

# SMART METERS – SMARTER PRACTICES

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## 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.

## SMART METERS - SMARTER PRACTICES

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.