices to be optimised, it is necessary to assess the science robustly and understand the consumer psyche.

Improving consumer response

"*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).

Hunn (2011) adds a valid point to the debate about smart appliances with his comments shown above. He further notes that the wholesale introduction of such technology at this time could provide "*a very dangerous distraction to the core requirements of smart energy. … It adds technical uncertainty at a point when the*

industry is trying to coalesce on standards for smart meters and it distracts appliance vendors from concentrating on core improvements to the technology of their devices."

"*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).

If appliance manufacturers take such matters into consideration, they can greatly reduce their risks in a volatile financial climate.

By delaying the rollout of a number of smart appliances at the present time to help ensure the success of smart grids, appliance manufacturers could allow themselves a 'window of opportunity' to better develop more ecologically and environmentally friendly technologies and launch them when the public is ready to receive them – a true 'Win/Win' situation.

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Financial implications of Smart Meters

Will Smart Meters save money?

The International Monetary Fund states that there is the possibility of a double-dip recession in many advanced economies and advocates the need to reduce risk in investments (IMF 2011). Smart Metering risks should be reduced wherever possible to increase their viability. Strategic rollouts could reduce such risk.

The rules of investment

"*Investors should start with a view of skepticism. They should become intellectual investors rather than emotional investors. They should be careful, and they should be skeptical*."
Arthur Levitt, Jr.
Senior adviser at the Carlyle Group and former Chairman of the US Securities and Exchange Commission.

Cost impact

For indications on the cost impact in the UK of a number of different Smart Meter options, including that of a dumb meter/smart box option, refer to MMDB (2007).

Consumer Impact with four roll-out options and Hybrid 2		
Roll-out option/ Technology	Consumer Net Present Value	Average Annual Impact per meter
New, Replacement and Voluntary		
ERA Spec	- £8,287,000,000	- £8.29
BEAMA Spec	- £4,276,000,00	- £4.3
Dumb+Smart	+ £343,000,000	+ £0.48
Meter Retrofit	+ £982,000,000	+ £0.85
Clip-On	+ £617,000,00	+ £1.05

Source: MMDB (2007) – other options such as fibre-optic Smart Metering should additionally be appraised.

At present Smart Metering is listed as the least financially attractive

investment of all smart grid initiatives (N-ERC 2011).

World market

As the World faces a prolonged period of austerity (IMF 2011), and the possibility of redundancy increases at an alarming rate, it is necessary to show that Smart Metering does not place further burden on those facing hardship. In such troubled times, people need robust proof of the benefits to themselves of 'opting in' to such programs. Alternative ways of reducing energy consumption, such as through optimised building design and the creation of more energy efficient appliances, too need to be championed.

The possible costs and benefits of different Smart Metering systems in terms of health, productivity and the environment should also be factored into the equation, so that optimum solutions are developed. Human Rights issues too have to be factored in.

Another matter to be taken into consideration is the cost to nations of upgrading utilities' IT infrastructures - *which often currently run on a mix of old computing systems that often do not properly communicate with each other* - for the huge onslaught of data information they will be receiving from Smart Meters (Antow 2011).

There is also the question of whether some of the money currently earmarked for Smart Metering should be diverted to the creation of grids that are more secure against the harsh solar storms NASA predict for 2012-2014 which could severely damage infrastructures and national economies – *Refer to the section on 'Vulnerability to Space Weather'.*

UK installations

The UK deployment of Smart Meters is already set to become the most expensive in the world (Datamonitor 2010). It has been rumoured that at present Smart Meters will cost around £350 to install per household (Anderson & Fuloria 2010).

In March 2011, UK energy customers were told they would have to pick up the £11.3 billion rollout cost through their bills (uSwitch.com 2011). This may cause some resentment, as a survey of consumers in 2010 revealed 83% were not prepared to pay additional costs for their installation (Which 2010). *Before* that press release, only 15% of the public had welcomed their introduction (uSwitch 2010) - *it is vital to have the public's support for Smart Meters to succeed.*

At present consumers appear more concerned with the financial costs of using them than the environmental cost of inefficient energy use.

The 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).

At present smart grid systems have a life expectancy of 10-20 years (Mills & LaMonica 2010). If consumers have to meet the full installation cost, it might take them 15 years worth of savings (*at the returns predicted for 2020*) to pay for a Smart Meter that may require replacing within that period or have already been replaced.

This figure does not take into account loss of earnings from having to stay at home on the day of meter installation – *the average daily wage in the UK at present is just under £100* (ONS 2010) - or the potential costs that inappropriate Smart Meter specifications and rollout timings might have on the national economy.

There are also additional consumer costs that have to be taken into account. To obtain the major benefits of Smart Metering consumers will have to spend further money on communications devices, programmable communicating thermostats, appliance chips and other automated equipment (in addition to paying directly or indirectly for the Smart Meter units). Computers and high-speed Internet connections also appear essential to optimise operation (TURN 2011).

"If consumers don't reduce usage then the [Smart Meter] system becomes an expensive white elephant."
Jon Lane, Energy Director at The Datamonitor Group*

*Datamonitor is a world-leading provider of premium global business information, delivering independent data, analysis and opinion.

There are also concerns that the project could be as technologically challenging as NHS National Project for IT (Flinders 2011), which further indicates the need for the UK to increase its knowledge base to better address matters and allay public concerns. Initiatives such as SmartGrid GB (SG GB 2010) may prove very timely.

USA

In some instances huge rises in bills have been reported primarily due to faulty Smart Meter units, inappropriate billing systems, shortcomings in consumer education and unusual extremes in weather conditions prompting extra energy usage (Burbank ACTION 2011, CBS 5, Zeller 2010). It seems these matters can be remedied. Some overcharging was additionally caused by units mistakenly charging customers for the units of electricity they generated (via green technologies such as solar panels) and fed back into the grid (Wolff 2010). This fault too now appears to be corrected.

The actual costs to some consumers as related to apparent health issues from some types of Smart Metering regimes and from faulty Smart Meter installations that have caused fire damage to their properties remains to be addressed – Refer to sections on '*Health Matters'* and *'Electrical safety and Smart Meters'*.

California

The annual report PG&E submitted to the California Public Utilities Commission (CPUC) on their Smart Meter program shows that to date no energy savings have been made as a result of their large scale Smart Meter rollout (PG&E 2011).

Table I PG&E SmartMeter™ Program Enabled Demand Response Programs Subscription Statistics December 31, 2010

		Demand reduction (MW)		Energy savings (MWh)		
Program	Service accounts	Aggregrate Load Impact	Financial benefits (thousands)	Energy savings	Financial benefits (thousands)	Total financial benefits (thousands)
Demand response						
Programmable Communicating Thermostat	0	0	$0	0	$0	$0
Peak Time Rebate	0	0	$0	0	$0	$0
SmartRate™/ PDP	24,535	6.5	$546	0	$0	$0
Real Time Pricing (RTP)	0	0	$0	0	$0	$0
Time of Use	0	0	$0	0	$0	$0
Total	24,535	6.5	$546	0	$0	$0

Source: PG&E (2011).

The Division of Ratepayer Advocates of the CPUC believes that the $1 billion Smart Meter program for the Southern California Gas Company (SoCalGas) "*will cost ratepayers $185 million more than the benefits to be produced over the project's lifetime*" (DRA 2010).

"*There is no compelling reason to move ahead with this expensive project, especially at a time when Southern Californians are already struggling to pay their bills and with unemployment so high*."
Dana Appling, Director of DRA (DRA 2010).

As noted by TURN Consumer Advocates, "*The cost of retrofitting or replacing existing appliances alone will be astronomical. Without the expenditures, consumers will not see any difference from the new meters except higher electric bills. … The meters have failed to provide customer benefits commensurate with their costs,*" (TURN 2011).

The Helix Water Board has decided to reject Smart Meter technology on the grounds of cost. With Helix undergoing budgetary restrictions they decided it was not appropriate to introduce Smart Meters.

Additionally, there was a lack of public interest shown in the web portal set up for their Smart Meters in a pilot study. Of the 28 registered users, 9% of pilot customer accounts, only three visits per week were registered after an initial 20 visits per week (Suzuki 2011). Health concerns and Human Rights issues had also been raised. Such matters must be addressed and solutions recognised.

Connecticut

In Connecticut, Attorney General George Jepsen stated that the utility's plan to replace existing electric meters with advanced technology "*would be very expensive and would not save enough electricity for its 1.2 million customers to justify the expense*."

Jepsen urged regulators to "*continue to evaluate emerging meter system technologies as well as other conservation programs*" and only sanction installation of advanced meters when they are proven to be cost effective.

"*The pilot results showed no beneficial impact on total energy usage, … the savings that were seen in the pilot were limited to certain types of customers and would be far outweighed by the cost of installing the new meter systems*." Attorney General George Jepsen.

Jepsen calls for a "*surgical*" approach in the brief where Smart Meters are only provided to those who request, and can pay, for them (Tweed 2011). The creation of more energy efficient devices would also be of benefit.

Developing Countries

In Chile, it has been claimed that the costs of installing Smart Meters are "*greatly surpassing the benefits, principally because of the initial capital investment costs*." Ramila & Rudnick (2010) further claimed that installed Smart Meters benefitted "*society as a whole, but not … customers within the area of installation, who originate the benefits and pay for the meters.*"

Stromback & Dromacque (2010), talking of Brazil, noted that those on very low incomes may need to be exempt from paying for Smart Meters, indicating once more the benefits of finding other ways to finance such projects if they are to be a success with all consumers.

The VaasaETT Global Energy Think Tank suggests that Smart Meters are "*not necessarily appropriate … for developing nations, or those were household consumption is low*." Concerns were also raised about how resilient the technology may be to climates such as Brazil's (Stromback & Dromacque 2010).

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It appears imperative that Governments, States and individuals make fully informed decisions on Smart Metering issues as related to their true costs, as determined by Cost Benefit Analyses (CBAs) which take into account issues noted in this present review document.

Smart Meters and Economic Instruments

'Polluter pays principle'

Marshall (2010) suggests that this principle, adopted for atmospheric pollution by CO_2, should also be applied to electromagnetic pollution; with possibly a tax being placed on all products that do not conform to the internationally adopted EMC Standards.

Introducing the 'polluter pays principle' would provide welcome incentives for industries to create more 'environmentally friendly' technologies (*particularly if extended to be more in line with existing WHO policies on Health Promotion*) and would provide further incentive for improved science-based stakeholder processes and technological innovation – a true 'Win/Win' situation. Refer also to Appendices 5 and 6.

Other EMF researchers suggest that such measures should also apply with regard to the more rigorous national standards that already exist in some countries and environmental and public health safeguards.

"*National Authorities should endeavour to promote the internalisation of environmental costs and the use of economic instruments, taking into account the approach that the polluter, should in principle, bear the cost of pollution with due regard to the public interest and without distorting international trade and investment*."
Principle 16 of the Rio Declaration - the 'polluter pays principle.' (UNEP 1992).

The EU's environmental policy is based on the precautionary principle and that "the polluter should pay" (CVTFEU 2010).

Infrastructure design

The infrastructure chosen to support Smart Meters, and the design of the units themselves, may have marked effects on the environment and the economy.

Creating 'eco-sustainable' and 'bio-sustainable' environments

Economic instruments can be used as a means of better considering 'external costs' to provide increased understanding of signals in trends for Smart Metering and possible 'knock on' effects.

It is important to ensure that comprehensive cost benefit analyses are undertaken so that correct and informed decisions can be taken by authorities and individuals.

Economic Instruments influence activities and/or effect change from their impact on market signals. They take on board a variety of policy tools including deposit-refund systems, marketable permits, performance bonds and pollution taxes.

Possible 'external costs' to consider for different Smart Meter regimes may include:

- health impacts to the public
- wellbeing impacts
- indirect impacts on work efficiency
- costs to other industries
- disability discrimination
- natural resource depletion
- environmental degradation
- biodiversity issues
- human rights claims
- security of supply
- timings of rollouts
- cyber security, etc.

Economic Instruments can be devised in a number of ways to encourage end objectives: Increasing the cost of goods and services which harm health and the environment, in addition to increasing financial returns for those adopting more sustainable approaches which promote more environmentally-friendly results (WHO 2011).

Relevance of Economic Instruments to policy-makers

Economic instruments assist the implementation of the 'polluter pays principle'. They are frequently compared to 'command and control' policy approaches which define allowable control technologies (via regulations or laws) and determine pollution reduction targets.

Subsidies

"*Subsidies, usually provided by government … often create perverse economic incentives; they can encourage producers to generate higher levels of environmental pollution -- and higher levels of associated health impacts*." WHO (2011).

"*Such subsidies conflict with the polluter and user pays principles by sending false price signals. They also … distort competition and inhibit the development of substitutes that are more environmentally-friendly*," WHO (2011).

Providing incentives for investments in innovation and improved environmental technology for smart grids and related technologies allow both environmental and financial benefits to be created.

There is a need to investigate ways environmentally harmful subsidies to smart grid related industries or enterprises can be reduced.

As noted by the WHO (2011), "*Tax breaks or other financial incentives might be offered to groups, individuals or industries investing in cleaner technologies*." It appears appropriate that these are applied to the development of Smart Meters and related technologies to help optimise returns.

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Optimising energy usage

The real need is for consumers to reduce their energy usage. This can be encouraged by a number of different measures in addition to Smart Metering – *Refer to Appendix 2*. Darby (2010) notes that whilst real-time displays of usage can be of benefit, there is little evidence that the rollout of Smart Meters 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 the change in system. Experts already voice concerns over this.

Research by van Dam et al., (2010), indicates that initial savings created through the use of 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.

There is also debate over how many people will actually use in-home displays (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 [In the UK it is reckoned that on average £1.92 will be saved per month (approximately £0.06 per day) by households (DECC 2011) – present author's comment]. 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).

In apparent response to this suggested consumer apathy Google recently axed its PowerMeter electricity monitoring tool 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.

Consumer Focus, the statutory consumer champion for the UK, is particularly concerned that poorer households could bear increased hardship under time-of-use Smart Meter tariffs, as they may be less able to change their patterns of use or determine how to save money from altering their usage. It states "*Consumers must not be forced on to time-of-use tariffs and must have the option to switch back to standard tariffs if they find themselves worse off,"* (Webster 2011).

The effectiveness of consumer monitoring versus advising customers to simply "*turn off electrical items when not in use*", more energy efficient building design, having simple tarrif schemes, and industry creating more energy efficient (and biologically and environmentally friendly) devices appear not to have been fully assessed. *Additionally, research indicates that manually operating appliances when the price is low is the consumers' favoured way of optimising energy consumption* (Paetz et al. 2011).

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Cost of securing critical electric infrastructures

There is a very real risk that, unless adequate precautions are taken, many Smart Meters, in their present formats, may be more readily damaged by space weather and malicious manmade events than their predecessors. Governments worldwide are taking such threats very seriously (EIS 2011, 2010). Industry is now starting to address this matter.

Smart grids (and Smart Meters) may need to be protected against electromagnetic pulse (EMP) damage to comply with the International Infrastructure Security Roadmap developed to secure power supplies. It seems the costs of such measures for different metering systems have yet to be obtained. Additionally ensuring that Smart Meters cannot be disconnected remotely would greatly help reduce risk of blackouts caused by hackers and rogue states.

Where/if appropriate, it is proposed that customers should be allowed the option of paying for upgrades for hardening their Smart Meters. Whether this could be recouped in the long term through reduced insurance premiums remains to be seen.

The option also exists of delaying further rollouts of Smart Meters until the main risk period from solar EMP subsides, whilst undertaking appraisals as to the best ways to proceed to optimise their performance and address consumer concerns (whilst also educating the public on energy saving measures and asking them to reduce their energy usage).

Future proofing investments

For Smart Meters to meet the international Electric Infrastructure Security Council (EIS) requirements and be a financial success, they need to be “future proofed’ and made more desirable to the end user. One way to help achieve this may be through providing a mainly fibre-optic system. This reduces health and security issues and makes smart grid more attractive for investors.

Anderson & Fuloria (2010)’s suggestion of bringing on board additional highly qualified IT professionals and systems engineering

staff (at the earliest possible opportunity) to help further recognise and address potential IT problems and optimise Smart Meter solutions to could be of great benefit.

Possible cost effects of Smart Meters on health and productivity

Rigorous research has to be undertaken to investigate claims on the effects of different types of Smart Meters and Smart Metering regimes on health and the environment – *ideally before they are installed – Refer also to 'Healh Matters' and Appendix … .*

The alleged change in Indoor Environmental Quality (IEQ) created by some wireless Smart Meter emissions, as demonstrated by some existing rollouts, may adversely affect individuals' productivity and wellbeing (EMFSN 2011, Schreier et al. 2006). These matters need to be appropriately addressed and solutions applied.

It is recognised that poor indoor environmental quality (IEQ) alone can greatly impact health and productivity, possibly at a cost of up to hundreds of billions of dollars per year (Kats et al. 2003).

It is vital to ensure that Smart Meters and related technologies are biologically friendly and do not harm IEQ.

The possible damage that health problems allegedly related to some types of Smart Meters might have on national productivity, and the level of burden these may place on already overstretched health services, have yet to be properly assessed.

The possible effects of emissions on Nature - *if proven true* - too have to be considered. Ideally empirical or theoretical studies should be undertaken on the potential economic effects on the environment of the rollout of different types of Smart Meter system.

Cost benefits of ensuring human rights are recognised

The possible costs of human rights challenges to various Smart Meter configurations should be addressed before further large scale rollouts are undertaken so that the likelihood of challenges are reduced through the specification/development of appropriate units.

Failure to adequately address human rights issues has already stalled Smart Meter installation in the Netherlands (metering.com 2009).

Cost benefit analysis

The UK's Department of Energy and Climate Change (DECC) have estimated in the past that Smart Meters may deliver "*a net benefit to consumers of around £5.98 billion over 20 years,*" (Ofcom 2009).

This works out to around an average of £299 million annually.

The above sum appears significantly less than the damage that might be inflicted on human health, productivity, national security and the environment if the wrong types of Smart Metering system and infrastructures are specified.

Transparent and detailed cost benefit analyses are urgently required taking into account the potential effects (beneficial or detrimental) of different Smart Meter regimes, as related to the billions countries spend on health, the environment and security of their supply and data - *all of which may be effected by Smart Metering decisions*.

As an example: as RF/microwaves are now recognised as being a potential human carcinogen (WHO/IARC 2011), the possible effects of RF/microwave emissions emitted from some types of unit should also be factored into such analysis. The annual cost to England alone (not the UK) from cancer is £18.33 billion - *with figures set to rise to £24.72 billion over the next ten years* (Featherstone & Whitham 2010). *Refer also to 'Health Matters' and Appendix 1.*

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Life Cycle Costing

Life Cycle Costing (LCC)*, taking into account health and productivity, as determined by multifactoral Environmental Impact Assessments (EIA) and Health Impact Assessments (HIA), should be used to help determine which types of Smart Meter systems are best for optimising overall investments and financial returns.

*[LCC is a methodology used to identify the most financially viable solution to save money through estimating the total cost of ownership of a product, structure or system over its useful life based on a variety of factors].

Creating financial opportunities

In 2009, Ernst & Young warned that the UK Government at that time that it had underestimated the cost of a nationwide Smart Meter rollout and stated that the end cost could be £13.4 billion.

"*Very big and complex projects of this sort always cost more than anticipated," … [the Government's figures appeared to rely] on an assumption of absolute efficiency*."
Tony Ward, Power and Utilities Partner in Ernst & Young (Pagnamenta 2009).

As indicated earlier in this document, once Health Impact Assessments (HIA), Environmental Impact Assessments (EIA) and Life Cycle Costings (LCC) factors are taken into consideration (alongside potential customer savings over time and security issues); *there is very little opportunity for countries such as the UK to make financial gains from installing Smart Meters, unless radical changes are undertaken*.

One such way of achieving financial viability and addressing potential public health concerns appears to be through investing in innovative fibre-optic smart grid networks similar to those used in Chattanooga, Tennesee – *Refer to section on 'Smart Alternatives'*.

The higher initial costs of fibre-optic Smart Meters might be mitigated through countries achieving greater national productivity and wellbeing over their lifespan than might be the case with widespread use of wireless units (in their present format). Their infrastructure is also less vulnerable than wireless alternatives and can provide additional sources of income from broadband providers.

Challenging financial perceptions

"*There is only one difference between a bad economist and a good one: the bad economist confines himself to the visible effect; the good economist takes into account both the effect that can be seen and those effects that must be foreseen*."
Frédéric Bastiat (1801-1850) political economist and leading advocate of free markets and free trade in the 19th century.

In the past wishful thinking, over simplification and incomplete understanding of the matters at hand have often prevented optimum solutions being achieved.

Such approaches can be tremendously counterproductive to all concerned, particularly where risks are high, and appropriate stakeholders and technological solutions that could be brought in are virtually ignored or dismissed out of hand.

It is already evident that billions of dollars have been misspent worldwide in the rush to implement smart metering. It is time to address this issue properly with robust interdisciplinary research and the ability to "*think outside the box*" and also take onboard other measures can also help reduce energy usage.

Benefits of investing in innovation

By investing properly in the smart grid infrastructure, it can be made far safer and used in highly innovative ways, including Internet provision (through leasing fibre-optic capacity to providers of general broadband services).

"*The internet is a tremendous opportunity for innovative UK companies. The UK internet economy was worth £100 billion in 2009 … That's roughly 7.2% of gross domestic product, making the internet a larger factor in the UK economy than construction, mining, tourism, agriculture and a number of other industries. And the internet is expected to be worth 10% of UK GDP in 2015.*"
Eric Schmidt, Executive Chairman of Google.

As the introduction of smart grids using fibre-optic technology has already been shown to improve business investment over other types of system and optimise/'future-proof' Internet connections; it is proposed that their adoption should be seriously considered.

No-one has yet fully assessed the potential benefits of introducing a fibre-optic smart grid and broadband network for a whole country. The bringing onboard of other energy saving measures too should be considered - *Refer also to Appendix 2*.

Improving revenue streams

It is important to secure a meaningful sustainable growth strategy for the smart grid by opening up its revenue streams. As noted by Lord Green, UK Minister of State for Trade and Investment (when discussing infrastructures) growth can be provided from investment by external sources seeking business opportunities (Parsley 2011).

There is a window of opportunity for increased investment by external sources in the UK's smart grids; possibly through creating new Electric Market Reforms (EMR), as a first step towards creating a robust 'future-proof' national infrastructure of smart grids – *present author's comments*. Other energy saving concepts and technological innovations could provide further opportunities for sound investment.

"… *we have to all think more proactively about where opportunities are*."
Lord Green, UK Minister of State for Trade and Investment (Parsley 2011).

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Conclusion

Image source: posterize, http://www.freedigitalphotos.net/images/view_photog.php?photogid=1665

Optimising opportunities for success

Looking to the future

For Smart Metering and smart grids to stand a chance of real success, there is a need for the adoption of 'open innovation' approaches based on collaboration and co-creation that respect security issues, human rights, public health, the environment and the need for beneficial best practice and timely innovation.

"*Companies face tough dilemmas every day for which there is a uniquely prepared mind somewhere in the world who possesses the right combination of expertise and experience to solve that problem*," Tapscott & Williams (2008).

History has continually proven that, when more facts are known, properly thought out strategies can often provide cheap and simple solutions for seemingly unsolvable problems.

The 'Win/Win' approach

There are already experts available worldwide who can provide creative, technical, legal and scientific insights into how Smart Metering and smart grids can be improved and optimised.

If larger interdisciplinary teams are created, numerous problems (both those that have been seen and are unforeseen) can be solved far more rapidly, whilst creating more resilient 'biologically friendly' technology, legal frameworks and 'win/win' scenarios for all concerned.

Whilst some Smart Meters - *in their present form* - may adversely affect health, and there are concerns about system security and the timing of rollouts; more suitable alternatives are available - or can be created.

"This is a once in a lifetime opportunity and if … [we get] it right it will genuinely be the case that 'everybody wins' …

It will be those … who look to be part of the 'smart scene' by seeing these challenges as a means of opening up new business opportunities who will benefit. …

This is a unique opportunity for those professionals associated with developing the 'intelligent' buildings of tomorrow, and who themselves are smart enough to help make the 'smart revolution' happen."
Terry Rowbury, Director-Energy Sector, BEAMA*

*BEAMA is the independent expert knowledge base & forum for the electrotechnical industry in the UK & Europe.

The need for strong vision

It is imperative that the precautionary principle is employed and that national security, public health, public safety and the economic well-being of countries are taken into consideration when considering the types of Smart Meter systems to adopt and the timing of their rollouts – *Refer also to the Appendices*.

The adoption of other measures that can further reduce energy usage should be actively encouraged.

"*Coming together for maximum mutual benefit requires strong vision, openness, responsibility, commitment, accountability, fairness, mutual respect, and the wisdom to know how to act appropriately on the findings discovered so that maximum long-term gains are made by all parties*," Isaac Jamieson (2010).

Those who positively address the matters raised in this review document may be more likely to create successful Smart Metering systems – they may also be more likely to be the leaders in the forthcoming 'bio-electromagnetically friendly' technological revolution. Adopting pioneering (*instead of closed*) mindsets has already been proven to generate superior results and innovation in the electronics industry (Hiltzik 1999). Which countries will choose to adopt this path remains to be seen.

Those who fail to address such issues may leave themselves at increased risk of economic destabilisation, public distrust and ever increasing lawsuits. Cost effective 'Win/Win' solutions that benefit the individual, national economies and the environment should be sought wherever practical.

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Appendix 1 – Health & Smart Meter safety survey

High number of health complaints reported after installation of wireless Smart Meters (SDA 2011).

Excerpts from online survey* are given below:
The figures reflect whether individuals or members of their homes experienced health impacts (n = 318).

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%

Meter type preferred

94.1% of respondents (n = 387) stated that they would prefer to retain or restore their original analogue meters, and 91.7% (n = 374) stated that they did not wish to pay more for such meters.

*The EMF Safety Network initiated that survey 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 consultant Dr. Ed Halteman from the firm Survey Design & Analysis (SDA 2011).

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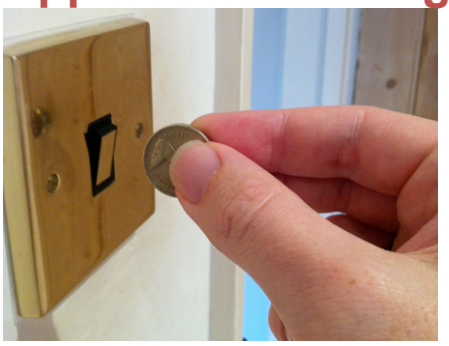
Appendix 2 – Energy use & financial implications



Governments, States and individuals should be able to make fully informed decisions on Smart Metering issues related to their true costs, as determined by Cost Benefit Analyses (CBAs) that take into account issues raised in this present review document. 'Willful blindness' (or access to incomplete facts) is not a sustainable option.

The type of Smart Metering system proposed may greatly determine its likelihood of success or failure. Safeguards also have to be put in place to address public and scientific concerns.

It is already contested by some researchers whether consumers and nations will make worthwhile savings with the Smart Metering systems *presently* proposed by many utilities.

A 12-month study by Hargreaves (2011), undertaken in dwellings where monitors displaying electricity use had previously been installed demonstrated that the initial enthusiasm towards energy saving measures with the monitors soon wore off. In some homes their use was abandoned, whilst in others they caused rows over energy consumption between partners or parents and teenagers.

"*Rather than feeling motivated to save more energy and money householders were left feeling frustrated and despondent that the changes they could make were very small and they were receiving little or no meaningful support from anywhere else, such as government and local authorities.'* Hargreaves (2010).

Dr Hargreaves claims the current UK decision to rollout Smart Meters has been hastily arrived at, without sufficient evidence on their likely impact, and that key opportunities may be being missed by the process being rushed.

"*SmartMeters represent a high-cost, high-tech approach where a less expensive and more expansive one will do. The best way to address global warming 'and higher electric bills' is already available, and it is called conservation*" (Hawiger 2010).

Conservation

Many measures do not require the benefits of Smart Meters and smart technology only Common Sense. Among the simple measures that can be adopted are:

- Proper insulation of homes and offices.
- Switching off lights* and equipment in empty rooms and corridors.
- Creating ways to bring natural light deeper into buildings reducing daytime need for artificial lighting and energy use.
- Getting up earlier when it is light reducing need for artificial light.
- Avoiding having appliances on standby.
- Ensuring heaters, air-conditioning and boilers are energy efficient.
- Energy efficient appliances.
- Use of appliances powered manually or from free energy.
- Keep heating thermostats at 19 °C (66.2 °F) or less.
- Wearing more clothes indoors when cold so less heating required.
- Opening windows and doors for increased ventilation on hot days instead of using air-conditioning or electric fans.
- Switching off equipment when not in use and avoiding using standby mode when not in use (as this still consumes energy).
- Boiling only the water required when using kettles.
- Using less bathwater when bathing, or ideally, having short showers.
- Line drying clothes instead of using a tumble drier.

Through proper education of the general public, *substantial* energy savings can be achieved even *without* the introduction of smart grids - *and at far lower risk than is being created by many rollouts.*

It is necessary to optimise smart grid design whilst promoting such measures and taking into account the true needs of the consumer.

*The replacement of traditional incandescent lighting with compact fluorescent bulbs (CFLs) is frowned upon in some circles because of potential health and environmental risks (Oliver 2008).

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Appendix 3 - Health Promotion

Image source: Kookkai_nak, http://www.freedigitalphotos.net/images/view_photog.php?photogid=2354

There is a need for 'biologically friendly' meter regimes that enhance health and wellbeing.

There are a number of health promotion initiatives that have been instigated by the World Health Organization (WHO), which provide incentive for Governments, international organisations, international industries, technological companies, schools and local communities to achieve the target of '*Health For All*' through improved health promotion and the creation of healthier technologies and environments.

> *"Systematic assessment of the health impact of a rapidly changing environment - particularly in areas of technology, work, energy production and urbanization - is essential."* WHO (1986).

It is important to ensure that health impacts are undertaken for the technologies used for Smart Meters, smart grids and related equipment, and that they are made as 'biologically friendly' as possible to enable people to lead healthy lives.

Ottawa Charter for Health Promotion

First International Conference on Health Promotion Ottawa, 21 November 1986 - WHO/HPR/HEP/95.1

This Charter is an international agreement signed in 1986 at the First International Conference on Health Promotion in Ottawa, Canada, which was organised by the World Health Organization (WHO 1986). It has acted, and continues to act, as a catalyst for a wide range of beneficial actions which encourage improved health promotion measures worldwide.

Extracts from the Ottawa Charter are given below:

Health Promotion

"*Health promotion is the process of enabling people to increase control over, and to improve, their health. To reach a state of complete physical, mental and social well-being, an individual or group must be able to identify and to realize aspirations, to satisfy needs, and to change or cope with the environment. …* "

Advocate

"*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.*"

Enable

"Health promotion focuses on achieving equity in health. Health promotion action aims at reducing differences in current health status and ensuring equal opportunities and resources to enable all people to achieve their fullest health potential. This includes a secure foundation in a supportive environment, access to information, life skills and opportunities for making healthy choices."

"People cannot achieve their fullest health potential unless they are able to take control of those things which determine their health. …"

Health Promotion Action Means:
Build Healthy Public Policy

"*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.*"

"… It is coordinated action that leads to health, income and social policies that foster greater equity. Joint action contributes to ensuring safer and healthier goods and services, healthier public services, and cleaner, more enjoyable environments."

"Health promotion policy requires the identification of obstacles to the adoption of healthy public policies in non-health sectors, and ways of removing them. The aim must be to make the healthier choice the easier choice for policy makers as well."

Create Supportive Environments

"Our societies are complex and interrelated. Health cannot be separated from other goals."

"Systematic assessment of the health impact of a rapidly changing environment - particularly in areas of technology, work, energy production and urbanization - is essential and must be followed by action to ensure positive benefit to the health of the public. The protection of the natural and built environments and the conservation of natural resources must be addressed in any health promotion strategy."

Strengthen Community Actions

"*Health promotion works through concrete and effective community action in setting priorities, making decisions, planning strategies and implementing them to achieve better health."*

"At the heart of this process is the empowerment of communities - their ownership and control of their own endeavours and destinies."

"… This requires full and continuous access to information, learning opportunities for health, as well as funding support."

Moving into the Future

"*Health is created and lived by people within the settings of their everyday life; … Health is created by caring for oneself and others, by being able to take decisions and have control over one's life circumstances, and by ensuring that the society one lives in creates conditions that allow the attainment of health by all its members*."

Commitment to Health Promotion

"*The participants in this Conference pledge:*

- *to move into the arena of healthy public policy, and to advocate a clear political commitment to health and equity in all sectors;*

- *to counteract the pressures towards harmful products, resource depletion, unhealthy living conditions and environments …; and to focus attention on public health issues such as pollution, occupational hazards, housing and settlements;*

- *"to acknowledge people as the main health resource; to support and enable them to keep themselves, their families and friends healthy … and to accept the community as the essential voice in matters of its health, living conditions and well-being;"*

- *"to recognize health and its maintenance as a major social investment and challenge; and to address the overall ecological issue of our ways of living."*

Adelaide Recommendations on Healthy Public Policy

Second International Conference on Health Promotion, Adelaide, South Australia, 5-9 April 1988

Excerpts:

Healthy Public Policy

"Healthy public policy is characterized by an explicit concern for health and equity in all areas of policy and by an accountability for health impact. The main aim of health public policy is to create a supportive environment to enable people to lead healthy lives."

"Such a policy makes … social and physical environments health-enhancing. In the pursuit of healthy public policy, government sectors concerned with agriculture, trade, education, industry, and communications need to take into account health as an essential factor when formulating policy."

"These sectors should be accountable for the health consequences of their policy decisions. They should pay as much attention to health as to economic considerations."

The value of health

"Health is both a fundamental human right and a sound social investment. Governments need to invest resources in healthy public policy and health promotion in order to raise the health status of all their citizens. A basic principle of social justice is to ensure that people have access to the essentials for a healthy and satisfying life."

"… this raises overall societal productivity in both social and economic terms. Healthy public policy in the short term will lead to long-term economic benefits as shown by the case studies …"

"New efforts must be made to link economic, social, and health policies into integrated action."

Accountability for Health

"Public accountability for health is an essential nutrient for the growth of healthy public policy. Governments and all other controllers of resources are ultimately accountable to their people

for the health consequences of their policies, or lack of policies."

"*A commitment to healthy public policy means that governments must measure and report the health impact of their policies in language that all groups in society readily understand. …*"

Partners in the policy process

"*Government plays an important role in health, but health is also influenced greatly by corporate and business interests, nongovernmental bodies and community organizations. Their potential for preserving and promoting people's health should be encouraged.*"

Future Challenges

"Health for All will be achieved only if the creation and preservation of healthy living and working conditions become a central concern in all public policy decisions."

"*The most fundamental challenge for individual nations and international agencies in achieving healthy public policy is to encourage collaboration (or developing partnerships) in peace, human rights and social justice, ecology, and sustainable development around the globe.*"

Jakarta Declaration on Leading Health Promotion into the 21st Century

"*… The Fourth International Conference on Health Promotion is the first to be held in a developing country, and the first to involve the private sector in supporting health promotion. It has provided an opportunity to reflect on what has been learned about effective health promotion, to re-examine the determinants of health, and to identify the directions and strategies that must be adopted to address the challenges of promoting health in the 21st century. The participants in the Jakarta Conference hereby present this Declaration on action for health promotion into the next century.*"

Health promotion is a key investment

"Health is a basic human right and is essential for social and economic development. Increasingly, health promotion is being recognized as an essential element of health development. It is a process of enabling people to increase control over, and to improve, their health. …"

Health promotion makes a difference

"*Research and case studies from around the world provide convincing evidence that health promotion is effective. Health promotion strategies can develop and change lifestyles, and have an impact on the social, economic and environmental conditions that determine health. Health promotion is a practical approach to achieving greater equity in health. …*"

New responses are needed

"To address emerging threats to health, new forms of action are needed. … There is a clear need to break through traditional boundaries within government sectors, between governmental and nongovernmental organizations, and between the public and private sectors."

"Cooperation is essential; this requires the creation of new partnerships for health, on an equal footing, between the different sectors at all levels of governance in societies."

Priorities for health promotion in the 21st Century

1. Promote social responsibility for health

"Decision-makers must be firmly committed to social responsibility. Both the public and private sectors should promote health by pursuing policies and practices that:

- *avoid harming the health of individuals*
- *protect the environment …*
- *include equity-focused health impact assessments as an integral part of policy development*."

2. Increase investments for health development

"*In many countries, current investment in health is inadequate and often ineffective. Increasing investment for health development requires a truly multisectoral approach … Greater investment for health and reorientation of existing investments … has the potential to achieve significant advances in human development, health and quality of life*."

"*Investments for health should reflect the needs of particular groups such as women, children, older people, and indigenous, poor and marginalized populations*."

3. Consolidate and expand partnerships for health

"*Health promotion requires partnerships for health and social development between the different sectors at all levels of governance and society. Existing partnerships need to be*

strengthened and the potential for new partnerships must be explored."

"*Partnerships offer mutual benefit for health through the sharing of expertise, skills and resources. Each partnership must be transparent and accountable and be based on agreed ethical principles, mutual understanding and respect. …*"

4. Increase community capacity and empower the individual

"Health promotion is carried out by and with people, not on or to people. It improves both the ability of individuals to take action, and the capacity of groups, organizations or communities to influence the determinants of health."

5. Secure an infrastructure for health promotion

"*… All countries should develop the appropriate political, legal, educational, social and economic environments required to support health promotion.*"

Call for action

"…In order to speed progress towards global health promotion, the participants endorse the formation of a global health promotion alliance … to advance the priorities for action in health promotion set out in this Declaration.

Priorities for the alliance include:

- *raising awareness of the changing determinants of health*
- *supporting the development of collaboration and networks for health development*
- *mobilizing resources for health promotion*
- *accumulating knowledge on best practice …*
- *fostering* transparency and public accountability in health promotion"

"*National governments are called on to take the initiative in fostering and sponsoring networks for health promotion both within and among their countries.*"

"*The participants call on WHO to take the lead in building such a global health promotion alliance and enabling its Member States to implement the outcomes of the Conference. A key part of this role is for WHO to engage governments, nongovernmental organizations, development banks, organizations of the United Nations system, interregional bodies, bilateral agencies, the labour movement and cooperatives, as well as the private sector, in advancing the priorities for action in health promotion.*"

Mexico Ministerial Statement for the Promotion of Health: from Ideas to Action

Excerpts:
"*Gathered in Mexico City on the occasion of the Fifth Global Conference on Health Promotion, the Ministers of Health who sign this Statement:*

- *Recognize that the attainment of the highest possible standard of health is a positive asset for the enjoyment of life and necessary for social and economic development and equity. …*
- *Conclude that health promotion must be a fundamental component of public policies and programmes in all countries in the pursuit of equity and better health for all.*
- *Realize that there is ample evidence that good health promotion strategies of promoting health are effective*."

"Considering the above, we subscribe to the following:

Actions

To position the promotion of health as a fundamental priority in local, regional, national and international policies and programmes."

"… To take the leading role in ensuring the active participation of all sectors and civil society, in the implementation of health promoting actions which strengthen and expand partnerships for health. …"

"The support of research which advances knowledge on selected priorities. … To establish or strengthen national and international networks which promote health."

"*To advocate that UN agencies be accountable for the health impact of their development agenda. …*"

This Ministerial Statement was signed by the following countries:
Algeria, Angola, Argentina, Australia, Austria, Bangladesh, Belize, Bhutan, Bolivia, Brazil, Bulgaria, Cameroon, Canada, China, Colombia, Costa Rica, Cuba, Czech Republic, Denmark, Dominica, Dominican Republic, Ecuador, El Salvador, Finland, France, Gabon, Germany, Guatemala, Hungary, India, Indonesia, Iran, Israel, Jamaica, Korea, Kuwait, Lao PDR, Lebanon, Madagascar, Malaysia, Maldives, Malta, Morocco, Myanmar, Nepal, Netherlands, New Zealand, Nicaragua, Niger, Pakistan, Panama, Paraguay, Poland, Portugal, Puerto Rico, Russian Federation, Saint Kitts and Nevis, Saint Lucia, Samoa, Slovakia, Slovenia, Spain, Swaziland, Sweden, Switzerland, Turkey, United Kingdom, United States, Uruguay, Vanuatu, Venezuela, Yugoslavia, Zambia.

The Bangkok Charter for Health Promotion in a Globalized World (WHO 2005).

Excerpts:

"The Bangkok Charter identifies actions, commitments and pledges required to address the determinants of health in a globalized world through health promotion. … [It] affirms that policies and partnerships … to improve health and health equality, should be at the centre of global and national development."

"The Bangkok Charter complements and builds upon the values, principles and action strategies of health promotion established by the 'Ottawa Charter for Health Promotion' and the recommendations of the subsequent global health promotion conferences which have been confirmed by Member States through the World Health Assembly."

"The Bangkok Charter reaches out to people, groups and organizations that are critical to the achievement of health, including:
- *governments and politicians at all levels*
- *civil society*
- *the private sector*
- *international organizations, and*
- *the public health community."*

"The United Nations recognizes that the enjoyment of the highest attainable standard of health is one of the fundamental rights of every human being without discrimination."

"Health promotion is based on this critical human right and offers a positive and inclusive concept of health as a determinant of the quality of life and encompassing mental and spiritual well-being."

"Health promotion is the process of enabling people to increase control over their health and its determinants, and thereby improve their health. It is a core function of public health and contributes to the work of tackling communicable and noncommunicable diseases and other threats to health. …"

Strategies for health promotion in a globalized world

Effective interventions

"Progress towards a healthier world requires strong political action, broad participation and sustained advocacy.

Health promotion has an established repertoire of proven effective strategies which need to be fully utilized."

Required actions

"To make further advances in implementing these strategies, all sectors and settings must act to:
• *advocate for health based on human rights and solidarity*
• *invest in sustainable policies, actions and infrastructure to address the determinants of health*
• *build capacity for policy development, leadership, health promotion practice, knowledge transfer and research, and health literacy*
• *regulate and legislate to ensure a high level of protection from harm and enable equal opportunity for health and well-being for all people*
• *partner and build alliances with public, private, nongovernmental and international organizations and civil society to create sustainable actions."*

Key commitments

1. Make the promotion of health central to the global development agenda

"*Health promotion must become an integral part of domestic and foreign policy and international relations, …*
This requires actions to promote dialogue and cooperation among nation states, civil society, and the private sector. …"

2. Make the promotion of health a core responsibility for all of government

"… health is a major determinant of socioeconomic and political development.
Local, regional and national governments must:
• *give priority to investments in health, within and outside the health sector*
• *provide sustainable financing for health promotion."*

"To ensure this, all levels of government should make the health consequences of policies and legislation explicit, using tools such as equity-focused health impact assessment."

3. Make the promotion of health a key focus of communities and civil society

"*Communities and civil society often lead in initiating, shaping and undertaking health promotion. They need to have the rights,*

resources and opportunities to enable their contributions to be amplified and sustained. …"

"Civil society needs to exercise its power in the marketplace by giving preference to the goods, services and shares of companies that exemplify corporate social responsibility."

"Health professional associations have a special contribution to make."

4. Make the promotion of health a requirement for good corporate practice

"*The corporate sector has a direct impact on the health of people and on the determinants of health …"*

"*The private sector, like other employers and the informal sector, has a responsibility to ensure health and safety …".*

"The private sector can also contribute to lessening wider global health impacts, ... by complying with local national and international regulations and agreements that promote and protect health. …"

A global pledge to make it happen

All for health

"Meeting these commitments requires better application of proven strategies, as well as the use of new entry points and innovative responses."

"Partnerships, alliances, networks and collaborations provide exciting and rewarding ways of bringing people and organizations together around common goals and joint actions to improve the health of populations."

"Each sector – intergovernmental, government, civil society and private – has a unique role and responsibility."

Closing the implementation gap

"*Since the adoption of the Ottawa Charter, a significant number of resolutions at national and global level have been signed in support of health promotion, but these have not always been followed by action. The participants of this Bangkok Conference forcefully call on Member States of the World Health Organization to close this implementation gap and move to policies and partnerships for action."*

Worldwide partnership

"*This Bangkok Charter urges all stakeholders to join in a worldwide partnership to promote health, with both global and local engagement and action*."

Commitment to improve health

"Conference participants request the World Health Organization and its Member States, in collaboration with others, to allocate resources for health promotion, initiate plans of action and monitor performance through appropriate indicators and targets, and to report on progress at regular intervals. United Nations organizations are asked to explore the benefits of developing a Global Treaty for Health."

The Bangkok Charter contains the collective views of international experts and does not necessarily represent WHO decisions or stated policies – *comment by present author*.

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"*The concept of health promotion is positive, dynamic and empowering which makes it rhetorically useful and politically attractive. … Further developmental work is clearly required …*" WHO (2009) / HPI (1986).

Appendix 4 - Educational buildings and Smart Meters

Image source: Grant Cochrane, http://www.freedigitalphotos.net/images/view_photog.php?photogid=2365

> "*Pupil's education, health and wellbeing should be at the centre of any initiatives to introduce new technologies into schools. The technologies need to be adding value and need to be safe*."
> WFIS (2011).

Anecdotal evidence and peer-reviewed studies, investigating radiation similar to that emitted by specific types of Smart Meters and related devices, indicate that exposures to some EMF regimes may be linked to reduced learning abilities and a number of health ailments – *Refer to section on 'Health Matters'.*

It appears prudent to adopt the 'Precautionary Principle' with regard to Smart Meter rollouts in kindergartens, schools and colleges, and use wired alternatives to standard RF/microwave emitting technologies where feasible.

United Kingdom

> "*Everyone in the education system must do what is sensible to keep pupils safe and healthy. This includes making the school environment as safe as possible*. …"
> Directgov (2011).

At present the UK Government is having Smart Meters installed in all schools (SM.com 2010).

As a result of the UK Government's resolve on making learning environments "*as safe as possible*", and its adherence to the 'Jakarta Declaration on Leading Health Promotion into the 21st Century' (WHO 1997) – it appears crucial to ensure that Smart Meters (and other items of electrical equipment) are specified, or retrofitted, with this in mind.

Europe

The Parliamentary Assembly of the Council of Europe (PACE) recommends that the member states of the Council of Europe take "*all reasonable measures*" to reduce the exposure of children and young people to manmade electromagnetic fields to those that are 'As Low As Reasonably Achievable' (ALARA).

Whilst not discussing Smart Meters specifically, PACE suggests that for schools preference should be given to adopting wired as opposed to wireless connections to reduce potential exposures (PACE 2011).

United States

The American Public Health Association (APHA) - in recognition of the Rio Declaration on Environment - states the 'Precautionary Principle' should be the foundation of US public health policy to protection children's health. It also "*calls for explicit inclusion of the precautionary approach in all federal, state, and local legislation, rules, or policies… that may impact the health of children …*" (APHA 2001).

International

"*Studies confirm the importance of a school's physical and psychosocial environment to the health of the students and staff and the success or failure of school health programmes …*" WHO ECCSH (1997).

"*Schools can make a substantial contribution to a student's health and well-being. This has been increasingly recognised by many international initiatives including those from the World Health Organization (WHO), UNICEF, UNESCO, the U.S. Centers for Disease Control and Prevention (CDC), the International Union for Health Promotion and Education (IUHPE) and others.*" IUHPE (2009).

Health Promoting Schools (HPS)

The presence or absence of environmental pollutants, such as electromagnetic pollution, may significantly impact on the learning and wellbeing of some individuals.

"*Healthy students learn better. The core business of a school is maximising learning outcomes. Effective Health Promoting Schools (HPS) make a major contribution to schools achieving their educational and social goals.*" IUHPE (2010).

The essential elements required in HPS, based on the WHO's Ottawa Charter for Health Promotion (WHO 1986), include having 'Healthy school policies' that are clearly defined in documents or accepted best practices which promote health and well-being; and that the school's physical environment (buildings, grounds and equipment) help promote health.

Another of the essential elements required in HPS is that potential environmental contaminants detrimental to health are addressed (IUHPE 2009).

It is proposed that Health Promoting Schools should ideally seek to adopt metering (and ICT) regimes that are indicated as being the most 'biologically friendly'.

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Appendix 5 - Need for additional stakeholders

Image source: Master isolated images: http://www.freedigitalphotos.net/images/view_photog.php?photogid=1962

Input from additional stakeholders may be required for Smart Meter rollouts to be a true success. An example is given of the present situation in the UK.

To date official meetings undertaken to develop the specifications for the UK's Smart Meters "*have excluded not just potentially critical academics, but also the technical staff of the meter suppliers*" (Anderson & Fuloria 2010). This situation needs to be addressed.

To optimise opportunities for success - *and soundly address its critics* - it appears prudent to robustly expand the UK's Ofgem Smart Metering Implementation Programme Consumer Advisory Group. At present the group consists of representatives of: Age UK, Consumer Focus, the Fuel Poverty Advisory Group (FPAG), Which?, the Public Utilities Access Forum (PUAF), plus DECC and Ofgem representatives (Ofgem 2010).

As noted by Jamieson et al (2010), Robbins (2008) suggests that the optimum number of stakeholder representatives could be between five to twelve, whilst Corder/Thompson & Associates (CTA 2002) suggests this number could be as high as twenty. The present author suggests that due to the complexity of the subject a figure towards twenty may prove more appropriate.

An expanded group could include academics, technical staff and experts on: human rights issues, electromagnetic pulse (EMP) and electromagnetic compatibility (EMC) issues, cyber-security, health (*as related to the biological effects of possible emissions from Smart Meters & related technology*) and environmental matters.

Amongst those who could be considered for inclusion as stakeholders are groups involved with electrohypersensitivity and

chronic RF/microwave exposure issues. In the UK these include: bemri.org, Cavisoc, Electrosensitivity UK, the EM Radiation Research Trust, Mast Action UK, Mast Sanity, Powerwatch, WiFiinschools.org.uk and WiredChild.

It is recognised by the WHO (1986) that it is vital to take into consideration the health impact of technology on the environment.

An efficient restructuring is required to optimise the chances of Smart Meter success. A more collaborative approach could also prove of great benefit in determining what is realistic, practical and achievable.

This restructuring might now be achievable as a result of initiatives such as SmartGrid GB which was launched by Charles Hendry MP, UK Minister of State for Climate Change in June 2011(SG GB 2011).

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Appendix 6 - Improving science-based stakeholder processes

Extracts from the EPA's findings on 'Improving Science-Based Environmental Stakeholder Processes' (US EPA 2001):

Finding 1

"An adequate treatment of science is possible in stakeholder processes, but typically only if substantial financial resources, adequate time, and high-quality staff are available from the outset to allow the necessary deliberation and provide the necessary support on an iterative basis through ongoing interaction with the stakeholders."

"Absent such resources, stakeholder decision processes, of the types considered in this commentary, frequently do not do an adequate job of addressing and dealing with relevant science."

Finding 3

"If group stakeholder processes, … are to result in environmental decisions that are adequately informed by science, participants … must share a commitment to explore the implications of all relevant science, and a willingness to reframe the problems they address when scientific evidence leads in unanticipated directions."

Finding 5

Using stakeholder process … should be undertaken with great care. … it can appropriately be applied to only a modest subset of environmental regulatory decisions in which:

a) adequate staff, generous financial resources, and sufficient time are available to provide expert support on an iterative basis;

b) parties are willing to adapt their thinking and the problem formulation to the scientific evidence as it becomes understood;

c) the problem being addressed involves a small number of well identified affected parties who can all be made party to the decision process; …

Finding 6

"If and when a stakeholder process is to be used as the vehicle for decision-making, great care must be taken to assure that all relevant interests are represented in a full and balanced manner. Only then can modest ambiguities involving fact-value tradeoffs be allowed to persist without risking serious errors in outcome. …"

Reference

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Appendix 7 - Privacy matters – *thoughts from a Smart Meter opponent*

SMART METERS - A little too smart?

Jerry Day (2011), http://www.youtube.com/watch?v=8JNFr_j6kdI

"*We are now entering the brave new world of Smart Meters. That means your electric meter will do so much more than just show how much electricity you use. New Smart Meters are watching you. They sense all kinds of goings on. They see when you turn something on or off. They see how many watts your electric toothbrush pulls.*

They send a record of that little event over wireless networks, bouncing through your neighbors' Smart Meters all the way to the power company where they keep a record of all your power consumption, volumes and patterns, every minute of every day and store that data forever on computers that you will never get to see.

That data shows when you are at home, shows when you are sleeping, shows when you are on vacation, when you have visitors, when you use a lamp, a power tool, some extra computers and when you look like you are running a business out of your home. It even senses when you bootleg energy off the grid.

Your Smart Meter data shows a vivid pattern of your personal living patterns and whether or not you were at home on the night of the murder. This is not electrical metering. This is personal surveillance. This is a search without a warrant every day.

This is your personal private life going straight out through your electric meter to the power company, to the government, to the police, to the insurance company, to anyone who cuts a deal with your power company to look at your life under a microscope. Sorry, it's actually worse than that. People who don't cut a deal can get your information too by simply intercepting the wireless signal spewing from the side of your house.

Yes Smart Meters are radio-transmitters. Here's how you tell, this one is a 1-watt radio station licensed by the FCC. On this all news radio station, every detail of your electrical life is shooting off to some institutional data centre somewhere. [*Look at the data strip on the face of the meter which gives its specification].*

Already the police in Ohio, Texas, British Columbia and places I don't know about are regularly using Smart Meter data to pinpoint marijuana grow houses, enforce business licenses and punish

people for doing things in the privacy of their own homes, that you were not supposed to do, but they would not even know you were doing if they weren't spying on you.

Your power company apparently gets to sell your life story to whomever it wants. Any unusual power consumption pattern is considered probable cause to raid you for growing marijuana or running a computer server without a business license.

This is about as Big Brother as it gets. Those friendly men with their truckload of Smart Meters are going door to door with something a little different than a Christmas carol. My personal opinion is that you and I need to demand that these things be taken off our homes.

It is not possible for your power company to claim that they have the right to install a surveillance device on your house. Smart Meters are no different from wire-tapping devices. And, in case you didn't know, wire-tapping is illegal in all 50 of the states and the federal territories.

If you let your power company put a Smart Meter on your house, you may as well walk around all day with a Facebook helmet webcam pointed at yourself. They have convinced themselves installing Smart Meter is lawful by some reaching to the moon jive called implied consent. If you say they can change your meter, they pretend you consent, even when you don't know really what they are doing.

Here's a tip. Tell them they can't change your meter; they had no trouble billing you with the old meter. If you send them a notice by certified mail that they may not install a Smart Meter or any other surveillance device on your house, your implied consent goes out the window. I would do that if I were you. In fact I did that and I'm not even you. You can see a copy of my letter in the drop down next to this video. You can copy and paste that into your word processor. Make sure and change the info into your own info. The post office will give you the certified mail slip.

Those friendly guys on the sidewalk told me that they plan to put a Smart Meter on every house in America. If they do that it will no longer be America."

Comment by present author - Privacy guidelines have now been created for California in the USA, Ontario in Canada and the UK. Refer to the section on '*Privacy Initiatives*'.

Appendix 8 – Seletun Resolution

Scientific panel on electromagnetic field health risks: consensus points, recommendations, and rationales.

Fragopoulou et al. (2010).

Abstract

In November, 2009, a scientific panel met in Seletun, Norway, for three days of intensive discussion on existing scientific evidence and public health implications of the unprecedented global exposures to artificial electromagnetic fields (EMF). EMF exposures (static to 300 GHz) result from the use of electric power and from wireless telecommunications technologies for voice and data transmission, energy, security, military and radar use in weather and transportation. The Scientific Panel recognizes that the body of evidence on EMF requires a new approach to protection of public health; the growth and development of the fetus, and of children; and argues for strong preventative actions.

10 Key Points:

1. Global populations are insufficiently protected, thus currently at risk;
2. Sensitive Populations are extra vulnerable;
3. Government actions are urgently warranted now, based on evidence of serious disruption to biological systems;
4. The Burden of Proof for the safety of radiation-emitting technologies should fall on Producers and Providers not Consumers;
5. EMF Exposures should be reduced in advance of complete understanding of mechanisms of action;
6. The current operative measure of Radiation Risk is inadequate, and misguides on safety and health risks;
7. An international Disease Registry is needed to track Time Trends of the incidence of Illnesses to correlate illnesses with exposures;
8. Pre-market health testing and safety demonstration is needed for all radiation-emitting technologies;
9. Parity is needed for occupational exposure standards, compared to those for the general public;
10. Persons with Electrohypersensitivity need the classification Functionally Impaired.

Reference

Fragopoulou et al. (2010). Scientific panel on electromagnetic field health risks: consensus points, recommendations, and rationales. Reviews on Environmental Health, 25(4), pp. 307-317.

Appendix 9 – Website listings

Utility news and smart grid related information (*partial listing*)

Detect Energy - http://detectenergy.com/
eMeter - http://www.emeter.com/Green Tech - http://news.cnet.com/
Metering.com - http://www.metering.com/
SmartGridOpinions, http://www.smartgridopinions.com
smartmeters - http://www.smartmeters.com
VaasaETT Global Energy Think Tank –
http://www.vaasaett.com/?s=smart+meters

Smart Metering and Advanced Metering Infrastructure (AMI)

Aclara® - http://www.aclaratech.com
ADD GRUP - http://www.addgrup.com
ANDREA Informatique - http://www.andrea.fr
Applied Precision Ltd - http://www.appliedp.com
Avnet Memec - http://www.avnet.com
Cewe Instrument - http://www.ceweinstrument.se
Connect Group Consulting Limited - http://www.connectgroupltd.com
DIEHL Metering Group - http://www.diehl.de
Digi International - http://www.digi.com
Echelon Corporation - http://www.echelon.com
El Sewedy Industries Group - http://sewedy-eg.com
Elster - http://www.elster.com
eMeter - http://www.emeter.com
Ferranti computer systems - http://www.ferranti.be
Freescale Semiconductor - http://www.freescale.com
Holley Metering Limited - http://www.holleymeter.com
Inhemeter - http://www.inhemeter.com
International Electrotechnical Commission – http://www.iec.ch
ISKRAEMECO - http://www.iskraemeco.si
Itron - http://www.itron.com
IUSA - http://www.grupo-iusa.com
Kamstrup - http://www.kamstrup.com
Landis+Gyr - http://www.landisgyr.com
Microchip Technology Inc. - http://www.microchip.com
ON Semiconductor - http://www.onsemi.com
Pacific Trading & Recycling LLC - http://www.pacifictradingandrecycling.com
Panasonic - industrial.panasonic.com
Paradox Engineering - http://www.pdxeng.ch
Process Vision Oy - http://www.processvision.fi
PROLAN - http://www.prolan.com
Radiocrafts - http://www.radiocrafts.com
Renesas - http://am.renesas.com
RF Micro Devices, Inc. (RFMD®) - http://www.rfmd.com
Sanxing Electric - http://www.sanxing.net.cn
Secure - http://www.securetogether.com
Shenzhen Kaifa Technology Co., Ltd - http://www.kaifa.cn
Londian Electrics - http://www.londian.com.cn

Sierra Wireless - http://www.sierrawireless.com
Silicon Laboratories - http://www.silabs.com
Sinoware Technology - http://www.sinowaretech.com
Shenzhen Star Instrument Co. Ltd. - http://www.szstar.com
Telit Wireless Solutions - http://www.telit.com
Telvent - http://www.telvent.com

Utilities that have participated to date in creating the Smart Grid Maturity Model

North America	Rest of World
Excelon/PECO	Tokyo Electric
Manitoba Hydro	Shanghai Municipal Electric Power Co.
BC Hydro	Alliander
Bonneville Power	EDF (UK)
Portland Gen.	DONG Energy
Salt River Proj.	ERDF (France)
Sempra	Union Fenosa
Austin Energy	NDPL (India)
Co Serv	Zhejiang Energy
Centerpoint	CLP (Hong Kong)
Entergy	Energy Australia
Glendale W & P	Country Energy
Detroit Edison	CPFL (Brazil)
EPCOR	EDP (Brazil)
Hydro Ottawa	
Excelon/ComEd	
VELCO	
Allegheny Power	
Dominion Vir.	
First Energy	
AEP	
PHI	
Progress Energy	
Duke Energy	
SCANA Corp	
East Miss EPA	

Global Intelligent Utility Network Coalition

This is a group of select utilities that collaborates to accelerate, shape, and share in the development of smart grid. Its members are:

Australia

Queenbeyan: Country Energy - http://www.countryenergy.com.au/

Brazil

Sao Paulo: CPFL - http://www.cpfl.com.br/

Denmark

Copenhagen: DONG Energy – http://www.dongenergy.com

France

Paris: ERDF - http://www.erdfdistribution.fr/Accueil

India

Delhi: NDPL - http://www.ndpl.com/

Netherlands

Arnhem: Alliander - http://www.alliander.com/nl/alliander/

United States of America:

Dallas, Texas: Oncor Electric Delivery - http://www.oncor.com/
Houston, Texas: CenterPoint Energy - http://www.centerpointenergy.com/home
New York, NY: IBM - http://www.ibm.com/us/en/
Raleigh, North Carolina: Progress Energy - https://www.progress-energy.com/
San Diego, California: Sempra Energy – http://www.sempra.com/
Washington, D.C.: PHI - http://www.pepcoholdings.com/services/outreach/

Energy Companies for Smart Metering (*partial listing*)

CISCO - http://www.cisco.com/web/strategy/energy/external_utilities.html
Spencer Ogden Smart - http://www.sosmartenergy.com/
Europäischen Funk-Rundsteuerung GmbH (EFR) - http://www.efr.de/CMS/

United Kingdom

Department of Energy & Cllimate Change (DECC) - http://www.decc.gov.uk/en/content/cms/tackling/smart_meters/smart_meters.aspx
SmartReach: consortium created to address UK Government mandate on Smart Metering - http://smartreach.com/
npower.com – http://www.npower.com/SmartMetering
British Gas Smart Meters – http://www.britishgas.co.uk/Smart_Meters
Southern Electric – http://www.southern-electric.co.uk/smart_meter
Energy Retail Association – http://www.energy-retail.org.uk/smartmeters.html

Russia

ENERGOAUDITCONTROL - http://www.ackye.ru/

South Africa

Eskom - http://www.eskom.co.za/live/index.php

United States of America:

SGIC Smart Grid Information Clearinghouse - http://www.sgiclearinghouse.org/
Smartgrid.gov - http://www.smartgrid.gov/

References

Ferro, E. (2009), Global Intelligent Utility Network Coalition – The Power of Partnerships, IBM, 11 pp. http://www.asiapacificpartnership.org/pdf/PGTTF/ddsm/presentations/The_Power_of_Partnerships_Erica_Ferro.pdf
Smart Grid Maturity Model (2010), Software Engineering Institute, Carnegie Mellon, 12pp. http://www.sei.cmu.edu/library/assets/brochures/SGMM-1010.pdf

Appendix 10
Smart Metering projects worldwide

Argentina
Cooperativa de Obras y Servicios Públicos de Brinkmann

Australia
Alice Springs Solar City
Adelaide Solar City
Blacktown Solar City
Country Energy
MidCoast Water
SP Ausnet
Synergy Trial
Townsville Solar City
Wide Bay Water

Austria
Energie AG
Linz Strom

Azerbaijan
Azerigaz

Belgium
Belgium

Bosnia and Herzogovinia
Elektroprivreda HZ HB Mostar

Brazil
Ampla Energia
Foz do Iguaçu
Government Sponsored Project in Campinas

Canada
Berwick Electric Commission
BC Hydro
Chatham-Kent Hydro
Enersource Hydro Mississauga
Halton Hills Hydro
Horizon Utilities
Manitoba Hydro
Norfolk County
Ontario IESO Overview
Peterborough Distribution
Powerstream
Toronto Hydro-Electric System Limited
Toronto Water
Thunder Bay Hydro

China
China
Guizhou Province

Colombia
EMCALI - UENE

Croatia
ODS Croatia

Czech Republic
CEZ
E.ON Czech Republic

Denmark
EnergyMidt
Elro Net
NRGi
Odense Energi
SEAS NVE
Syd Energi

Dominica
Dominica Electricity Services

Dominican Republic
Corporación Dominicana De Electricidad

Estonia
VKG Elektrivõrgud OÜ

Finland
Fortum
Fortum Espoo Oy
Haukiputaa Electricity Cooperative
Kainuun Energia
Kemin Energia
Satapirkan Sähkö Oy
Tornion Energia
Vattenfall Verkko Oy

France
Electricitie De France

Smart Metering projects worldwide (*continued*)

Germany
EnBW
EWE
Mainova
RWE Pilot in Mülheim an der Ruhr
Stadtwerke Bochum & EVB
Stadtwerke Dusseldorf
Stadtwerk Haßfurt
Stadtwerke Neu-Isenburg & EVB
Stadtwerke Schwerte & EVB Energie
STW Setec & EVB
SVO Energie & EVB
TWK Kaiserslautern & EVB
Yello Strom

Italy
Acea Distribuzione
ENEL
Italian Gas Developments

India
Grinpal Energy Management
City of Mumbai

Iran
IGMC Project

Ireland
Ireland

Jamaica
Jamaica Public Service

Japan
Kansai Electric Power

Jerusalem
Marmilla, Jerusalem

Malaysia
Tenaga Nasional Berhad

Malta
Enermalta

Mexico
Federal Commission of Electricity

Netherlands
Oxxio/Nuon
Smart City Project in Amsterdam

New Zealand
Contact Energy
Genesis Energy
Mercury Energy
Meridien Energy

Norway
Kragero Energi
Skagerak Nett AS

Pakistan
KESC - Karachi Electricity Supply Company
GEPCO - Pakistan Electric Power Company
LESCO - Pakistan Electricity Company

Philippines
Meralco

Portugal
EDP Distribuciao
Quinta De La Portela

Puerto Rico
Puerto Rico Electric Power Authority

Romania
Distrigaz Sud

Russia
Energoauditcontrol

Serbia
Elektrovojvodina D.O.O.

Singapore
Singapore SP Services

Spain
Endesa
Iberdrola

Sweden
E.ON Sverige
Gothenburg Energy
Halmstad Energi och Miljo
PiteEnergi
Staffanstop Energi AB
Utsikt Nät AB
Vattenfall

Smart Metering projects worldwide (*continued*)

Switzerland
Stadtwerke Feldkirche

Thailand
Provincial Electricity Authority

Trinidad and Tobago
Trinidad and Tobago Electricity Commission

Turkey
Elektromed

United Arab Emirates
United Arab Emirates

United Kingdom
GB Smart Metering
Guernsey Electric
Northern Ireland Electricity

United States of America

Alabama
Alabama Power
Alabama Power Smart Meter of Southern Co
City of Andalusia

Arizona
Arizona Public Service
Salt River Project
Sulphur Springs Valley Electric

California
Burbank Water and Power
Discovery Bay
Glendale Power & Water
Modesto Irrigation District
Pacific Gas & Electric
Sacramento Municipal Utility District
San Diego Gas and Electric
SFPUC
Silicon Valley Power
Southern California Edison

Colorado
Boulder - Smart City
Xcel Energy

Connecticut
Connecticut Light and Power
Metropolitan District (MDC)

Delaware
Delmarva Power - a PHI Company

Florida
City of Tallahassee
Florida Power & Light
Tampa Electric Co.

Georgia
Georgia Power
Jackson EMC
Suwanee EMC

Hawaii
Hawaiian Electric Company
Kauai Department of Water

Idaho
Idaho Power

Illinois
ComEd Trial in Chicago

Indiana
Duke Energy Indiana
Whitewater, IN

Iowa
Alliant Energy
Des Moines Water Works

Kentucky
Duke Energy - Kentucky
Kentucky Power
Louisville Gas and Electric

Louisiana
Cleco Power

Maine
Central Maine Power

Maryland
Baltimore Gas and Electric
Cumberland, Maryland
Potomac Electric Power Co

Massachusetts
Boston Water and Sewer Commission
National Grid US
Pittsfield Township
Western Massachusetts Electric Company

Minnesota
City of Duluth

Missouri
Laclede Electric CoOperative

Mississippi
Gulfport

Smart Metering projects worldwide (*continued*)

New Hampshire	Texas
Central Vermont Public Service	AEP Texas
Portsmouth, NH	Arlington & Grand Prairie
Vermont Electric Coop	Austin Energy
New Jersey	Bluebonnet Electric
Atlantic City Electric	Centerpoint Energy
PECO Smart Meter Plans	City of Corpus Christi
New York	City of Denton
Amenia NY	OnCor
Horseheads	Post, Texas
Ithaca, NY	San Marcos City Council
Long Island Power Authority	Stamford, Texas
National Grid	Utah
PSE&G	Heber Light and Power
Smart Grid Trial in Queens	Spanish Fork
North Carolina	Vermont
Piedmont Electric Membership	Central Vermont Public Service
Southern Company	Vermont Electric Coop
Ohio	Virginia
AEP Ohio	Appalachian Power
City of Cuyahoga Falls	City of Danville
Mansfield	Dominion Power of Virginia
Oklahoma	Dominion Virginia Power
Oklahoma Gas And Electric	Wythe County
Pennyslyvannia	Washington
Cumberland, Maryland	Gridwise Trial
Dubois, PA	Okanogan County PUD
PECO AMI Trial	Portland General Electric Co.
PECO Smart Meter Plans	Seattle City Light
PPL Pilot in Harrisburg	Tacoma Power
PSE&G	Wisconsin
West View Water Authority	Alliant Energy Corporation
Rhode Island	
National Grid	
Tennessee	
Clarksville Department of Electricity	
EPB	
Pulaski Electric Service	

Refer also to:

Google Maps (2011), Smart Metering Projects Map, http://maps.google.com/maps/ms?ie=UTF8&oe=UTF8&msa=0&msid=115519311058367534348.0000011362ac6d7d21187

Appendix 11 - EMF & related web sites (*partial listing*)

International

AAAS – The American Association for the Advancement of Science - http://www.aaas.org/aboutaaas/
BioInitiative Working Group - http://www.bioinitiative.org/
Council of Europe - http://www.coe.int/lportal/web/coe-portal
The Collaborative on Health and the Environment CHE EMF - http://www.healthandenvironment.org/working_groups/emf
CTIA The Wireless Association® - http://www.ctia.org/
Europeans on Smart meters - http://www.facebook.com/pages/Europeans-on-smart-meters/122384431183034
The Foundation for Information Policy Research (FIPR) http://www.fipr.org/
International Agency for Research on Cancer (IARC) - http://www.iarc.fr/
International Electro-Magnetic Fields Alliance (IEMFA) - http://international-emf-alliance.org/
REFLEX - Risk Evaluation of Potential Environmental Hazards From Low http://ec.europa.eu/research/environment/pdf/env_health_projects/electromagnetic_fields/e-reflex.pdf
Stop Smart Meters NOW, http://www.facebook.com/pages/Stop-Smart-Meters-Now/
Smart Meter Site in Spanish *(under construction)* http://www.concienciaradio.com/nosmartmeters/
Underwriters Laboratories Inc. (UL) - http://www.ul.com/
VaasaETT Global Energy Think Tank - http://www.vaasaett.com/
World Health Organization (WHO) - http://www.who.int/en/

Australia

Australian Centre for RF Bioeffects Research - http://acrbr.org.au/
EMF Facts Consultancy - http://www.emfacts.com
EMR Australia - http://www.emraustralia.com.au/

Austria

Mobilefunk-Initiative - http://www.plattform-mobilfunk-initiativen.at

Belgium

Etudes & Vie - http://www.etudesetvie.be/
Lasante.be - http://www.lasante.be/
Teslabel Coordination - http://www.teslabel.be/

Canada

Canadians for A Safe Learning Environment (CASLE) - http://www.casle.ca/Home/tabid/36/Default.aspx
Citizens for Safe Technology Canada - http://www.citizensforsafetechnology.org/
Clean Energy Foundation Canada - http://www.cleanenergycanada.com/
Coalition québécoise de lutte contre la pollution électromagnétique - http://www.cqlpe.ca/
EM Radiation Health Alliance of BC - http://emrabc.ca/
EMR Heath Alliance of BC, http://emrabc.ca/
Gulf Islanders for Safe Technology - http://www.gifst.ca/
La Maison du 21e siècle - http://www.21esiecle.qc.ca/

RF.com Canada - http://www.rfcom.ca/welcome/index.shtml
Rule of Law Defenders - http://www.hosnyinfo.com/home
Safe Living Technologies Inc. Canada - http://www.safelivingtechnologies.ca/
WEEP Initiative Canada - http://www.weepinitiative.org/index.html

Denmark

Danish Association of Electrosensitives - http://www.el-allergi.dk/

Éire/Ireland

Alliance for Irish Radiation Protection - http://www.eirewaves.com/

France

Accuel – France Nature Environment - http://www.fne.asso.fr/
Agence Nationale des Fréquences (ANFR) – http://www.anfr.fr/
Association pour la Recherche Thérapeutique Anti-Cancéreuse (ARTAC) - http://www.artac.info
Association Agir pour l'Environnement - http://www.agirpourlenvironnement.org/
Association Santé–Environnement en Rhône-Alpes - http://www.sera.asso.fr/
Association Santé–Environnement France - http://www.asef-asso.fr/
Autorité de régulation des communications électroniques et des postes (ARCEP) - http://www.arcep.fr/
Agence Nationale de sécurité sanitaire - http://www.anses.fr/
Ecoforum – http://www.ecoforum.fr
Centre de Recherche et d'Information Indépendantes sur les Rayonnements ElectroMagnétiques (Criirem) - http://www.criirem.org
Collectif SEMO - http://www.dangersemo.com/Site_SEMO/WEB_SEMO_page_1.html
electrosensible.org – http://www.electrosensible.org
Europe Ecologie - http://www.europe-ecologie.fr/
EuroTinnitus a,s.b.l. - www.eurotinnitus.com
Fédération Française des Telecoms – http://www.afom.fr/
Fondation pour une Tere Humaine – http://www.terrehumaine.org
Fondation Santé et Radiofréquences – http://www.sante-radiofrequences.org
International Radiation Protection Association – www.irpa.net
Liberterre - http://www.liberterre.fr/
Mobilou.info – http://www.mobilou.info
Next-Up News of the World France - http://www.next-up.org
Pour une Réglementation des Implantations d'Antennes Relais de Téléphonie Mobile (PRIARTéM) - http://www.priartem.fr/
Pratiques - http://www.pratiques.fr/
Robin Des Toits France - http://www.robindestoits.org/
SantéPublique éditions - http://www.santepublique-editions.fr
Science… & pseudo-sciences - http://www.pseudo-sciences.org/
www.contaminations-chimiques.info - http://www.contaminations-chimiques.info/
Sciences Citoyennes fondation – http://www.sciencescitoyennes.org
TcherMobile.org - http://www.tchermobile.org/
Zone Blanche – White Zone - http://www.zoneblanche.fr/

Germany

Bürgerwelle, http://www.buergerwelle.de/
Der Mast muss weg! - http://www.der-mast-muss-weg.de/
diagnose FUNK – http://www.diagnose-funk.org/
ECOLOG-Institut - http://www.ecolog-institut.de
www.elektrosmog.com - http://www.elektrosmog.com/
ElektroSMOG NEWS - http://www.elektrosmognews.de/
Forschungsgemeinschaft Funk e.V. - http://www.fgf.de/
Gigahertz Solutions – http://www.gigahertz-solutions.com/
human ecological social economical project (h.e.s.e.) - http://www.hese-project.org/
Informationszentrum Mobilfunk - http://www.izmf.de/
Initiative der direkten Demokratie – http://www.iddd.de
International Commission on Non-Ionizing Radiation Protection - http://www.icnirp.de/
Die Kompetenzinitiative zum Schutz von Mensch, Umwelt und Demokratie e.V.- http://www.kompetenzinitiative.de/
Mobilfunk Bürgerforum.de - http://www.mobilfunk-buergerforum.de
Puls-Schlag – http://www.puls-schlag.org/
Risiken des Mobilfunks – http://www.mobilfunkrisiken.de
www.risiko-elektrosmog.de - http://www.risiko-elektrosmog.de
Strahlung-gratis … nein danke! - /http://www.strahlung-gratis.de/
Verband Baubiologie- http://www.verband-baubiologie.de/

Iceland

Nordic Society for Radiation Protection - http://www.nsfs.org/

Italy

Associazione Italiana Elettro Sensibili / Italian Association for the Electrosensitive - http://www.elettrosensibili.it/
CO.NA.CEM - http://www.conacem.it/
International Commission for Electromagnetic Safety – http://www.icems.eu

Korea

Korean EMF Pages - http://emf.or.kr/

Luxembourg

Biirgerfrequenz a.s.b.l. - http://www.biirgerfrequenz.lu/

Netherlands

Beperk de Straling – http://www.beperkdestraling.org
Stichting EHS / Dutch EHS Foundation - http://www.stichtingehs.nl/
Nationaal Platform Stralingsrisico's / Dutch National Platform on Radiation Risks - http://www.stralingsrisicos.nl/
Stop UMTS! - http://www.stopumts.nl/
www.milieuziektes.nl - http://www.milieuziektes.nl/
Stralings gevoeligheid - http://www.straling.org/

New Zealand

Ban the Tower: New Zealand - http://www.banthetower.co.nz/
Dr. Neil Cherry (1946-2003) - http://www.neilcherry.com/
EMR - http://www.emr.co.nz

Wi-Fi in Primary Schools-New Zealand - http://www.webshack.co.nz/wifiinschools.htm

Norway

Norwegian Association for the Electro-Hypersensitive - http://www.felo.no/

Portugal

Antenas Agui NAO Portugal - http://antenasaquinao.blogspot.com/

South Africa

Electromagnetic Radiation Research Foundation of South Africa - http://www.emrrfsa.org/smart-meters/

Spain

Asociación Independiente para Defender la Salud - http://www.asides.es/
Asociación Vallisoletana de Afectad@s por las Antenas de Telefonía (AVAATE) - http://www.avaate.org

Sweden

FEB Sweden Electrosensitivity - http://www.feb.se/

Switzerland

Association Romande Alerte (ARA) – http://www.alerte.ch/
Bürgerwelle Schweiz – http://www.buergerwelle-schweiz.org
Femme-medicine.ch - http://www.femme-medecine.ch/
gigaherz.ch - http://www.gigaherz.ch/
MCS-SOS - http://www.mcs-sos.ch/
Strahlungfreies Kreuzlingen, http://www.strahlungsfrei.ch

United Kingdom

Age UK – http://www.ageuk.org.uk/
The British Electrotechnical & Allied Manufacturers Association (BEAMA) - http://www.beama.org.uk/en/about-us/
Bioelectromagnetic Research Initiative - http://bemri.org/
Consumer Focus – http://www.consumerfocus.org.uk/
Department of Energy and Climate Change (DECC) – http://www.decc.gov.uk/
Department of Health (DH) - http://www.dh.gov.uk/
ElectroSensitivity.org – http://www.electrosensitivity.org
Electrosensitivity UK(ES-UK) - http://www.es-uk.info/
EM Radiation Research Trust - http://www.radiationresearch.org/
Fuel Poverty Advisory Group (FPAG) - http://www.decc.gov.uk/en/content/cms/about/partners/public_bodies/fpag/fpag.aspx
Independent Expert Group on Mobile phones (IEGMP) – http://www.iegmp.org.uk
Mast Action - http://www.mastaction.co.uk/
Mast Sanity - http://www.mastsanity.org/
Mast-Victims.org - http://www.mast-victims.org/
Office of Gas and Electricity Markets (Ofgem) - http://www.ofgem.gov.uk/
Powerwatch - http://www.powerwatch.org.uk/
Public Utilities Access Forum (PUAF) – http://www.puaf.org.uk/
scram.uk.com – http://www.scram.uk.com
SmartReach – http://smartreach.com/

STOP SMART METERS! (UK) - http://stopsmartmeters.org.uk/
TETRAWATCH - http://www.tetrawatch.net/
Which? – http://www.which.co.uk/
Wi-Fi in Schools - http://wifiinschools.org.uk/index.html
WiredChild - http://wiredchild.org/

United States of America

American Coalition Against Smart Meters - http://www.causes.com/causes/594297-american-coalition-against-smart-meters?recruiter_id=66515572
The Bioelectromagnetics Society - https://www.bems.org/
Center for Safer Wireless - http://www.centerforsaferwireless.org/index.php
Condo Residents Against SmartMeters - http://smartmeters.webbery.net/
ElectromagneticHealth.org - http://www.electromagnetichealth.org
The EMR Network – http://www.emrnetwork.org
The EMR Policy Institute - http://www.emrpolicy.org/
Government Accountability Office (GAO) - http://www.gao.gov/
Microwave News – http://www.microwavenews.com
SAFEWIRELESS.ORG - http://www.safewireless.org/
US National Research Council - http://www.nationalacademies.org/nrc/

Arizona:

Ban Smart Meters Arizona.com - http://www.bansmartmetersarizona.com/index.html

California:

Alliance for Human and Environmental Health – http://www.allianceheh.org
Burbank Action - https://sites.google.com/site/nocelltowerinourneighborhood/home
California Public Utilities Commission (CPUC) - http://www.cpuc.ca.gov/puc/
Council on Wireless Technology Impacts - http://www.wirelessimpacts.org/
Division of Ratepayer Advocates in California (DRA) - http://www.dra.ca.gov/dra/
EMF Safety Network - http://www.emfsafetynetwork.org
Eon3 EMF Blog - http://eon3emfblog.net/
No Smart Meters SF - http://nosmartmeters.blogspot.com/
People's Initiative Foundation: Santa Monica CA - http://www.thepeoplesinitiative.org/
Refuse Smart Meters Mendocino - http://www.refusesmartmetersmendo.blogspot.com/
San Francisco Neighborhood Antenna-Free Union, - http://www.antennafreeunion.org
Smart Meter Action Group - http://smartmeters.transbay.net/doku.php?id=dnc
Smart Meter Dangers - http://www.smartmeterdangers.org/
SNAFU: San Francisco California USA - http://www.antennafreeunion.org/
Stop OC Smart Meters – http://www.stopocsmartmeters.com/
Stop Smart Meters - http://stopsmartmeters.org/
TURN The Utility Reform Network – http://www.turn.org

Florida:

smart / meter / matrix - http://smartmetermatrix.org/

Illinois:
Naperville Smart Meter Awareness - http://www.napervillesmartmeterawareness.org/
Maine:
Smart Meter Safety - http://smartmetersafety.com/
Maryland:
Maryland Residents Against Smart Meters - http://www.marylandresidentsagainstsmartmeters.org/index.html
Michigan:
Smart Meters - Stop the Invasion! – http://www.w4ar.com/Smart-Meters.html
Minneapolis:
Guinea Pigs "R" Us – http://www.guineapigsrus.org
New Jersey:
Mobile Impact: Brandon New Jersey - http://brandonfarmswatertower.com/wordpress/
New Mexico:
Why Fry? Smart Meters – http://whyfry.org/tag/smartmeters
Tennessee:
Stop Smart Meters Now.com - http://www.stopsmartmetersnow.com/?page_id=33
Texas:
Ban Smart Meters - http://www.bansmartmeters.com/blog/

Human Rights organisations (*partial listing*)

International
Amnesty International - http://www.amnesty.org.uk/
Asian Human Rights Commission – http://www.humanrights.asia/
Asia-Pacific Human Rights Information Center - http://www.hurights.or.jp/english/
Derechos Human Rights – http:www.derechos.org/ - *in Spanish*
Human Rights Watch - http://www.hrw.org/about
Inter-American Court & Commission of Human Rights (OAS) - http://www.cidh.oas.org/
Directorate General of Human Rights and Legal Affairs of the Council of Europe - http://www.coe.int/t/dghl/default_en.asp
United Nations Human Rights - http://www2.ohchr.org/

Africa
African Commission on Human and Peoples' Rights - http://www.achpr.org/
Australia
Australian Human Rights Commission – http://www.hreoc.gov.au/
Canada
The Canadian Human Rights Commission - http://www.chrc-ccdp.ca/
China
Human Rights in China - http://www.hrichina.org/what-we-do
Denmark
The Danish Institute for Human Rights - http://www.humanrights.dk/
International Society for Human Rights (ISHR) - http://www.ishr.org/
Éire/Ireland
Irish Human Rights Commission – http://www.ihrc.ie/

France

Commission nationale consultative des droits de l'homme / French National Consultative Commission on Human Rights (NCCHR) (France) - http://www.cncdh.fr/

Germany

German Institute for Human Rights - http://www.institut-fuer-menschenrechte.de/en/home.html

Iceland

Icelandic Human Rights Centre - http://www.unhcr.org/48fdec2c2.html

Netherlands

Netherlands Institute of Human Rights - http://sim.law.uu.nl/

New Zealand

Human Rights Foundation of New Zealand - http://www.humanrights.co.nz/

Norway

Norwegian Centre for Human Rights - http://www.jus.uio.no/smr/

Russia

Moscow Research Center for Human Rights (Russia) - http://www.ishr.org/

South Africa

South African Human Rights Commission - http://www.sahrc.org.za/home/

Sweden

The Swedish Government's Human Rights Website - http://www.humanrights.gov.se/

United Kingdom

Directgov – Human Rights - http://www.direct.gov.uk/en/governmentcitizensandrights/yourrightsandresponsibilities/dg_4002951

United States of America

U.S. Department of State – Human Rights - http://www.state.gov/g/drl/hr/

Space weather and manmade EMP (*partial listing*)

Committee on Space Research (COSPAR) - http://cosparhq.cnes.fr/Meetings/Cosponsor.htm
DTIC® Online, Information for the Defense Community - http://www.dtic.mil/dtic/
The Electric Infrastructure Security Summit – http://www.eissummit.com/
EMPact America – http://www.empactamerica.org/about.php
EMPrimus – http://emprimus.com
Federation of American Scientists - http://www.fas.org/
Institute of Electrical and Electronics Engineers (IEEE) - http://ieeexplore.ieee.org/
Institute for Space Applications and Remote Sensing - http://www.space.noa.gr/
International Astronomical Union - http://www.iau.org/
International Electrotechnical Commission (IEC) - http://www.iec.ch/
National Aeronautics and Space Administration (NASA) - http://www.nasa.gov/
National Geographic - http://www.nationalgeographic.com/
NASA – http://www.nasa.gov
NATO – http://www.nato.int/
Ofcom - www.ofcm.gov/swef/2011/
Powerwatch - http://www.powerwatch.org.uk/

physicstoday – http://www.physicstoday.org/
Public Technology Group - http://www.pti.org/
US National Research Council - http://www.nationalacademies.org/nrc/
US National Security Working Group - http://rsc.jordan.house.gov/
US National Academy of Sciences - http://www.nationalacademies.org/nrc/
US National Oceanic and Atmospheric Administration. (NOAA) - http://www.swpc.noaa.gov/
Sage Policy Group, Inc. – http://www.sagepolicy.com/
SPACE.COM - http://www.space.com/
Space Weather Enterprise Forum - http://www.nswp.gov/swef/
Zurich Services Corporation - http://www.zurichservices.com/

Privacy and Security (*partial listing*)
The Electronic Frontier Foundation (EFF) – http://www.eff.org/
eMeter® - http://www.emeter.com/
European Telecommunications Standards Institute (ETSI) - http://www.etsi.org/WebSite/AboutETSI/AboutEtsi.aspx
The Foundation for Information Policy Research (FIPR) - http://www.fipr.org/
Information and Privacy Commissioner, Ontario Canada - http://www.ipc.on.ca/
Institute of Electrical and Electronics Engineers (IEEE) - http://ieeexplore.ieee.org/
International Data Privacy Law - http://idpl.oxfordjournals.org/
US National Institute of Standards and Technology - http://csrc.nist.gov/
PROsecurity zone - http://www.prosecurityzone.com/

Appendix 12 - Glossary and abbreviations

AAAS – The American Association for the Advancement of Science. This is an international non-profit organization dedicated to advancing science around the world by serving as an educator, leader, spokesperson and professional association.

Age UK – This UK charity seeks to help create a world in which older people flourish. It believes that everyone should be able to enjoy good health in later life, free from the diseases and disabilities associated with growing older. It funds research into, amongst other things, dementia and strokes.

AFCI – Arc-fault circuit interrupters (AFCI) are circuit breakers designed to prevent fires by detecting non-intentional electrical arcs and disconnecting the power supply before the arcing starts a fire.

Anonymisation – The process of removing the ability for Smart Meter data to be traced to an individual.

APHA – The American Public Health Association. This is a professional organisation for public health professionals based in the United States. Its mission is "… *to protect all Americans and their communities from preventable, serious health threats* …"

Autism – This is a lifelong developmental disability characterised by restricted and repetitive behavior, impaired communication and impaired social interaction. It affects how individuals relate and communicate with others.

BEAMA – The British Electrotechnical & Allied Manufacturers Association. This is the independent expert knowledge base & forum for the electrotechnical industry in the UK & Europe.

BECTA – The British Educational Communications and Technology Agency. This was the UK Government's partner for the use of ICT in education. It closed on 31st March 2011.

bemri.org – The Bio-Electromagnetic Research Initiative, a cooperative formed to provide an EMF research portal for the scientific community and interested members of the lay public showing the latest scientific information and hypotheses regarding EMFs.

BERR – [UK Department for] Business Enterprise and Regulatory Reform.

Bio-sustainability – a core concept for purposefully creating beneficial environments to enhance the health and wellbeing of humans, animals and Nature's eco-systems both now and for the future.

Blastoma – A type of cancer caused by malignancies in precursor cells (*often called blasts cells*).

CASLE – Canadians for a Safe Learning Environment. Website with practical resources for parents to work within the educational system to improve the condition of school buildings and products and practices used within so children and school staff occupy safe and healthy environments.

CCST – The California Council on Science and Technology. This offers expert advice to the State government and recommends solutions to policy issues that are science and technology-related.

Consumer Focus – This is presently the statutory consumer champion for the UK, though it is being disbanded with some of its functions being likely to transfer to Citizens Advice. It is involved in ensuring a fair deal for energy consumers and vulnerable consumers.

Council of Europe – This organisation works to develop common and democratic principles based on the European Convention on Human Rights and other reference texts on the protection of individuals throughout Europe.

CPUC – California Public Utilities Commission. This regulates amongst other things privately owned electric, gas, telecommunications and water companies. Its mandate is to serve the public interest through protecting consumers and ensuring the provision of safe, reliable utility services and infrastructures at reasonable rates whilst being committed to environmental enhancement and a healthy Californian economy.

CTIA - The Wireless Association® - an International Association for the Wireless Telecommunications Industry.

DCA – The former UK Department for Constitutional Affairs. All its affairs were taken over by the Ministry of Justice in 2007.

DECC – the UK's Department of Energy and Climate Change. Its brief includes supporting vulnerable customers, delivering secure energy and enabling a low carbon energy economy.

DH – The UK's Department of Health. It is the government department responsible for public health issues, adult social care and the UK's National Health Service. The UK's Health Improvement & Protection Directorate is part of this department.

Diabetes – A group of metabolic diseases where individuals have high blood sugar; either because cells are unresponsive to insulin the body produces, or because the body produces too little insulin.

Directgov – The UK Government's digital single point of access to UK public sector information and services. The information shown is developed by government departments.

DRA – Division of Ratepayer Advocates in California, USA. Its statutory mandate is to obtain the lowest feasible rate for service that is consistent with safe and dependable service levels. As part of this mandate it also advocates for customer and environmental protections.

Eco-sustainability – a means to create beneficial environments for living things and the world both now and for the future.

EFF – The Electronic Frontier Foundation is a US based organisation is involved in matters related to consumer rights, innovation, privacy and free speech.

EHS – Electrohypersensitivity. This condition is also known by a variety of other names including 'Electrosensitivity' (ES), 'Electromagnetic Hypersensitivity' (EHS) and 'Idiopathic Environmental Intolerance with Attribution to Electromagnetic Fields' (IEI-EMF).

EIA – Environmental Impact Assessment. This is an assessment of the possible beneficial or detrimental impact a proposed scheme may have on the environment taking into account natural, social and economic aspects.

EIS – The Electric Infrastructure Security Council. The EIS helps coordinate US and international infrastructure protection against electromagnetic threats. "*Working together to protect our nations' vital infrastructures against severe geomagnetic storms and EMP risks.*"

EMF – Electromagnetic field.

EMPact America – This is a bipartisan, non-profit organisation concerned with protecting Americans from natural or nuclear EMP catastrophes.

EM Radiation Research Trust – a UK registered charity involved in raising public awareness of the health effects of electromagnetic radiation worldwide. It also works with cross party members of the UK and European parliaments to help provide advice and information for parliamentary questions and reports, and is supported by Independent Scientific, Public Health and Technical advisors.

The EMR Policy Institute – This organisation was formed to advance sound electromagnetic radiation (EMR) public policy for the USA.

ERA – Energy Retail Association. This organisation represents the six main electricity and gas suppliers in the domestic market in Great Britain. It works closely with the Government, NGOs, charities and other organisations to ensure a coordinated approach related to energy.

ERDF – Électricité Réseau Distribution France. This subsidiary company of Électricité de France (EDF) manages 95% of the public electricity network in the French territories.

ES-UK – ElectroSensitivity UK is charity whose aim is to provide unbiased and balanced information to help those who have become EHS.

FCC – The Federal Communications Commission. This is an independent US Government agency. It works towards goals in the areas of broadband, competition, homeland security, the media, public safety, the spectrum and modernising itself. It provides varied degrees of cooperation, leadership and oversight for communications bodies in other American countries.

Fibre-optics – Optical fibres that act as waveguides, or 'light pipes' to transmit light between the two ends of a fibre. They are used in for communications purposes and allow transmission over longer distances and at higher data rates than other types of communication.

FIPR – The Foundation for Information Policy Research is an independent body that undertakes study on the interaction between information technology and society.

Fuel poor households – Households which spend at least 10% of their annual disposable income on home energy use.

FPAG – The UK Fuel Poverty Advisory Group. This advisory Non-Departmental Public Body for England is sponsored by DECC. The role of the

Group is amongst other things to consider and report on the effectiveness of current policies aiming at reducing fuel poverty.

GAO – The US Government Accountability Office is also sometimes referred to as the “congressional watchdog" and has a brief to investigate how the US federal government spends taxpayers’ dollars.

Geomagnetic storms – These are temporary disturbances of the Earth's magnetosphere caused by disturbances in the matter occurring between the starts in our Galaxy.

GFI – Ground Fault Interrupters, also known as Residual Current Devices (RCDs), are circuit breakers that protect from individuals from electrical shock.

GNP – Gross national product. This the market value of all services and products produced annually by labour and property supplied by a country’s residents.

HAN – Home area network. These can be used to enable communication between Smart Meters, In-Home Displays (IHDs) and other devices in consumers' premises.

HIA – Health Impact Assessment. This is a combination of procedures, methods and tools by which a policy, program or project may be assessed for its potential effects on public health and the distribution of those effects.

IARC – International Agency for Research on Cancer. Its mission is to coordinate and undertake research on the causes of human cancer, mechanisms of carcinogenesis, and to develop scientific strategies for cancer control and prevention.

ICNIRP – International Commission on Non-Ionizing Radiation Protection. It is an international commission that specialises in radiation protection issues, including determining exposure standards for RF/microwave emissions.

ICT - Information and Communication Technology.

IEEE – The Institute of Electrical and Electronics Engineers. This is the World’s largest professional association that is committed to advancing technological innovation and excellence for the benefit of humanity.

IEQ – Indoor Environmental Quality. The overall quality of a building’s interior as related to the comfort and health of its occupants.

IHD – In-Home Display. These are electronic devices linked to Smart Meters for providing information on individual customer’s energy consumption.

IUHPE – The International Union for Health Promotion and Education. A worldwide, independent and professional association committed to improving the health and wellbeing through education, community action and the development of appropriate public health policy.

The International Electro-Magnetic Fields Alliance (IEMFA) - This is an independent global body of scientific experts on living processes, with a multilevel, multidisciplinary health focus. Its principal aim is to disseminate coherent, health-oriented information and advice.
LCC – Life Cycle Costing. The investigation and valuation of environmental impacts of scheme caused by its existence.

Mast Action UK – Mast Action UK (MAUK) is a voluntary national organisation set up to help communities and individuals with mast siting problems.

Mast Sanity – National organisation in the UK opposing the inappropriate siting of mobile phone and Tetra masts and the installation of wireless Smart Meters.

Microwaves (MW) – These are electromagnetic waves between 1 m and 1 mm in length that occur over the frequency range of 300 MHz (0.3 GHz) to 300 GHz. Sometimes frequencies in this range are (*incorrectly in the present author's opinion*) referred to as radiowaves.

MLA – Member of the Legislative Assembly. A representative elected by the constituency's voters to the legislature or legislative assembly of a sub-national jurisdiction.

NASA – The US's National Aeronautics and Space Administration is an executive branch agency of the US government, responsible for the US civilian space program, aeronautics and aerospace research and the prediction of space weather.

NHS – The UK's National Health Service. This is the shared name for 3 of the 4 four publicly funded healthcare systems in the UK.

National Security Council (NSC) – This is the UK's chief forum for collective discussion of the UK Government's objectives for national security and how they can be best achieved in the current financial climate.

NK cells – Natural killer cells. These are a type of cytotoxic lymphocyte which are a major component of the innate immune system. They cells play a major role in the rejection of tumors and cells infected by viruses.

NRR – The UK's National Risk Register of Civil Emergencies.

NOAA – US National Oceanic and Atmospheric Administration. The brief of this agency is to enrich life through science. Its reach extends from the surface of the Sun to the depths of the oceans.

Ofgem – Office of Gas and Electricity Markets, the UK's regulator for electricity and gas markets. It is responsible for protecting gas and electricity consumers in the UK.

PACE - The Parliamentary Assembly of the Council of Europe. This deals with Human Rights issues, Democracy and Rule of Law for 47 Member States. It is committed to preserving the environment and environmental health, whilst also improving prevention of environment-related health hazards. Observer States for the Council of Europe include the United States and Canada.

PLC – Power Line Communications. These are systems developed to carry data on a conductor that is also used for electric power transmission. Also known as 'Linky' [in France], Broadband over Power Line (BPL), Power Line Access (PLA) and Power Line Telecommunication / Technology / Transmission (PLT).

Power density – This is the usual unit of measurement above 30 MHz, though electric and magnetic fields can also be measured. It is usually expressed in milli- or microwatts per square centimetre (mW/cm^2 or $\mu W/cm^2$), and is defined

as the amount of power per unit area in a radiated microwave field or other type of electromagnetic field.

Powerwatch – A small independent non-profit UK organisation involved in the EMF and microwave health debate. It works closely with decision-makers in government and business, and other like-minded groups, promoting policies for a safer environment.

Privacy by design – this is a design philosophy whereby privacy issues are considered before and during system is designed, rather than afterwards.

Psychosomatic responses – These are reactions created by the mind in response to a physical change just from the belief something has occurred. In medicine it is also known as the 'placebo effect'.

PUAF – The Public Utilities Access Forum – This is an informal association of organisations that helps develop policy on public utilities' regulation in England and Wales.

RCD – Residual Current Device, also known as Ground Fault Interrupters (GFIs), are circuit breakers that protect from individuals from electrical shock.

RF – Radiofrequency waves. These are in the frequency range of between 3 kHz to 300 MHz. Some authorities state that RF waves cover the frequency range of 3 kHz to 300 GHz that also encompasses all microwave frequencies.

RF/microwaves – This term covers wavelengths in both the radio frequency and microwave frequency areas, i.e. of 3 kHz to 300 GHz.

REFLEX – Risk Evaluation of Potential Environmental Hazards From Low Energy Electromagnetic Field Exposure Using Sensitive *in vitro* Methods. This EU funded project ran from 2000 to 2004.

Safe School Committee – Organisation set up in Canada to fully support equal access to technology for all children in schools through the use of wired internet connections. It seeks to help create the healthiest learning environment for children.

SHE – Schools for Health in Europe. The SHE Network is open for any organisation or professional with an interest in schools and health. It aims to support organisations and professionals to further develop and sustain school health promotion by providing the European platform for school health promotion.

Security by Design – This is a design philosophy aimed to ensure the security of a system is designed from conception to be secure. With this concept security risks and issues are identified early in the system's development.

Smart grids – These can intelligently and efficiently integrate the actions of all users connected to them for the economic and sustainable use of energy supplies. They are created through the integration of a globe-spanning network of thousands of companies.

SmartGrid GB – This initiative has been set up to provide an open forum for a wide range of concerned organisations to come together, share ideas and information and develop thinking on how the smart grid can be optimised to create consumer, economic and environmental benefits.

Smart Meter – This is a utility meter that records energy consumption in intervals of an hour or less and communicates that information at least daily back to the utility for billing and monitoring. They enable two-way communication between the meter and the utility.

SmartReach – This UK consortium was created to address the UK Government mandate on Smart Meter installation and is comprised of three UK companies: BT, Arqiva and Detica. It is "*committed to helping protect the environment and to making a meaningful contribution to the development of a thriving low–carbon economy*."

SMPS – Switching-Mode Power Supply. These can induce electromagnetic interference and high-frequency transients in the wiring systems they are attached to.

Solar flares – These are large energy releases on the surface of the Sun. They eject clouds of atoms, electrons and ions through the corona into space. The clouds they create often reach Earth a day or two after each event.

Solar maxima – This is the period of greatest solar activity in the solar cycle of the Sun.

SSITA - Safe Schools Information Technology Alliance. A UK alliance of partner organisations, parents, teachers, scientists, lawyers and other experts working to identify issues and concerns regarding wireless technologies in schools, nurseries, day care environments and colleges.

UL – Underwriters Laboratories Inc. (UL) is a global independent safety science company. It develops standards and test procedures for assemblies, components, equipment, materials, products and tools, predominantly dealing with product safety.

UN – United Nations. This is an international organisation whose stated aims are facilitating cooperation in economic development, Human Rights, international law, international security, social progress and achievement of World peace.

US NRC – The US National Research Council. Its mission is to improve government decision making and public policy, increase public understanding, and promote the acquisition and dissemination of knowledge in matters involving science, engineering, technology, and health.

VaasaETT Global Energy Think Tank – This provides global reach for best practice and knowledge in the energy industry. Its own expertise is combined with a network of thousands of specialists and partners in five continents to provide high quality independent work.

Verband Baubiologie – An international professional association for building biologists and adjacent vocational fields.

WAN - Wide Area Network – Smart Metering WAN can be used for two-way communication between Smart Meters and DCC (via the WAN module in the customer's premises).

Which? – This is an independent UK based campaigning and product-testing charity that undertakes advocacy campaigns on consumer protection issues,

Dr Isaac Jamieson Email: isaac.jamieson AT live.co.uk

Author biography:

Dr Isaac Jamieson is a scientist, architect and built environment consultant specialising in the design and enhancement of bio-sustainable environments and technologies. He was Honorary Secretary and Treasurer of the Electrostatics Group of the Institute of Physics from 2008 to 2011, and is presently a scientific advisor on stakeholder groups in the EU and UK involved in policy decisions for the creation of healthy environments at national and international level. In addition to this he has in the past undertaken work for the Lifelong Health Project at Imperial College London, related to the development of environmental design factors and preventive interventions aimed to encourage healthy ageing and enhance wellbeing. He undertakes freelance consultancy work, private commissions and international research collaborations.

He organised the International one-day conference 'Electromagnetic Phenomena and Health – a Continuing Controversy?' at the Institute of Physics in London in 2008.

His recent research papers and reviews include:

Jamieson (2011), Underground Living and Health. Presentation given at 'Designing for Intelligent Underground Buildings' seminar held by the CIBSE Intelligent Buildings Group, CIBSE HQ, London on 6 July 2011.

Jamieson (2010) Visible Light Communication (VLC) Systems, bemri.org/visible-light-communication.html

Jamieson, Holdstock, ApSimon & Bell (2010), Building Health: The Need for Electromagnetic Hygiene?, IOP Conference Series: Earth and Environmental Sciences – http://iopscience.iop.org/1755-1315/10/1/012007

Jamieson (2010), Intelligent Communication: The Future of EMF Discourse and Risk Governance?, IOP Conference Series: Earth and Environmental Sciences – http://iopscience.iop.org/1755-1315/10/1/012009

Jamieson & Briggs (2009), Towards Effective Risk Discourse: the Role of Stakeholder Partnerships. International Journal of Risk Assessment and Management, 13, (3-4), pp. 276-293.

Disclaimer

EM Radiation Research Trust – UK registered charity No. 1106304. It is involved in raising public awareness of the health effects of electromagnetic radiation worldwide. It also works with cross party members of the UK and European parliaments to help provide advice and information for parliamentary questions and reports, and is supported by Independent Scientific, Public Health and Technical advisors. **It relies entirely on donations from the general public for the work that it does. http://www.radiationresearch.org/**

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Revision 1: January 2012

Vulnerability to Space Weather, Manmade EMP & Cyber Attack

Summary

Solar super storms

It is predicted by NASA and by the NOAA that the Sun may be entering a particularly energetic period (*similar to that in which the most powerful solar storm ever recorded occurred*), with very energetic solar storms happening every couple of months instead of years, with activity peeking around 2013-2014. Scientists are already talking about the likelihood of solar "black swan event" in 2012. The risks posed by space weather are known and significant, a severe event could potentially have serious impacts upon infrastructure and society. The UK National Security Strategy identifies space weather as a Tier 1 risk, the highest of identified "priority risks." Under the worse case scenario, large areas of the Earth could be without electricity for long periods, possibly several months, with high loss of life. Countries, and areas, with "fragile" grid infrastructures are likely to be affected most - smart grid electronics may introduce additional vulnerabilities to exposed grids. The use of Smart Meters instead of analogue meters may also increase risk, as they are more likely to be damaged by solar events.

Practicality, Security, War, Terrorist or Cyber-Attack

It is recognised that if countries fail to implement suitable measures to protect themselves against electronic attack they leave themselves open to extreme danger.

Manmade EMP Events

High-Altitude Electromagnetic Pulse (HEMP)

The term HEMP is often used for EM signals created from a nuclear detonation interacting with the Earth's upper atmosphere. There are already nations possessing the capability to use HEMP devices to cause catastrophic results to critical infrastructures over wide geographical areas. Smart grid components are more prone to damage from HEMP than the parts of the system they replace. HEMP may seriously damage solid-state Smart Meters. The US National Security Working Group 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 … will be replaced with modern versions that are inherently more vulnerable to EMP."*

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

Extremely powerful portable radio transmitters (which may be mobile and coordinated) can be built to create NNEMP. Its effects are similar to solar threats and HEMP but are usually more localised. As noted by Radasky, "*… 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 … HEMP.*" This vulnerability needs to be urgently addressed. There is presently no protection for Smart Meters against EMP. Even simple EMP devices such as a coil of wire and a battery at close range can disable them.

Preventing Natural and Manmade EMP Catastrophes

Smart grids create more potential points of failure from EMP than traditional grids. Ideally, protective no cost / low cost measures should be considered early in the brief and applied before rollout. Action is required sooner rather than later and could create numerous beneficial opportunities. As noted by Arbuthnot et al., "*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."*

Cyber Security

The UK National Security Council recognises cyber-attacks as a Tier One threat. It has already been claimed that hackers from foreign countries have reconnoitered the US electricity grid possibly seeking to discover exploitable systemic vulnerabilities such as those found in present Smart Meter systems. Smart Meters can create substantial new cyber-vulnerabilities. As noted by Anderson & Fuloria, one of the gravest of these 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 author's comment]*."* This risk does not exist with analogue meters.

Conclusion – the design of power grids, meter systems and electrical appliances needs to be rapidly rethought to deal with the real life issues that have been raised.

Vulnerability to Space Weather, Manmade EMP & Cyber Attack

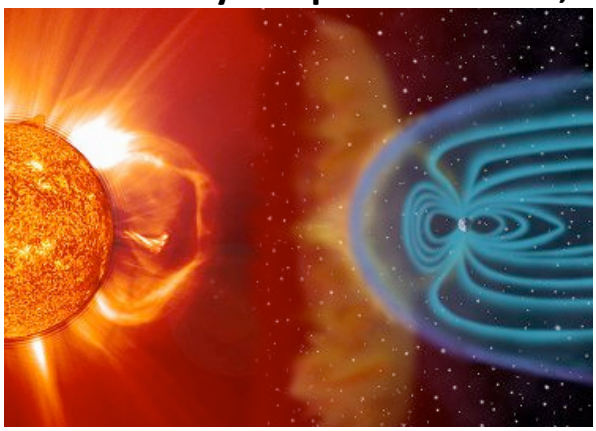


Image source: Courtesy US National Oceanic and Atmospheric Administration (NOAA).

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 U.S. 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, Europe, or other areas of the planet.

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 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 author's 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 (Birnbach 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 countries protect their 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 of the Earth 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 author contends 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, including Smart Meters, 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 Provence 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*].

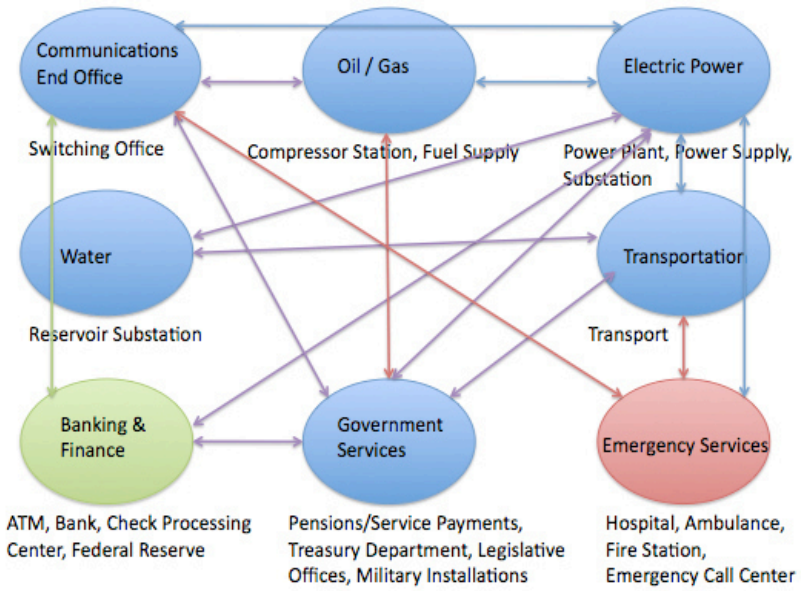
Fortuitously, that solar storm hit in the middle of the night: if it had hit during peak load conditions, grid closure may have cascaded into the USA (Riswadkar & Dobbins 2010). It caused over 200 power anomalies in North America. These included (as previously mentioned) the blackout of the province 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 author*]. 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 economy is sensitive to geomagnetic storms due to a network of interdependencies. [Adapted from original graphic by US Department of Homeland Security].

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 author*.

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 smart grid systems worldwide – 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 author of this present document suggests 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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Practicality, Security, War, Terrorist or Cyber-Attack

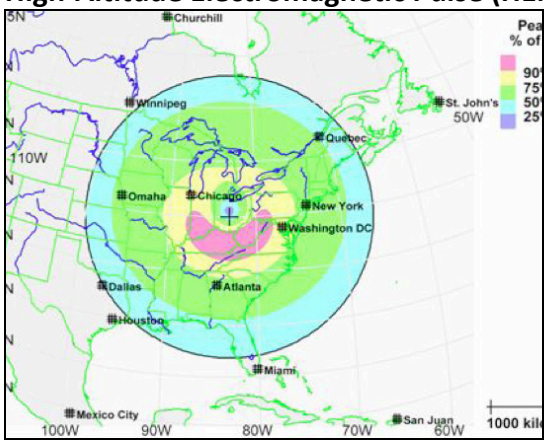
"*If the world's industrial countries fail to devise effective ways to defend themselves against dangerous electronic assaults then they will disintegrate within a few years*" UK House of Commons Defence Committee (2012).

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 US 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 author).

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 author's 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 Paolo 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 is 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 author's comment*.

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Preventing Natural and Manmade EMP Catastrophes

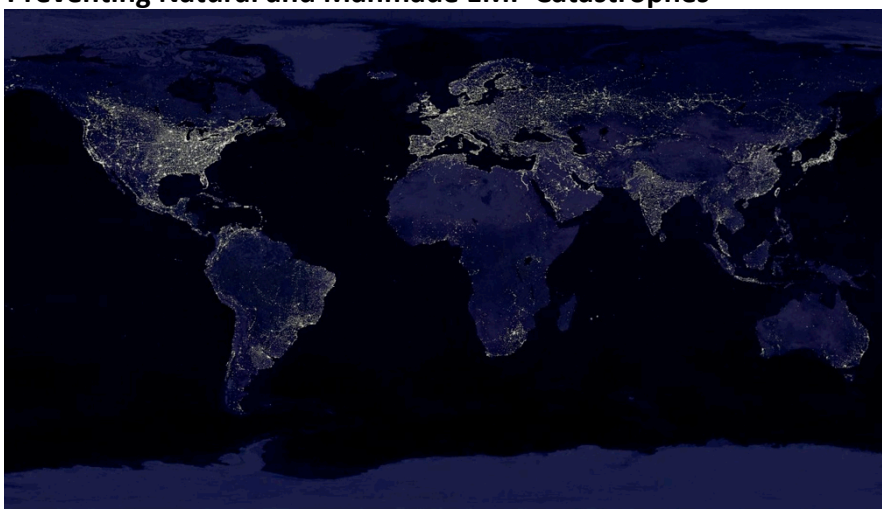

Image source: NASA

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.*
• 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.
• Develop regional and national smart grid restoration plans and survival plans for populations.
• Provide Government endorsement & tax incentives for required work.
• Undertake "controlled" power cuts when necessary to protect grid.
• Identify & address regulatory gaps that preclude effective mitigation.
• Manufacture robust essential components for infrastructure, such as large transformers, within own country – this may greatly help shorten recovery periods and create extra jobs.

*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. The corresponding estimate for the U.S. would be approximately $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.

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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).

Built In Security

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). 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).

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).

Smart Meter Data

Every electrical appliance has its own energy fingerprint readable by Smart Meters. Those accessing such information have indications of the appliances individuals have and how often they use them.

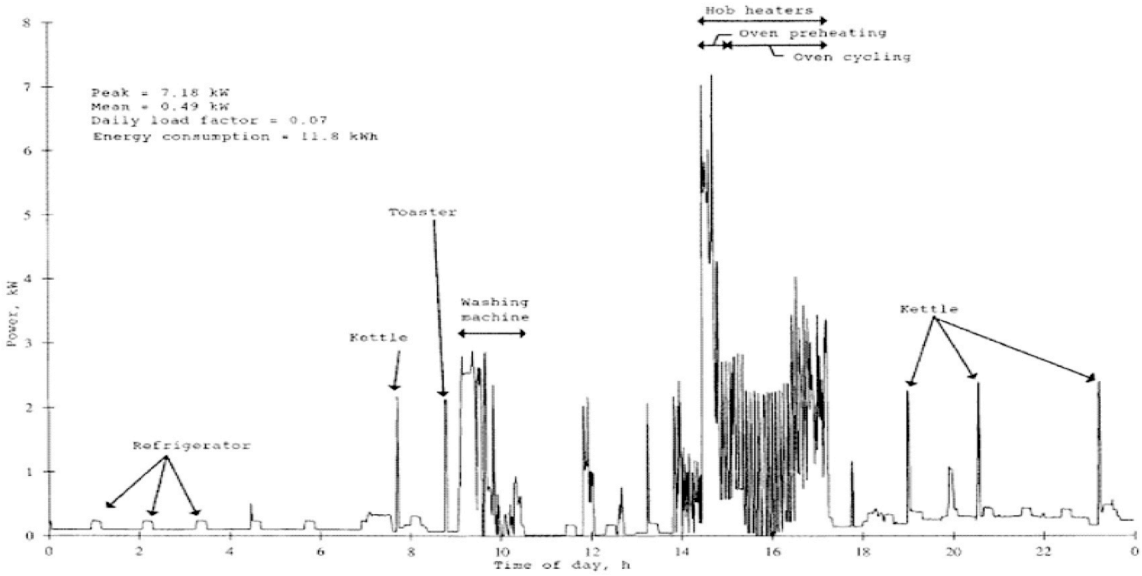

Image source: Newborough & Augood (1999).

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 (such as sleep problems*), 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)
*Emissions from some wireless Smart Meters have been reported to be linked to health and sleep problems (EMF SN 2011) – *present author's comment*.

Data Provision & Privacy/Security Issues

"*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).*
**Refer also to Appendix 7 of main document*.

"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).

Unlike conventional meters that measure total energy use through day and night tariffs (and are normally read four times every year), Smart Meters allow energy use to be read with far finer granularity (typically every half-hour). There is much debate as to what level of information should be provided by Smart Meters and to whom it should be provided. "… *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*." Quinn (2009).

As an example of the level of privacy invasion that is possible, it was recently shown by Dario Carluccio and Stephan Brinkhaus (at the 28th Chaos Computing Congress (28c3) hacker conference in Germany) 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. Prior to concluding that the security encountered was poor and the data resolution the meters provided was too high, they were also able to demonstrate how easy it was to alter apparent energy usage (Wisniewski 2012).

A court in the Netherlands (Cuipers & Koops 2008) has already determined that the mandatory collection of non-essential fine-grained Smart Meter data is against Article 8(1) of the European Convention of Human Rights (which the UK is signed up to). That ruling has led to mandatory Smart Meter installation being halted in the Netherlands (metering.com 2009). It is important to address such potential legal issues as early as possible and ensure that necessary safeguards are put in place.

"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*", as it is their degree of positive acceptance, support and involvement with Smart Meters and related technology that will determine the level of success smart metering achieves.

"*Data protection issues play a very important and even decisive role in the successful implementation of smart metering*," Knyrim & Trieb (2011).

As noted by Berliri & Maxwell (2010):
- 'Privacy by Design' creates opportunities rather than threats for smart grids – *it instills consumer confidence.*
- Consumers concepts of privacy are altering; soon statutory provisions may be inadequate. Privacy should be embedded into the technology.
- There may be competitive advantages for those able to offer the highest levels of privacy protection.

Robust privacy measures and policies are required to cover data usage and distribution if consumers are to be brought onboard and potential security shortfalls addressed.

Smart grid privacy measures			
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	

Source: Sooriyabandara & Kalogridis (2011).

Undertaking robust measures to anonymise Smart Metering data and remove recognisable appliance load signatures can help to address privacy concerns (Efthymiou & Kalogridis 2010, Kalogridis et al. 2010). Such measures may include: Privacy Enhanced Home Energy Management using Elec Privacy algorithms (*to disguise the signatures of electronic equipment*) and Escrow: Data Anonymisation.

Privacy Initiatives

Ontario, Canada

The province of Ontario in Canada is a world leader in embedded privacy protections for smart grids (PBD 2010). Adopting its guidelines may help prevent many claims on Human Rights privacy issues that might otherwise stall or halt rollouts.

1. Proactive not Reactive; Preventative not Remedial "*Smart Grid systems should feature privacy principles in their overall project governance framework and proactively embed privacy requirements into their designs …*"
2. Privacy as the Default "*Smart Grid systems must ensure that privacy is the default — the "no action required" mode of protecting one's privacy — its presence is ensured*."
3. Privacy Embedded into Design "*Smart Grid systems must make privacy a core functionality in the design and architecture of Smart Grid systems and practices — an essential design feature*."
4. Full Functionality — Positive-Sum, not Zero-Sum "*Smart Grid systems must avoid any unnecessary trade-offs between privacy and legitimate objectives of Smart Grid projects*."
5. End-to-End Lifecycle Protection "*Smart Grid systems must build in privacy end-to-end, throughout the entire life cycle of any personal information collected*."
6. Visibility and Transparency *"Smart Grid systems must be visible and transparent to consumers - engaging in accountable business practices - to ensure that new Smart Grid systems operate according to stated objectives."*
7. Respect for User Privacy *"Smart Grid systems must be designed with respect for consumer privacy, as a core foundational requirement*."

That document states that the above principles should be applied to: accountable business practices; Information Technology (IT) systems; and physical design and networked infrastructure for smart grids (PBD 2010).

"… 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).

Another concern related to 'Privacy by Design' is that present smart grid systems have a life expectancy of 10-20 years, during which time any in-built security they may have risks becoming compromised or outdated.

United Kingdom

The UK is adopting an approach to privacy drawn on international best practice measures and the advice of privacy experts (DECC 2011). In September 2011, it was announced that the UK Government has established a central data and communications company to administer access to smart grid data to help allay consumer privacy concerns over Smart Metering. The UK Government will also oversee its security (smartmeters 2011).

California, USA

In July 2011, California voted to adopt it's own comprehensive set of privacy and security rules for the three utility companies that provide the majority of Californians with electricity (King 2011). If consumers wish, they will be able to allow third parties to receive their backhauled Smart Meter data directly from the utilities, as opposed to directly from the Smart Meters in order to support services

including demand response, energy advice and energy efficiency. It is important to note that the CPUC declared that "*The utilities … will bear no new liability for the actions of third parties which acquire information via this [mechanism]*."

The CPUC also stated that they will not exercise jurisdiction over third parties who directly receive energy usage data from installed devices that receive data via the HAN interface (King 2011). It is likely that the Californian and UK initiatives will be a success if they fully take into account Human Rights' privacy issues and the need to anonymise electrical metering data to gain public trust.

Texas, USA
In Texas all meter data on electricity shall belong to the customer (BSM (2011). Texas Utilities Code 39.107(b) states: "*All meter data, including all data generated, provided, or otherwise made available, by advanced meters and meter information networks, shall belong to a customer, including data used to calculate charges for service, historical load data, and any other proprietary customer information*. …"

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 author's 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).

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Conclusion – the design of power grids, meter systems and electrical appliances needs to be rapidly rethought to deal with the real life issues that have been raised.