**Planetary Association for Clean Energy**, Inc.
100 Bronson Avenue, Suite 1001
OTTAWA, Ontario K1R 6G8, Canada
(613) 236-6265 / fax: (613) 235-5876
paceincnet@gmail.com / www.pacenet.homestead.com
*An international collaborative network of advanced scientific thinking*
NGO in Special Consultative status with the Economic and Social Council of the **United Nations** (ECOSOC)

February 7, 2018

**For the attention of**
Esteemed Legislators and Public Servants
**Commonwealth of Massachusetts**
Testimony in support of:
**Bills S.107, S.108, S.1268, S.207, S.2079 S.2080, S.1864** and **H.2030**

As President of the **Planetary Association for Clean Energy** (**PACE**), I wish to bring to the attention of legislators and public servants of the Commonwealth of Massachusetts considerations stemming from several decades of independent scientific research and of multi-disciplinary peer review into electromagnetic and other issues that appertain to the following bills: **S. 107, S. 108, S.1268, S.207, S.2079, S.2080, S.1864** and **H2030**.

Our organization was founded by **Senator Chesley W. Carter**, while Chair of the Canadian **Senate's Standing Committee on Health, Welfare and Science** as well as member of the **Senate Special Committee on Science Policy**. He and his colleagues considered electromagnetic field issues to be among the top 3 scientific and technological priority issues of national concern. They arranged for a comprehensive study by the **National Research Council** and **Queens University** on the biological effects of electromagnetic fields, especially microwaves, which were published in official reports between 1971 and 1972. Like research was done by **Medical Research Council** (MRC) -replaced since 2000 by **Canadian Institutes of Health Research** (**CIHR**), and by other facilities.

Results are confirmed and elaborated by **US National Toxicology Program /NTP** (per 2004 **US FDA** request)
https://ntp.niehs.nih.gov/ntp/about_ntp/trpanel/2018/march/tr595peerdraft.pdf

From the mid-1980s, due to high level of policy concerns, PACE organized specialists' conclaves, at pioneer international conferences, on electromagnetic issues involving scientists, engineers, MDs and agencies. It was the first to facilitate the in-depth examination of medical issues associated with environmental hypersensitivity (EHS) and to help develop realistic exposure guidelines and standards, accepted since in many circles, including the **European Union.** These initiatives also led to now-mainstream electromagnetic measuring instruments, protocols, procedures for monitoring & tracing errors. PACE worked with **Canada Mortgage and Housing Corporation** (CMHC) to examine electromagnetic fields in Canadian housing, including those with advanced SMART systems. PACE conducts surveys premises with advanced metering infrastructure since **Hydro Québec's** experimental run years before their authorization in 2011.

**This omnibus testimony is submitted, jointly, to the following joint committees and specified bills:**

***Joint Committee on Public Health*** / Joint Committee on Public Health with regards to the following 3 bills: **S.1268** (Resolve creating a special commission to examine the health impacts of electromagnetic fields will look at non-industry-funded science and recommend public protections); **H.2030** (An Act relative to best management practices for wireless in schools and public institutions of higher education requires the Massachusetts Department of Elementary and Secondary Education to establish wireless technology standards to protect the health and safety of public school students and staff); and, **S.2079** (An Act reducing non-ionizing radiation exposure in schools).

***Joint Committee on Consumer Protection and Professional Licensure*** / Joint Committee on Consumer Protection and Professional Licensure with regards to the following 2 bills: **S.107** (An Act relative to disclosure of radiofrequency notifications requires manufacturer warnings be prominently displayed on product packaging of wireless radiation-emitting devices); **S.108** (An Act relative to the safe use of handheld devices by children requires specific language be included on product packaging, as modeled by an ordinance unanimously passed in Berkeley, California).

***Joint Committee on Telecommunications, Utilities and Energy*** / Joint Committee on Telecommunications, Utilities and Energy with regards to the following bill: **S.1864** (An Act relative to utilities, smart meters, and ratepayers' rights gives utility customers the no-fee choice of retaining non-wireless radiation-emitting water, gas and electrical meters and refusing installation of "smart" utility meters).

***Joint Committee on Financial Services*** / Joint Committee on Financial Services with regards to the following bill: S.2080 (An Act increasing medical awareness and insurance coverage of non-ionizing radiation injury and reliance upon credible independent medical research).

**PRINCIPAL FACTORS WARRANTING ATTENTION**

Our independent collaborative network submits that there are 3 principal factors that warrant the attention of the legislators and public servants of the Commonwealth of Massachusetts:

**HEALTH CONCERNS** with widespread power-frequency & wireless technology: 'There is extensive scientific evidence of adverse health effects associated with cumulative effects

**SAFETY & ACCELERATED CORROSION CONCERNS** with wireless technology, including smart meters: Significant problems have been attributed to smart meters, including explosions and fire

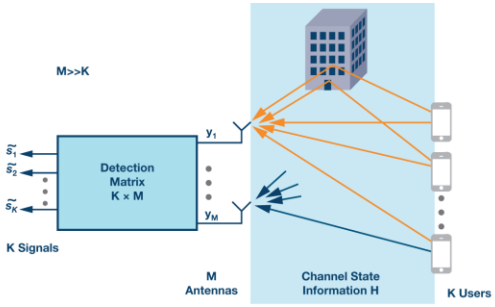
**ECONOMIC/INSURANCE COVERAGE CONCERNS**
Utilities in Canada and the US are facing class action suits based on health claims, and standard exclusion from any liability coverage for claims (Exclusion 32, **Lloyd's of London**/CFC Underwriting Limited)

**THE CUMULATIVE SPREAD OF ELECTROMAGNETIC FIELDS – ELECTROMAGNETIC HASH**

*These two images compare visible light night-time emissions associated with power-frequency electrical energy supply with those cumulative (in spatial terms) microwave technology band emissions for a similar portion of Eastern United States and Canada.* [1]

*Note the pervasiveness of current **electromagnetic hash**. This hash is projected to accrue by quantum leaps, with **4G** & **5G** wireless technology use.*

**Massachusetts** *exhibits marked contrast between power-frequency emissions density levels along the coast & parts of Cape Cod and those of the blanket coverage of other, microwave technology: Wi-Fi, meters, radar and other infrastructure electromagnetic field power density.*




| Detection Type | |
|---|---|
| Maximum Ratio (MR) | $\tilde{s} = H^H \mathbf{y}$ |
| Zero Forcing (ZF) | $\tilde{s} = (H^H H)^{-1} H^H \mathbf{y}$ |
| NMSE or RZF | $\tilde{s} = (H^H H + \beta I)^{-1} H^H \mathbf{y}$ |

This hash is so prevalent and uniform that microelectronics scientists are training how to exploit concentrations associated with "massive MIMO" (multiple-input, multiple-output) beam-forming and ricocheting due to multiple reflections in indoor and urban environments can be effectively used to create additional independent channels "that can serve the purposes of diversity and/or spatial multiplexing". In a figurative way, it is like piggy-back cell phones to use them as intermittent transmitting antennas?

The side graph indicates how a group of cell phones, bouncing their beaming both inside and outside a building, build up enough energy that can re-cycled for a matrix-like beam channel for other applications by infrastructure operators.

Is this ever-more intense electromagnetic field power density and more un-regulated beam-forming indoors and outdoors what Massachusetts Legislators and Public Servants want to see applied for unknown and uncertain effects on the life of the general population, on fauna and on flora throughout the Commonwealth?

What happens if such electromagnetic haze and the engineering of augmenting its potency damage bridges, pipelines, and other critical infrastructure facilities? Who pays? Is it the perpetuator (alone or in concert with others) or the public domain? Can the jurisprudence carry out its right and liberty to impose safety levels higher than those envisaged in guidelines, standards, or even in situations where nonesuch has yet been applied, so that legislators and courts can establish norms that are acceptable to the society-as-a-whole, retrogressively to the time of initiation of the harm's way? There is also the application of the Precautionary Principle, whose European experience is described in Appendix

[1] *Had Neil Armstrong used a cell phone on the moon in 1969, it would be monitored from Earth as **the brightest object in the universe** in the microwave spectrum! Daytime, the sun would have been brighter, but at night, the **cell phone would have outshone every star.** There is a reason why cell phones are outlawed in Green Bank, WV: even a single cell phone, from miles away, would blind the radio astronomers there and make it impossible for them to see the stars. Astronomers measure radio waves in janskys units. A typical star shines at 10 to 100 janskys. The Sun shines at about 500,000 janskys. A cell phone held against the head, emits into the brain about 100,000,000,000,000,000 janskys.*

**OUR ON-THE-GROUND EXPERIENCE WITH ELECTROMAGNETIC HASH AND WIRELESS INSTALLATIONS**

These surveys of meters (and their associated infrastructure) also include those conducted by experts across North America, have led to a number of real-life observations. At any given instance, the power density from often hundreds of emitters varies, usually at very fast rates, from many directions, including from above and below ground levels. Sources include portable units, radars, vehicles, towers, lighting fixtures, transmission lines, wiring, pipes, etc. In the case of smart meters, some meters transmit much more frequently, at higher intensity (often at levels higher than those indicated by federal guidelines), across more electromagnetic spectrum bands (including an irritating & troublesome audio range of clicks, rushes, hums and saw-tooth pulsing), introduce access to indoor environments of signals in the microwave band through wires and other conductors – even when no/low power is being consumed.

These circumstances can create combinatory and cumulative electromagnetic field effects with other emissions associated with wireless technology infrastructure, including electrostatics, clusters of charges which can cause interference and (sometimes even explosive) failure of devices such TV, AV and DVD players, battery chargers. We have monitored phenomena of greater microwave power density and electric fields that accrue to the height of AMI (smart meter) infrastructure antenna "collectors" – towards 15 – 20 feet elevation, thus affecting upper floor levels in some communities for entire groups of structures, and potentially even interfering with automobile performance, such as braking and acceleration.

When examining certain cases in detail, we observed that the advanced metering infrastructure can generate deleterious aggravation to fauna (notably pets (dogs and cats), horses, livestock, etc.) – sometimes to the point of ruin of keepers - and to flora, including crops. Such contra-indications are not indicated in formal submissions to review institutions, but can impact on regional welfare as well as ecology.

Their existence also raises the question of the applicability of the ***Precautionary Principle***, as indicated for such decisions as that of the Board, by the **United Nations Environmental Programme** (**UNEP**) and the recent guidelines from the **European Commission**.

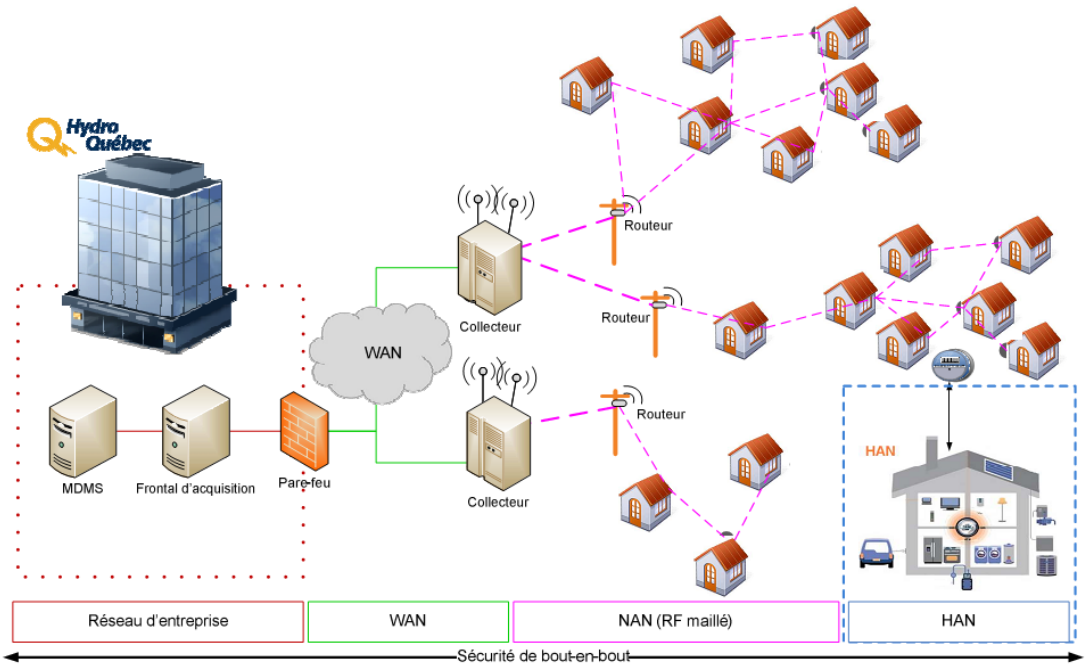
We suggest ***Hazard and Operability Study*** (***HAZOP***) methodology of considering everything that could possibly go wrong (used in software research). It applies to complex 'processes' such as wireless technologies whereby sufficient predictable and explicitly-identified information is available. This range of data is contrasted with pre-defined objectives and mandate. Prudent decision-making adjusts for foreseeable variations in time and requirements and harmlessness.

No attention is given to the generally involuntary introduction of 24-hour microwave transmitters indoors or in premises whether they are adjacent to zones of long-term occupation, such as bed-sites, working posts, and other places such a play areas for children. Furthermore, no assessment is currently factored by utilities as to actual installation locations of emitters and their **LAN** / **NAN** (**Local Area Network, Neighbourhood Area Network**) collectors/transmitters to avoid beaming through living areas. This is an especially significant issue for the linear community layouts, stringed along highways, so common in Massachusetts. Only the basic engineering efficacy and minimal costing is consider in installations of wireless facilities.

Ignored are the combinatory and signal amplificatory effects associated with soil moisture, wetlands, ricocheting, focusing (by way of conductive material frames such as doors, windows, stud walls, and other structures). Ultimately, beaming effects can occur in valleys, dependent on geologic surfaces, for example. Lower frequency facilities radio-frequency – Radio and TV transmitters / microwave / military and commercial radar donates energy to the other faster / higher frequency emitting sources' power density, from 4 to 10-fold, depending of a variety of factors, both of short-term (about a week-at-a-time and long-term duration.

Few smart meters are properly installed in due process – leading to injury of installers (it is one of the most dangerous professions) as well as serious fire & safety issues. Errors can include harmful, invisible ultraviolet radiation. Yet the meters can be wired – as in some countries. Wired smart meters send the usage data via electrical lines or telephone lines. However, most wireless devices use a mesh network system in which the meters relay the energy information

from meter to meter until it arrives at a collector meter, which then sends the information on to an antenna, usually mounted on a utility pole. From there, it is transmitted to the utility company. (See graph below, from Hydro Québec.)



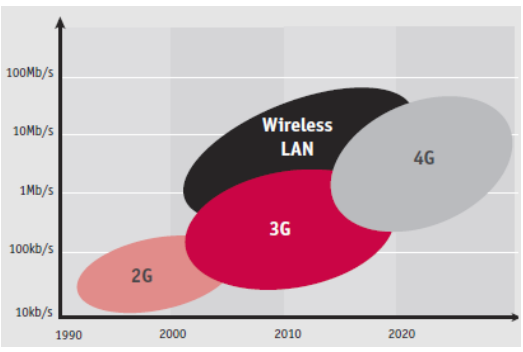

Electric smart meters have a 2nd antenna to "talk" to indoor new smart appliances and devices. This is called the **Home Area Network** (**HAN**). These appliances and devices, such as thermostats, air conditioning units, refrigerators, washing machines, dishwashers, and various sensing units are outfitted with 2-way transmitter/receivers which send to and receive information and to potentially control indoor devices and apps from the smart meter throughout the day. The graph below, prepared by Hydro Québec shows the ensemble of the microwave-based wireless version.

Massachusetts Legislators and Public Servants may note that collector antennas can receive up to about 5,000 meters so that lived-in premises process fulltime, non-stop, data relays. If collection antenna is out-lying, it powers up to connect – even exceeding federal guidelines. Geology, foliage, other obstacles, reflectivity, etc. leverage more power to critical heating (thermal effect) power density of injurious potential. Without appropriate evaluation and subsequent guidelines, such situations could occur frequently in the Commonwealth of Massachusetts, due to geography and coastline of the AMI's territory and the commonality of linear distribution of users not only in most urban areas.

Non-smart digital meters can have the capacity to be upgraded to smart meters merely by installation of a module which enables the wireless function. The switching mode power supply of digital meters is a major problem, as it is with AMI smart meters.

These dynamics are part of unintended mixing of signals & of their harmonics that were not originally planned to happen. They constitute a new ***electromagnetic hash*** extending over vast territories, onto the hinterland.

Increase in wireless "machine to machine" data demands more and more traffic, and more electric power (consuming, in some cases as much as all of power savings schemes). During a 2010 **Verizon *LTE*** Boston trial) **Research in Motion** (RIM) made it clear that increased bandwidth usage, including from smart meters, strain networks and interrupt calls.



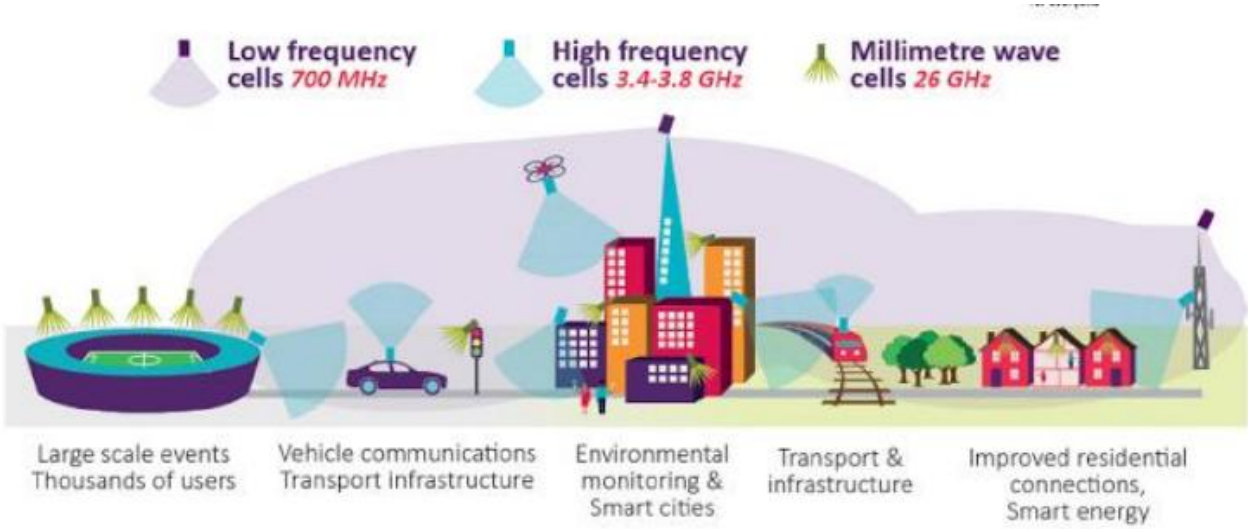

The illustration describes a Canadian analysis of the data usage by the incorporation of several wireless systems into LAN that smart meters also use. Massachusetts Legislators and Public Servants may want to consider how much of the question at hand doesn't become a transformational work order for <u>extensions into something that may outreach the public's ability to regulate as technology for the best interests of Massachusetts, beyond the Precautionary Principle</u>. Do Legislators want to allow

something that once initiated or maintained cannot stop or be modified to impede injurious affectation in the public sphere and territory?

More and more user & stakeholder requirements are being staged. Such upsurges and still emerging trends are combined with such uncertainties as: information insecurity, software development in expertises and attempts at forcing aging population to adapt to the technology.

Ancillary data may be collected from a HAN transceiver, destined, with continuous & significant spending (6.3% - $ 63 million – of Hydro Québec's AMI work estimates presented to its provincial review board) in updating software and informatics applications. Gathering information household by household, with algorithms, consumer preferences and movements can be packaged. Such info may be use even for determining voting profiles through chips located indoors in smart appliances, products, and circuits use & timing. [In 2012 Florida, a recent diaper purchase registered from a smart apps in a home by a meter, would profile for pollsters a confirmed pro-Democrat and thereby unworthy for robotic calls aimed at steering votes election-time. Such info is extra income for the data collector, and a disincentive for a utility in energy-efficiency initiatives and in advanced clean energy generation and transmission systems.]

In the near future this scenario expands into the ***5G*** – ***Internet of Things (IoT)***, which is well described by the 2 images below, from the **European Commission**. We see how the smart meter "domotics", in ***5G,*** are linked with LAN to electric grids, directly into hospitals, commerce, Graphene clothing, traffic monitoring, etc. Is this the decision of the Board?

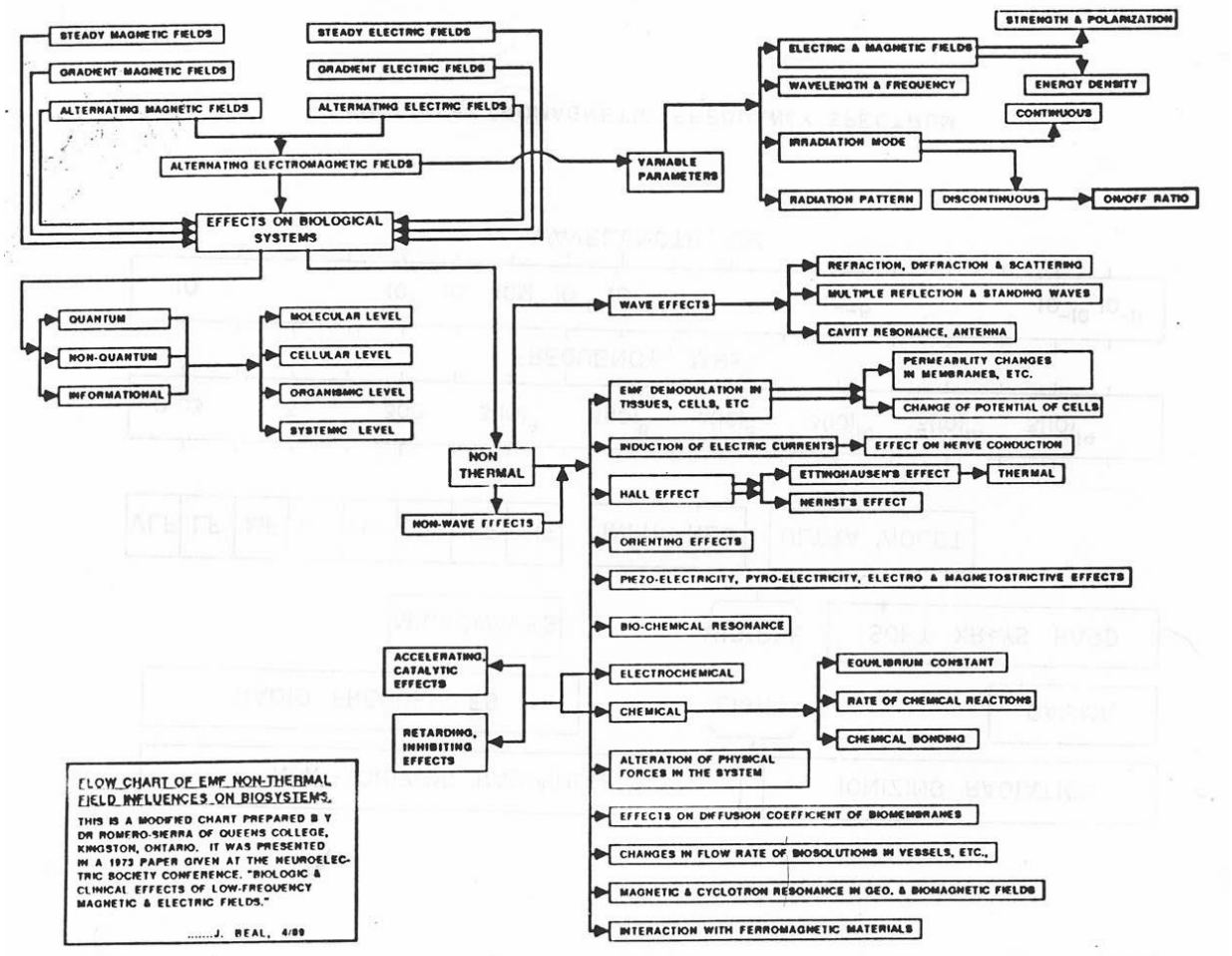



**HEALTH CONCERNS**

Many microwave technology emissions are not a matter of choice for those subjected to them, unlike when one decides or not to use a cellphone, or to purchase cigarettes. They are an imposition that Legislators and Public Servants are to determine for the public consumption of electric power. Most microwave technologies are ultimately telecommunication transceivers operating within premises at the ultrasound / radiofrequency band (80, 130 and 340 kHz – from their switching circuits inside the meters) and at the 2 microwave bands serving the HAN and LAN networks. Also, they may generate annoying audio clicks and noises, and microwave hearing issues.

The biological effects of these electromagnetic bands differ according to their frequency bands, their combinatory and non-linear (randomness) and their intensity/durations. Overall the electromagnetic haze is complex. A study that was performed by the **National Research Council,** before the commercialization of microwave technology outlines the numerous biological effects that can be caused by very low intensity emissions, at levels hundreds of times below the current federal guidelines**,** termed as "non-thermal", as not heating the body in less than 6 minutes.

A significant proportion of society is consciously sensitive to electromagnetic field emissions, another is not consciously so, but suffers malaise such as memory and attention, impaired motor function, cardiac arrhythmias and arrest, dizziness, irritability, insomnia, fatigue, difficulty in breathing, chest pain, and indigestion, among others. Such groups can consist of up to 30% of the population, according to studies. The **European Council *Resolution 1815 [2011***] arrived at a 0.1 microWatt/cm2 limit for general population, with an objective of lowering to 0.03 microWatt/$cm^2$, in contrast with the current federal guideline of the 600.0 -1,000.0 microWatt/$cm^2$. This ruling is uniquely based on raising body temperature by $1^o$ Celsius within a determined for a healthy young adult male, such as a soldier or fireman.



Biological effects on humans such as infants, pregnant women, the sick and the elderly are not implicitly considered by the federal guidelines. Consider the proportion of older persons (65+) alone in Massachusetts is growing to over 16%.

To understand the significance of the intensity-by-intensity impact of the power density of microwave exposure, the **Canadian Human Rights Commission** developed the listing below:

## Biological effects of wireless technologies below regulatory limit

| **Power density** ($\mu W/cm^2$) | **Reported Biological Effects** | **References** |
|---|---|---|
| 0.0000000000001 | Altered genetic structure in E. Coli | Belyaev 1996 |
| 0.0000000001 | Threshold of human sensitivity | Kositsky 2001 |
| 0.000000001 | Altered EEG in human subjects | Bise 1978 |
| 0.0000000027 | Growth stimulation in *Vicius fabus* | Brauer 1950 |
| 0.00000001 | Effects on immune system in mice | Bundyuk 1994 |
| 0.00000002 | Stimulation of ovulation in chickens | Kondra 1970 |
| 0.000005 | Effect on cell growth in yeast | Grundler 1992 |
| 0.00001 | Conditioned "avoidance" reflex in rats | Kositsky 2001 |
| 0.000027 | Premature aging of pine needles | Selga 1996 |
| **0.001** | **100 Yards / metres from a Cell Phone** | |
| 0.0027 | Growth inhibition in *Vicius fabus* | Brauer 1950 |
| 0.0027 to 0.065 | Smaller tree growth rings | Balodis 1996 |
| **0.007** | **50 Feet from a Cordless Phone** | |
| 0.01 | Human sensation | Kolbun 1987 |
| **0.016** | **1 Mile from a Cellular Tower** | |
| 0.06 | Altered EEG, disturbed carbohydrate metabolism, enlarged adrenals, altered adrenal hormone levels,structural changes in liver, spleen, testes, and brain in white rats and rabbits | Dumanskij 1974 |
| 0.06 | Slowing of the heart, change in EEG in rabbits | Serkyuk, reported in McRee 1980 |
| **0.05** | **10 Feet / 3 meters from a Wireless Computer** | |
| 0.1 | Increase in melatonin in cows | Stark 1997 |
| 0.1 to 1.8 | Decreased life span, impaired reproduction, structural and developmental abnormalities in duckweed plants | Magone 1996 |
| 0.13 | Decreased cell growth (human epithelial amnion cells) | Kwee 1997 |
| 0.168 | Irreversible sterility in mice | Magras 1997 |
| 0.2 to 8.0 | Childhood leukemia near transmitters | Hocking 1996 |
| 0.3 | Impaired motor function, reaction time, memory and attention of school children, and altered sex ratio of children (fewer boys) | Kolodynski 1996 |
| 0.6 | Change in calcium ion efflux from brain tissue | Dutta 1986 |
| 0.6 | Cardiac arrhythmias and sometimes cardiac arrest (frogs) | Frey 1968 |
| 0–4 | Altered white blood cell activity in schoolchildren | Chiang 1989 |
| 1.0 | Headache, dizziness, irritability, fatigue, weakness, insomnia, chest pain, difficulty breathing, indigestion (humans—occupational exposure) | Simonenko 1998 |
| 1.0 | Stimulation of white cells in guinea pigs | Shandala 1978 |
| 2.5 | Breakdown of blood-brain barrier (used a digital cell phone to radiate) | Salford 1997 |
| 5.0 | Leukemia, skin melanoma and bladder cancer near TV and FM transmitter | Dolk 1997 |
| 2.0 | (lower "Microwave hearing" - clicking, buzzing, chirping, hissing, or high-pitched threshold not tones known) | Frey 1963, 1969,1971,1973,1988 Justeson1979,Olsen1980,Wieske1963,Lin1978 |
| 5.0 | Biochemical and histological changes in liver, heart, kidney, and brain tissue | Belokrinitskiy l982 |
| 10.0 | Damaged mitochondria, nucleus of cells in hippocampus of brain | Belokrinitskiy 1982a |
| 10.0 | Impaired memory and visual reaction time in people living near transmitters | Chiang 1989 |
| 10.0 | Decreased size of litter, increased number of stillborns in mice | Il'Chevich (reported in McRee 1980) |
| 10.0 | Redistribution of metals in the lungs, brain, heart, liver, kidney, muscles, spleen, bones, skin, blood | Shutenko 1981 |
| **1,000.0** | United States **FCC Exposure Limit, Safety Code 6 Canada limit** | |

In addition, the mechanism which explains the non-thermal effects observed as have injurious affectation on humans, fauna and flora is that of oxidative reactions and their associated calcium flux (influx and efflux) from the full spectrum of electromagnetic fields. These reactions are, in simple terms, associated with the death of cells, whether human or of other biological kingdoms. See also **Appendix E** for detailed biological effects of microwave technology.

In view of these health concerns, it is suggested that the Legislators and Public Servants articulate their bills to:

a) Set up a database of all electromagnetic technology base stations and facilities and their emissions, as essential parts of their authorization;

b) Independent, random, on-going audit of all of these base stations be carried out, with due analysis of cumulative effects associated with electromagnetic hash to ensure that chosen guidelines are not exceeded and that they comply with agreed upon specifications – if they do not comply, they should be decommissioned until compliance is demonstrated;

c) Particular attention be paid initially to the auditing of facilities near to schools and sensitive areas (residences, hospitals, senior facilities and facilities for the environmentally sensitive); AMI units should not fall on any part of school grounds or buildings without the agreement of the school and parents; Planning authorities should have the power to ensure that microwave fields to which the public is / will be exposed be kept at the lowest levels commensurate with the telecommunications system, which is technically able to function at levels of less than 0.00001 microWatt/$cm^2$.

**SAFETY AND ACCELERATED CORROSION CONCERNS**

The complexity of safety concerns is described in excerpts from a report of the **Fire Marshall of Ontario**. (Appendix B)

Some safety concerns are described in our earlier statements, such as the manner of installation.

The illustrations below speak for themselves. Why should such haphazard attitude in installation be condoned, considering how these devices beam-form environmentally indoors and outdoors into massive matrices of electromagnetic hash that is constantly dynamic, often very intense and totally un-regulated?



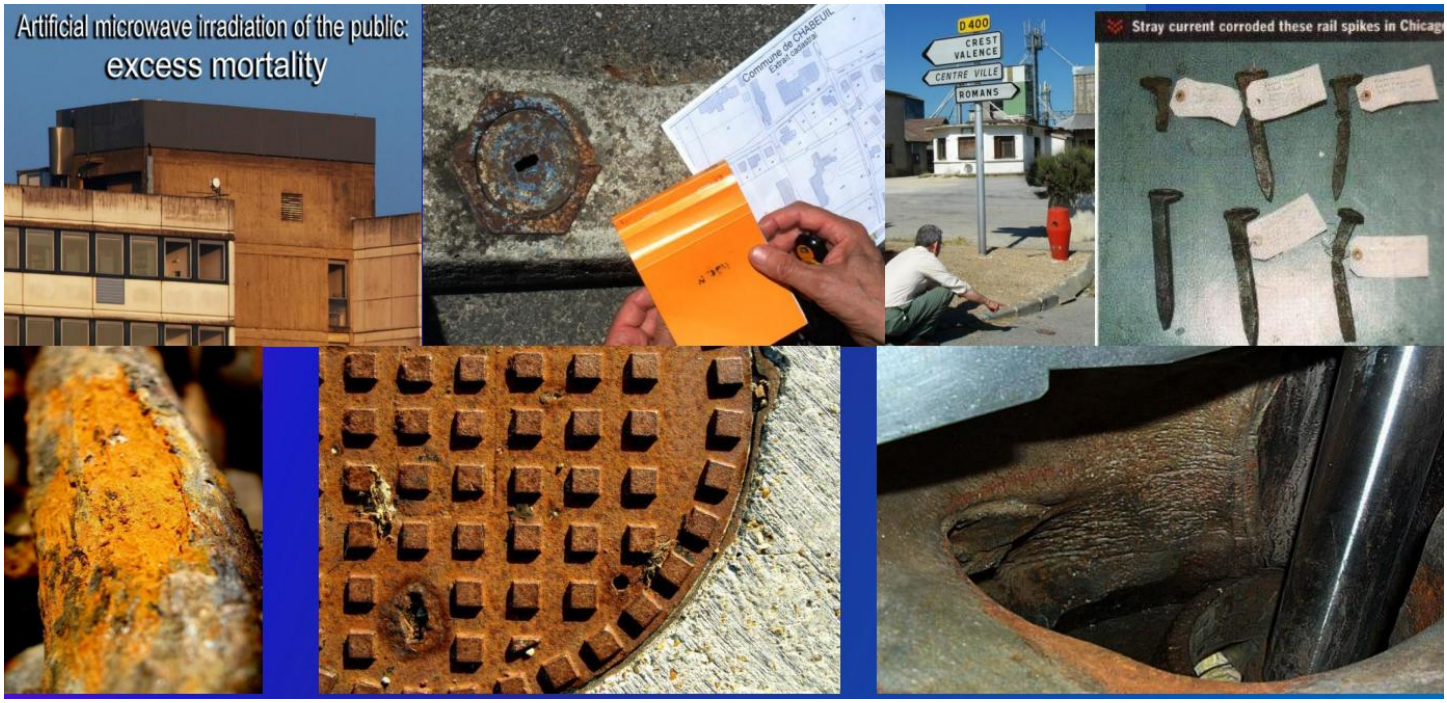



The public is generally in the dark about this electromagnetic hash and its problems. The public needs safe and reliable energy and communications service.

Accelerated corrosion has been mostly reported in the public domain in France. The image below to the right shows how a 3G tower induces voltage in nearby concrete rebar, which accelerates their corrosion (as well as disintegrating some concrete materials into powder). Such electromagnetic hash, with its ricocheting and near-field emission characteristics has probably affected also the collapse of balconies and even facings of buildings and of several water tours, and a massive downtown Calgary fire which closed down the city's financial district for several days.

Other images show effects on rooftop from tower arrays (**Cégep Laurendeau** collegiate in Montreal, Quebec which suffered mortality of teaching staff below the transmitters, sometimes several deaths in same beam-forming on workstations); typical corrosion of infrastructure fittings; corrosion of **Chicago** train fittings due to electromagnetic emissions; and also corrosion of nuclear rods in **Ohio** (and reported elsewhere) most likely associated with the advent of wireless communication systems.





**ECONOMIC / INSURANCE COVERAGE CONCERNS**

There is debate in financial circles whether the wireless infrastructure is economically self-sustaining. The slightest questioning evokes a major concern of what happens if availability of electric power and of communications is so closely subject to markets?

Regarding the insurance, the actual Lloyd's analysis is attached separately as a document. The rating is basically an ultra-high liability risk. This also includes, implicitly, the wireless frequencies induced problems, as we have surveyed through indoor wiring and such conductors as those associated with water and gas supply.

It is likely that even with UL certification, insurance is not a *fait accompli* – as after all, the entire AMI system, meter and the connectors – is composed of wireless transceivers.

Also, de facto acceptance of UL certification may incorporate the impossibility for the public domain to revert decisions at a later date, as well as for the users to disconnect or modify metering modalities. It does not make common sense to "throw away" existing or prior art quality devices for potentially lower quality, short-span duration ones.

Other problems include: Overcharging, accuracy, Reliability questions, Privacy invasion, Switching mode power supply (SMPS), Interference with electronics,Interference with medical devices, Hacking/cyber-security, Remote disconnection of power, Vulnerability to electromagnetic pulses (EMPs), No utility liability for hacked data, Increased burglary risk, Increased metal and infrastructure corrosion, impacts to building integrity, Job loss, Environmental costs, Control of household electrical use, Safety violations, Burdensome and excessive costs, Costs exceed benefits, Fraudulent claims and unavailable information, Strong-arm tactics by utilities, Potential violation of jurisdiction and mandate by utilities, No environmental assessment, Potential violation of Commonwealth and federal laws, Overburdening utility easements, Criminal negligence, Ignoring realities and open process.

The public is generally in the dark about this program and its problems, including economics and insurance concerns. Yet the public needs safe, affordable and reliable services that sustain civilization.

---

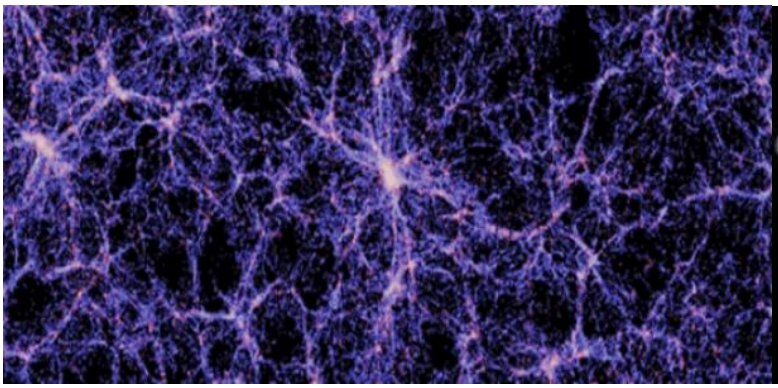
We hope this information moves the public and policy makers to take action.

Andrew Michrowski
President

(signed)

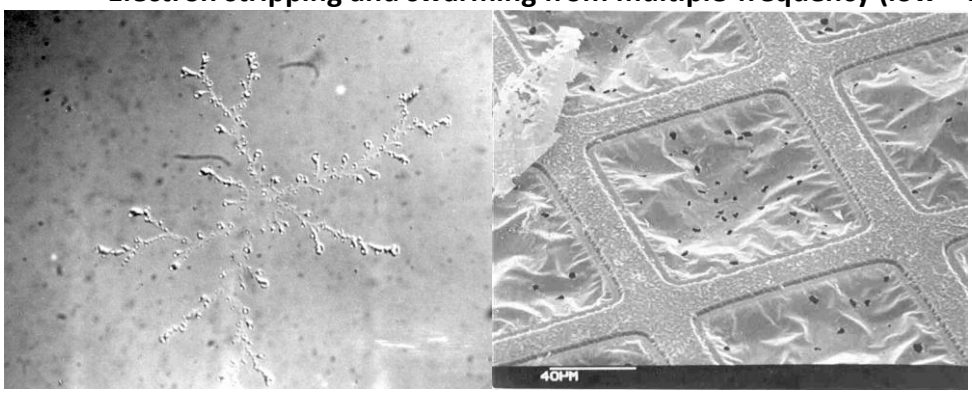
# APPENDIX A

**Visualizing aspects of electromagnetic hash / swarming:** *"γ-relaxation"* **clusters and** *"ion resonance"*



*The image to the left shows the physical phenomenon recently (2016) analyzed by* ***Dasadia Sarthak, University of Alabama in Huntsville (UAH)*** *by using Chandra X-ray Observatory observations captured from un-relaxed* [ ***"γ-relaxation"*** ] *clusters such as* **Abell 665** *that permit the study of superimposition (or "merger") features such as electromagnetic "shocks" and "turbulence, where undefined boundaries of charge clusters are drawn together. We can consider the prevalence of millions of electromagnetic gadgets in the same volume of space of indoor, structural, urban and rural areas to be quite similarly. This observation is, under peer review already being represented with this observation of weather and other geophysical – "because there is not much difference as far as the physics involved. Technically, we observe the same features in space that we do on Earth." UAH studies tornado and micro-climate disaster, including firestorms. The image to the right objectifies how an ion resonance phenomenon can appear like - above ground level - as an interference type of plasma cloud between overlapping fields of various bandwidths - at least 2 sources of different frequencies - (60Hz, with harmonics & and tones interchanging with RF and microwave bandwidths & their emission sources).*

**Electron stripping and swarming from multiple-frequency (low + high energy source) emissions**




*The image to the left is a SEM micrograph of electron stripping on chromium film target, fractal in formation, during the process of multiple frequency EMF resonance emissions. Note the same fractal drawing together of charges as observed by Chandra observatory and analyzed by* ***Dasadia Sarthak*** *(UAH). The optical photo of witness plate taken by* ***Kenneth Shoulders*** *at 1,500X showing electromagnetic swarm connected as bead chain structure.* [2] *Such random charges can evolve into tons of force and evidenced in accelerated nuclear reactor corrosion.*

## Challenge of monitoring currently-developing electromagnetic hash

The challenge of measuring and monitoring environments that are subject to so many emitters at so many sources of so many frequency ranges has been reported in peer-reviewed journals from around the world. For example: ***Hot Nano Spots" as an interpretation of so-called*** **Non-Thermal** ***biological mobile phone effects***. [3] to help explain why wireless devices, considered implausible for "non-thermal effect" due to low quantum energy and low specific absorption rate levels, can contain, even hotter "Nano spots" on a molecular level according to well-known mechanisms of *γ-relaxation*,

[2] Ken R. Shoulders, Steve Shoulders. **Charge clusters**. Planetary Association for Clean Energy Newsletter, Volume 9,1. (February 1997).

[3] Pfützner, H. (2016) "**Hot Nano Spots" as an Interpretation of So-Called Non-Thermal Biological Mobile Phone Effects**. Journal of Electromagnetic Analysis and Applications, 8, 62-69. doi: 10.4236/jemaa.2016.83007.Environ Res. 2016 Apr 27; 148:367-375.doi: 10.1016 / j.envres.2016.04.018. *[Epub ahead of print]*

assuming a heterogeneous system that consists of water molecules as well as larger-sized functional molecules. A consistent interpretation through temperature increase on the level of nanometer sized molecular compounds promises to favor interdisciplinary discussions with respect to safety regulations.

## Case study of electromagnetic hash – habitat for EHS individuals built by federal government

When challenged about unusual levels of emissions from a multiple Smart meter installation in habitat built by the Federal government housing (**CMHC-SCHL**) for EHS individuals, **Hydro Ottawa** CEO commissioned a 900 MHz only field survey (notwithstanding other frequencies monitored in PACE surveys). The information, underlinedprofusion of co-emitters, whose presence indicates the complexity of the issue at hand: quantification of injurious affection.

**Hydro Ottawa Test Conclusions -** The findings of the 60 Hertz at 900 Mhz Elster smart meter study. Conclusions derived from the Smart Meter inspection found that the meters were operating as per the manufacturer's parameters. No defects were identified during of two hour inspection conducted: supply voltage, the radio frequency levels and operation appeared normal and within the tolerances expected in an operating system.

Comments provided by the **Elster Canada** technical resource reported: *Based on my experience the readings you have in the table are typical. The in front of the meter readings can vary slightly depending on proximity of the handheld to the meter, and the readings are expected to be lower as you move further from the meter or obstacles come between the meter and the handheld.*

Hydro Ottawa confirmed on the analysis of the smart meter network in Barrhaven that the building at 3005 Jockvale Rd is in an area of low incidence of smart meter traffic compared to neighbouring areas of tighter density homes. The buffer provided by public buildings like churches, large parking lot, road and rail road right away does buffer the RF traffic from the greater network and results in lower densities. This does not diminish local traffic from the customers own smart meters.

**Alternate Sources of Interference**
Many sources of radio interference were identified at the customer's site during the course of Hydro Ottawa's investigation that were not related to Hydro Ottawa system. These points are being raised to provide balance to the Hydro Ottawa response as it would not be fair to consider the whole source of the customers physical complaints on a singular technology, the Hydro Ottawa smart meter that broadcasts for a couple of minutes a day – approximately four times a day. Sources of radiation identified during the inspection were:

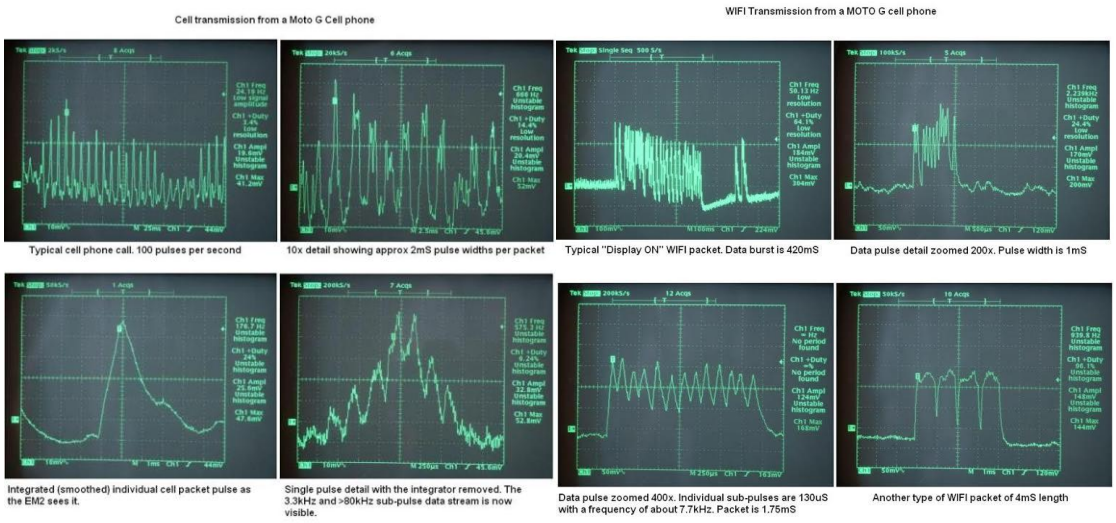
- **Hydro Ottawa**'s 900 MHz smart meters
- Customer owned 60 Hz supply voltage and unit wiring within the customer units and customer owned 60 Hz supply, end wall wiring and metering center and unit service conductors under concrete floor
- **Hydro Ottawa** primary transformer supply approximately 25 feet from the customer unit
- **Bell Canada** telecom infrastructure
- **Bell Canada** telecom VDSL Fibe infrastructure
- **Rogers cablevision** utility termination
- **Via Rail** train line with RF telemetry
- **Ottawa International Airport** flight path and resulting RF telemetry and traffic
- **City of Ottawa** Itron smart meter water meter module with RF broadcast
- Adjacent tenants in area having ***Wi-Fi*** connection for their broadband signal for their internet
- **Cellular towers** for public carriers
- **AM & FM commercial radio and television** broadcasts

**900 MHz Test Table of Findings:**
*Note: the less negative a reading was, the stronger the signal, the more negative the reading the weaker the signal.*

**Editor:** In 900MHz, **Ottawa Hydro** measured **0.03 - 0.06** in μWatt/cm$^2$ equivalence, **Actual power,** during 3 visits was: for micro-wave range: **7 – 8** μW/cm$^2$ **~ 233X higher** and, for the 10Hz-100GHz range: **40 - 80** μW/cm$^2$ **~ 1,333X higher** (from data, etc. modulations).

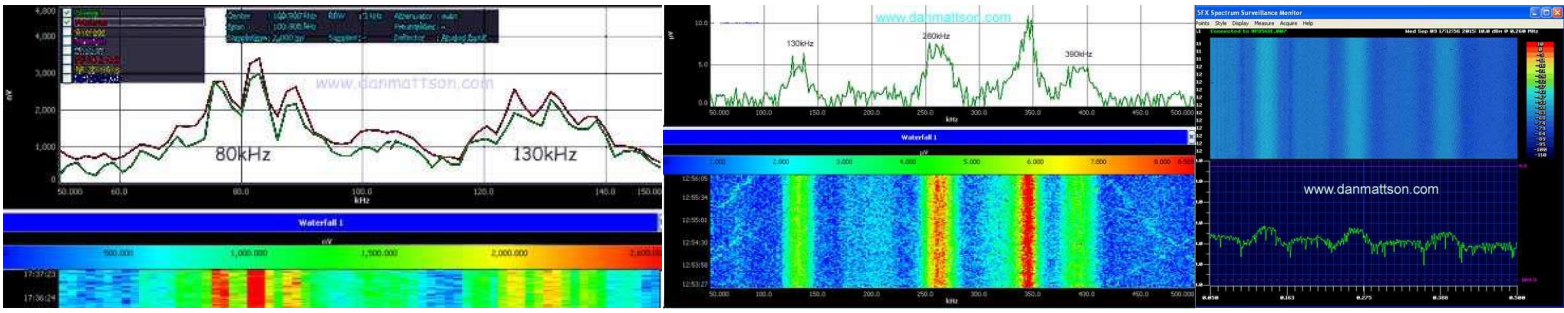
| | Observed Signal Itensity (in dBm) | | | | |
|---|---|---|---|---|---|
| Badge Number (LAN ID) | In Front of Meters | In Parking Lot (approx. 22m away) | Inside Entrance to Unit #2 | Inside Entrance to Unit #4 | Inside Entrace to Unit #6 |
| OTT633955 (415230) | -24 | -56 | -42 | -57 | -58 |
| OTT633957 (415232) | -23 | -61 | -49 | -41 | -54 |
| OTT633967 (415242) | -24 | -64 | -52 | -40 | -63 |
| OTT633966 (415241) | -24 | -50 | -50 | -37 | -66 |
| OTT633969 (415244) | -24 | -61 | -50 | -39 | -57 |
| OTT891577 (3007055) | -26 | -50 | -40 | -40 | -58 |
| OTT633956 (415231) | -24 | -67 | -47 | -36 | -62 |

## Tracings of complex modulation streams, microwave frequencies from cellphone and *Wi-Fi* transmissions



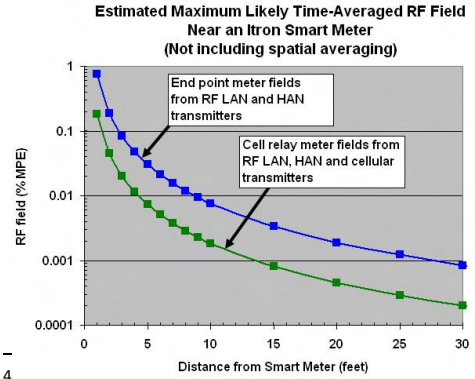

***Two series of data streams: from Cell and from Wi-Fi transmissions***. *A **MotoG** cell phone was monitored by **Dave Marett**, PEng. The detector is **Essentia EM2** (10Hz – 100 GHz) front-connected to oscilloscope. Probe's integrator removed to show pulse hash detail: some goes to several MHz, VLF, ELF <u>audio</u> range as well. This "higher clock speed" hash forces regulatory agencies to limit interference from "clock" & switching devices that generate "clocks" and switching emissions.* [4]

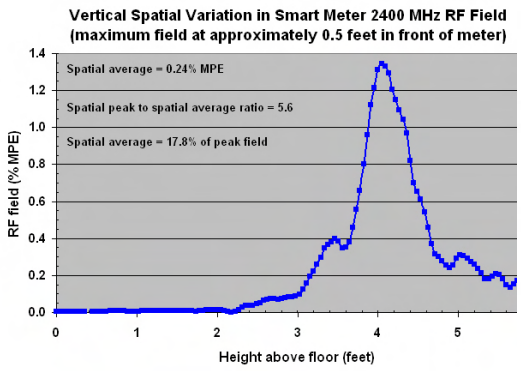
## Other frequencies emitted by typical Smart meter – switching for extra billing, etc.

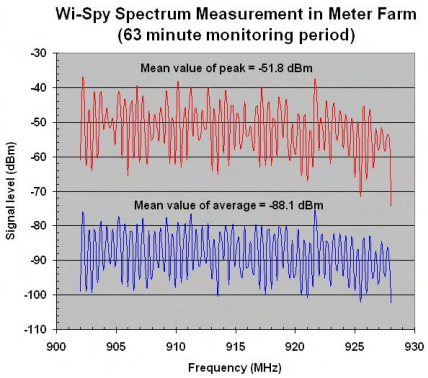



*These 3 images are switching frequency emissions in Smart meter traced as induced current at one hot leg. The 130 kHz signal is computed it at 625µA induced into 120/240 volt wiring. The 80 kHz signal (top left) may be induced or than radiated "noise". Such spike-like interactions can come from phone & cable wires, as noted by **Hydro Ottawa** – <u>and they also leak into waterworks & onto urban / rural infrastructures</u>. 340 kHz (middle) spike is sharable with electromagnetic swarming from some phone and cable lines, ground wires and power lines.*

## Position of EPRI (Electric Power Research Institute) [5] and independent on emissions from Smart meters



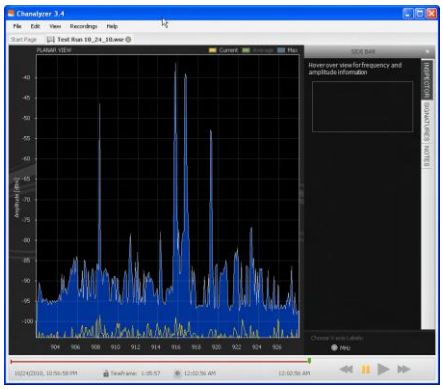



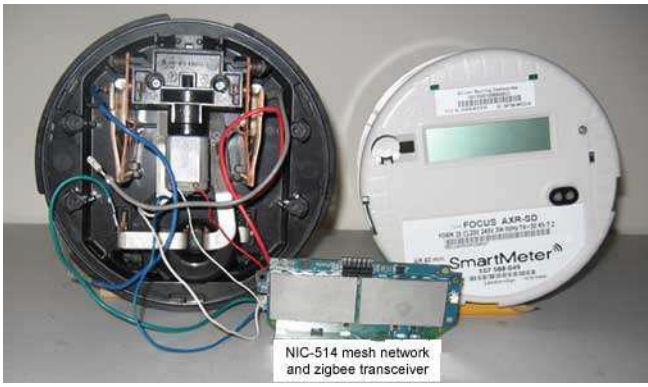




[4] Holland Shielding. http://hollandshielding.com

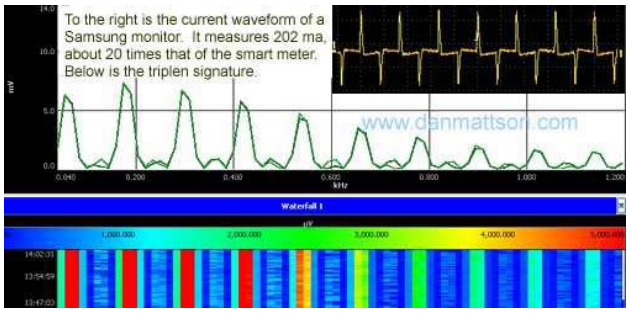
[5] G.Mezei, Richard Tell Associates, Inc. **An Investigation of Radiofrequency Fields Associated with the Itron Smart Meter**. Final Technical report 1021126. December 2010 www.epri.com. *This report is issued with a <u>disclaimer</u> of the possibility of "damages for any information, apparatus, method, process, or similar item disclosed in this document*".

***EPRI – Electric Power Research Institute*** *at Palo Alto, California, like* ***Hydro Québec*** *and other utilities tend to report only pulsed microwave radiation (902-928 MHz) and the ZigBee software transceiver signals for the HAN – Home Area Network to monitor indoor activities including RFIDs, circuits and "signatures", etc. They do not specify how number of meters, local co- factors & other co-utilities, supplier impact on final power density levels for users. Suppliers do not refer to ELF magnetic fields or to switch mode power supply switching frequency radiation (130 kHz) and associated harmonic emissions and distortions associated with installations. The switching mechanism within the circuit board in the bottom right Image converts 240 Volt AC to 12Vs DC and is described in data sheet as introducing "a small amount of frequency jitter, typically 8 kHz peak-to-peak, to minimize EMI emission." Electronics, electric utilities and telecommunication industries engineer try to overcome such transients, which are of primary concern. The switching device raises the issue of power factor which allows Smart meters to "meter" more. [Example for a typical refrigerator with a 0.7 power factor (420 Watts) may register as a 9.5 volt-amps (VA) in terms of random and continuous reactive loads, to be billed for 570 Watts – about 36% more. Furthermore such frequencies and harmonic distortions / noise can cause injurious affection on several fronts. EPRI concedes up to 14.0 microWatt/cm$^2$ power density versus European guideline of 0.1 microWatt/cm$^2$ and observations toward 100.0 microWatt/cm$^2$, and in cases of reflection, up to 8.904.39 microWatt/cm$^2$ (see: reference Cindy Sage engineering* **Itron** *Smart Meter comparative emission analysis below).*






**Example of a Home Area Network "signature" emission – LCD monitor – detectable by Smart meter *ZigBee***



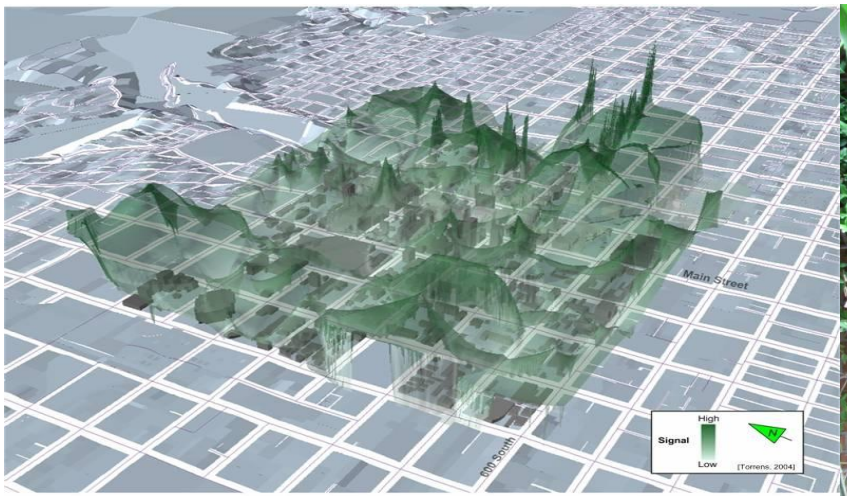

*All non-linear (random, discontinuous) loads, such as switching power supplies, produce such a signature waveform and frequency profile and all are unique. At left is a "signature" from a* ***Samsung 21"*** *LCD monitor with analog (VGA) input.*

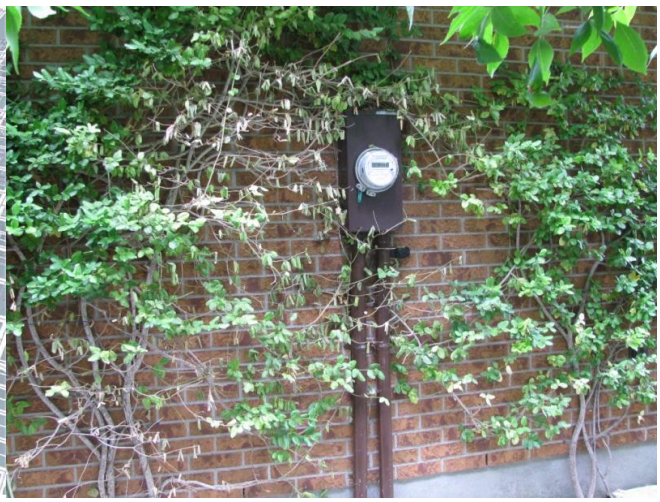
The interconnectedness objective has the potential for severe systemic upheavals. An early example was an end-of-the-month **IBM New Orleans World Trade Center** facility's inability to perform. After considerable trouble-shooting expertise confirmed integrity of software and hardware, it was observed that **US Navy Coast Guard** vessels were routinely testing – at full power – their radar at the harbour at the end-of-the-month, and thus affecting data and circuitry of I**BM** several miles away. Once the Coast Guard conducted exercises further away, there was no issue. With "smart" home/city / cars - "***HaLow"*** May 23 2016 **IEEE 802.11ah** specification, we can expect similar "unexplainable" failures at airports, etc.

The compilation below shows how certain factors, such as reflection of signals, grouping of Smart meters, use of ***ZigBee***-type software, duty cycle, the number of meters that a unit is reporting on behalf of - impact the level of power density emissions. There exist situations where the meter's emission levels exceed federal and **ICNIRP** guidelines, even without significant reflective factors. The switching mechanism's 130 kHz and 380 kHz signal's power density are not accounted for in this table, nor the monitored 80 kHz spike, as illustrated previously.

## Itron *Smart Meter comparative emission levels analysis - sample*

| **Emission levels of Itron OPENWAY® SMART Meter** μW/cm² (900 MHZ Antenna) | **At 20 cm** | **At 1 meter** | **At 3 meters** |
|---|---|---|---|
| **Common peak exposure levels of single Itron Smart meter** | | | |
| Smart meter, front<br>Smart meter, back | ~ 1 -10<br>~ 0.010 - 0.100 | outdoors<br>indoors | |
| **Sage Report—CALCULATED for 90% duty cycle** | | | |
| 1000% reflection<br>100% reflection<br>60% reflection | **8,904**.390<br>**1,294**.360<br>188.390 | 556.52<br>18.40<br>11.770 | 50.09<br>1.660<br>1.060 |
| **ACS Compliance Testing Laboratory (RSS-210/FCC15.247)—CALCULATED without reflection factor** | | | |
| 900 MHz LAN<br>2.4 GHz *ZigBee* | 227.0<br>31.0 | [9.0] | [1.0] |
| **Electric Power Research Institute—CALCULATED for upper range of possible RF fields** | | | |
| Peak level | (30 cm) 168.36 | 18.727 | 1.683 |
| **Itron, Inc.—CALCULATED** | | | |
| Centron Sentinel | | 68.0 – 81.0 | |
| **Richard Tell Associates, Inc.—CALCULATED with ground reflection factor 2.56** | | | |
| Maximum level | adjacent to meter 10.0 | 1.0 | 0.10 |
| **BC Centre for Disease Control—MEASURED (at British Columbia Hydro Laboratory)** | | | |
| Peak level, front<br>Min. detectable level of RF Probe | ≤ 20.0<br>≤ 20.0 | | |
| **Safe Living Technologies (Ontario)—MEASURED single SMART meter at residence** | | | |
| Peak level, front<br>Indoor peak level, back | ≥ 2.0<br>0.01 – 0.09 | | |
| **Electric Power Research Institute—MEASURED single SMART meter at residence** | | | |
| Peak level, front<br>Indoor peak level, back | (30 cm)<br>5.337 | 1.134<br>Bedroom behind meter 0.061 | In bath and bedroom2 0.055 |
| **ET&T (California)—MEASURED single SMART meter at residence** | | | |
| Peak level, front | | (30 cm) 2.10 | |
| **British Columbia Hydro—As quoted in its SMART Meter business case** | | | |
| < 10.0 | | 0.010 | |
| **British Columbia Hydro—CALCULATED AVERAGE based on transmit time per day** | | | |
| 0.6% duty cycle (8 min)<br>0.06% duty cycle (1 min) | 2.0<br>0.160 | [0.054]<br>[0.006] | [0.006]<br>[0.007] |



**Appendix B**

EXCERPTS FROM THE REPORT OF THE **FIRE MARSHALL OF ONTARIO**

- The old meter base connections may not have been in a condition for seamless exchange to a new meter
  - This should have been detected by the technician during the change over
  - Would installation guidelines help fix this?

- New meters may have defects that cause electrical failures or misalignment with old meter base
  - The meters are supposedly being designed and tested to specific standards to ensure safety
  - Do we have any policing bodies ensuring (like the CSA with Part II products) that the meters are designed correctly

- Careless installation during change over
  - Would installation guidelines help fix this?

- Considering the new smart meters fall under part 3 of the EC their installation has been left up to the utilities to determine. However they are directly plugged/meshing with a single component which falls under Part 2 which has to be installed in accordance with the requirements of part 1

- Therefore, when a utility owned (Part 3) component is directly meshed into a Part 2 component, would it make for more consistent connection, to have both components be scrutinized to the same standards and tested together and fall under the same installation guidelines

- Checking on the UL website we found that **only two** companies were listed which produced meters for the use in Canada
  - Schneider Electric USA Inc.
  - Triacta Power Technologies
  - Where are GE, Sensus etc.…?
- On the UL website we found a whole division which is devoted to Global meter testing and performance.
- On their website they state: UL tests for electronic electricity meters and their smart features to the requirements of the United States, Asia, Australia, Europe and South Africa
- While they don't say Canada it would make sense that they are testing ours as well?

- The following comes from the C22.2 No 115-M1989 Meter-Mounting Devices standard
  - Dated 1989
- Enclosures shall completely encase all current-carring parts when meters or other devices of proper types are mounted in position. Enclosures shall be so formed and assembled that they will have the strength and rigidity to resist the normal abuses to which they may be subjected without increasing their fire or accidental hazard due to partial collapse with resultant reduction of spacings, Loosening or displacement of parts, or other serious defects.
- Enclosures shall be of metal or other suitable material which, by investigation, has found to be satisfactory for the conditions of use
- Further states materials thickness. Types of connections. Torques applied to connections
- Additionally there are outlined Mechanical Strength tests
  - Metering connections shall be capable of withstanding the application of torques….
- Humidity, corrosion and weather tests

- Both standards state the components must be able to withstand abuse, have performance requirement tests (accuracy tests), require current carrying parts be separated along with temperature rise tests.
- However the meter base standard has additional simulation tests to ensure the structural integrity of all components
- Why was that missing from the Measurement Canada LMB – EG – 07 specification.
- Well simply it was because the mandate of Measurement Canada was only to ensure accuracy.

## APPENDIX C

## Issues with wireless technology applications

**Who wants our information and why?**

| Who wants smart meter data? | How could the data be used? |
|---|---|
| Utilities | To monitor electricity usage and load; to determine bills |
| Electricity usage advisory companies | To promote energy conservation and awareness |
| Insurance companies | To determine health care premiums based on unusual behaviors that might indicate illness |
| Marketers | To profile customers for targeted advertisements |
| Law enforcers | To identify suspicious or illegal activity* |
| Civil litigators | To identify property boundaries and activities on premises |
| Landlords | To verify lease compliance |
| Private investigators | To monitor specific events |
| The press | To get information about famous people |
| Creditors | To determine behavior that might indicate creditworthiness |
| Criminals | To identify the best times for a burglary or to identify high-priced appliances to steal |

Source: "Potential Privacy Impacts that Arise from the Collection and Use of Smart Grid Data," National Institute of Standards and Technology, Volume 2, pp. 30–32, Table 5-3.
http://spectrum.ieee.org/energy/the-smarter-grid/privacy-on-the-smart-grid
Reprinted in www.burbankaction.com

**RELIABILITY**

For this section, I will focus on PG&E. PG&E denied there were any technical problems for months until April 2010, when the CPUC forced them to release some records to the public. The records they released (there may be others) showed over 43,000 problems.

Problems with PG&E Smart Meters as of June 2010:

> "Among the problems that PG&E has admitted to are the following:
> • PG&E had to replace nearly 45,000 meters — 23,200 that were installed incorrectly, 12,376 that had data storage issues, and 9,000 that had wireless transmission problems.'
> • PG&E admits that less than 100% of its SmartMeters are accurate. This means that tens of thousands of PG&E customers are getting inaccurate bills.
> • Approximately 4% (13,674) of the Aclara SmartMeters 9 installed by PG&E are expected to have "poor read performance."

> • Based on "issues related to Aclara electric meter performance PG&E had to "contain" its deployment of Aclara meters at 145,000.
> • Deployment delays due to Silver Spring Network's inability to provide a consistent supply of SmartMeters.
> • "production performance problems" with Silver Spring Networks SmartMeters related to "[a]bility to read" the meters.
> • PG&E skipped approximately 12,000 meter installations between March 31 and May 20, 2009 based on interference with ground field interrupters ("GFI"). In buildings where a OFI is placed next to a Silver Spring Networks meter panel, PG&E determined that the SmartMeters could trip the GFI.
> • Silver Spring Networks found a problem with a component that could cause its meters to stop working. PG&E placed a "hold" on installing 340,000 meters that could be affected by this problem. As of March 2010, only 50,000 meters were removed from "hold" status. "
>
> City And County Of San Francisco's Petition To Modify Decision 09-03-026 To Temporarily Suspend PG&E's Installation Of Smart Meters, A.07-12-009, June 2010, p. 6.7

**Criminal negligence** is basically analogous to an "I don't care what happens" type of attitude. …Criminal negligence requires more than merely a mistake in judgment, inattention, or simple carelessness. It only pertains to conduct that is so outrageous and reckless that it marks a clear departure from the way an ordinary careful person would act under similar circumstances.

**Fiscal impacts**

Costs to residents forced out of homes
Property loss -- takings – loss of use of home
Costs to residents who become ill – medical expenses, shielding costs, damage to health, long-term costs
Death
Emotional harm
Fires, electrical wiring, appliance and electronic damage
Loss of wages
Unemployment costs
Cost of Smart appliances and devices
Environmental damage
Loss of bees
Increasing provincial/taxpayer liability for impacts from program not halted
Future costs of downed grid, locally, regionally, throughout the province, or the region
Grid blackout
Costs of Smart Meter/Smart Grid program through rates

The complicated communication and data management systems & new interfaces with the existing billing system are not subject to errors. Similarly, While testing of smart meter generally pass using averaged data, they tend to fail at a manufacturer's specification at 50°C – a potential circumstance – as noted by Ontario Office of the Fire Marshall, and a factor in the conflagration in downtown Calgary due to underground installations that closed the financial hub for several days.

Tolerances can vary between Boards, utilities and manufacturers. In California, for example, the "CPUC tolerances" are 2%, whereas PG&E tolerances for digital meters are .5%, and the manufacturer's tolerances are .2%. Palo Alto (a municipal utility district) decided after 3 years of research not to install Smart Meters because the costs would exceed benefits, and the benefits are minimal. They had also been monitoring the problems and complaints with Smart Meters.

**PRIVACY INVASION**

**Consumer profiling**

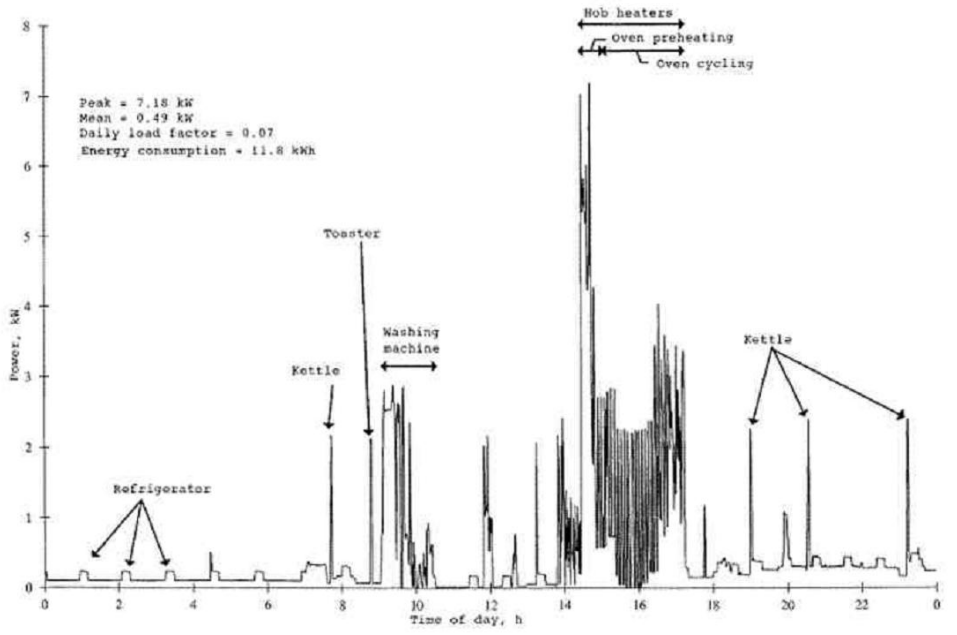



Image: National Institute of Standards and Technology

## COSTS EXCEED BENEFITS

There is little to no benefit for the consumer, with debatable energy savings; thus the costs exceed any possible benefits.

Connecticut Attorney General George Jepson (February 2011):

> "(Connecticut Light & Power's) proposal would force the company's ratepayers to spend at least $500 million on new meters that are likely to provide few benefits in return,

> "The pilot results showed no beneficial impact on total energy usage. And, 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,"

John Rowe, CEO of Exelon, parent company of Illinois utility company Commonwealth Edison, recently said of the smart grid:

> "… it costs too much, and we're not sure what good it will do. We have looked at most of the elements of smart grid for 20 years and we have never been able to come up with estimates that make it pay." (quoted by AG Madigan)

Illinois Attorney General Lisa Madigan (June 2011):

> "The utilities want to experiment with expensive and unproven smart grid technology, yet all the risk for this experiment will lie with consumers.
>
> The $63 million smart grid pilot program consumers are currently paying for has turned in disappointing results that reinforce what Rowe already knows. On hot summer days, people continue to run their air conditioners no matter how much information they have from their smart meter.
>
> Consumers don't need to be forced to pay billions for so-called smart technology to know how to reduce their utility bills. We know to turn down the heat or air conditioning and shut off the lights. The utilities have shown no evidence of billions of dollars in benefits to consumers from these new meters, but they have shown they know how to profit.
>
> I think the only real question is: How dumb do they think we are?"

Michigan Attorney General Bill Schuette (April 2012)

> …at least two very substantial issues remain that must be further addressed before the MPSC (Michigan Public Service Commission) authorizes or approves any further deployment of smart meters by Michigan electric utilities and the recovery from ratepayers of the costs of smart meter deployment. First, there must be a sufficient demonstration that implementation of the smart meter programs will actually produce a net economic benefit to customers. Second, customers must be afforded a meaningful and fair opportunity to opt out of smart meter installation without being penalized by unwarranted and excessive costs.
>
> A net economic benefit to electric utility ratepayers from Detroit Edison's and Consumers smart meter programs has yet to be established. In the absence of such demonstrated benefit, the Attorney General has opposed, and will oppose any Commission action that unjustly and unreasonably imposes the costs of such

programs upon ratepayers. To a significant extent, the asserted potential benefits to utility customers depend upon assumptions that a customer will consider additional "real time" data on electricity usage provided by smart meters, and adjust their electrical consumption to achieve cost savings under variable pricing programs that do not yet exist. (See Edison, Document No. 0146, p 5; and Consumers, Document No. 0148, pp. 6-7). Any assumption that large numbers of residential customers will have the time, ability and motivation to attend to, and act upon daily or even hourly changes in their electrical is questionable.

Comments, Michigan Public Service Commission Case No. U-17000, p. 3-4

What the record does reveal is that AMI is a pilot program that even Robert Ozar, Manager of the Energy Efficiency Section in the Electric Reliability Division of the PSC, concedes "is as yet commercially untested and highly capital intensive, resulting in the potential for significant economic risk and substantial rate impact." At best, the actual evidence presented by Detroit Edison to support the rate increase was aspirational testimony describing the AMI program in optimistic, but speculative terms. *What the record sadly lacks is a discussion of competing considerations regarding the program or the necessity of the program and its costs as related to any net benefit to customers.*

Michigan Court of Appeals Nos. 296374, 296379, slip opinion, pp. 7-9, April 10, 2012
Cited in Attorney General Comments, Case No. U-17000, p. 4-5

Division of Ratepayer Advocates, March 2012:

Executive Summary:
Key Findings presented in Section V of this report include:

- According to SCE's AMI business case, the total cost to customers will be greater than $5 billion, rather than the $1.6 billion cost explicitly approved by the CPUC, which only included nominal deployment costs;

- Many forecasted benefits have been delayed or reduced, which <u>erases</u> the projected margin of net benefits as calculated in SCE's business case [see below];

- SmartConnect-related costs not anticipated in SCE's original business case have already been approved by the CPUC in other proceedings, beyond the over $5 billion cost referenced above. In many cases, these costs were approved without a showing of incremental benefits, and DRA anticipates that more will be requested;

- SmartConnect features such as remote disconnect and SmartConnect-enabled time-varying rates have a high potential for adverse impacts for low-income and other "at-risk" customers… (p. 2)

…The failure to address and resolve questions about the benefits of smart metering and dynamic pricing versus the risks noted by consumer advocates has led such organizations to view smart metering propositions with mistrust. (p. 4-6)

Conclusion

The policy solutions developed concerning the issues raised in this RFI will have a profound impact on residential consumers, and low-income and fixed-income seniors in particular. It is unfortunate that many continue to inappropriately lump smart grid and smart meters together in a way that fails to address the consumer protections that are necessary in a transition to smart meters. As outlined in the attached paper, the adoption of smart meters should be carefully examined and considered in light of key concerns and, where implemented, should be accompanied by several essential consumer protections. (p. 10-11)

Comments to Department of Energy Smart Grid RFI: Addressing Policy and Logistical Challenges, November 1, 2010
http://energy.gov/sites/prod/files/oeprod/DocumentsandMedia/AARPNCLCPublic_CitizenCommentsDOE1101.pdf
Cited in
https://sites.google.com/site/nocelltowerinourneighborhood/home/wireless-smart-meter-concerns/going-deep-understanding-the-big-picture-and-real-costs-and-concerns

The "attached paper" mentioned above is the report:

The Need For Essential Consumer Protections: Smart Metering Proposals And The Move To Time-Based Pricing, August 2010
www.nclc.org/images/pdf/energy_utility_telecom/additional_resources/adv_meter_protection_report.pdf

SCE was the last electric IOU to file an AMI application (2007). At the time that PG&E and SDG&E submitted their applications (2005), SCE's business case analysis, including multiple scenarios, showed that AMI deployment was not a cost-effective endeavor. Two of its scenario analyses showed a Present Value Revenue Requirement (PVRR), largely due to the added Demand Response from large customers that already had interval meters. SCE stated that "the technology envisioned by the Ruling is unproven and commercially unavailable at this time." (p. 7-8)

…SmartConnect was adopted based on an estimate of $9.2 *million* in net benefits on a PVRR [Present Value Revenue Requirement) basis owing to the time-discounted value of money… (p. 10)

Conclusion:
The CPUC required California's large IOUs to file AMI applications and required a demonstration that AMI systems *could* produce net customer benefits. Initially, SCE found that AMI was *not* cost-effective for its customers, but AMI technological developments in 2005 and 2006 led to the SmartConnect application in 2007, which forecasted a very slim margin of lifetime net benefits on a present value basis. The CPUC authorized SmartConnect deployment costs of $1.634 billion, and SCE customers in aggregate have so far experienced a revenue requirement increase in excess of $193.1 million to cover these costs. This is a real cost increase, one which will certainly rise as more meters are purchased and deployed, and as SCE begins to incur post-deployment costs.

…Total SmartConnect costs paid by customers will actually be more than $5 billion (nominally), accounting for post-deployment costs and the financing costs incurred over the 20 years life of the SmartConnect system. This total cost will be even greater if the cost of future AMI-enabled investments and programs are included. While SCE's incremental cost requests have thus far been relatively conservative, it is important to note that PG&E and SDG&E have so far requested much higher amounts in incremental AMI funding: PG&E has requested and received approval for funding in excess of $500 million, and SDG&E has received funding approval for over $93 million. (p. 50)

Case Study of Smart Meter System Deployment: Recommendations for Ensuring Taxpayer Benefits; Hieta, Kao, Roberts

AARP, National Consumer Law Center, and Public Citizen:

...past experience with time of use rates cautions that initial interest in such rates tapers over time. In addition, the low take-rate in the PG&E service territory over the last two years does not bode well for the popularity of critical peak pricing.

...Studies to date attempting to show that low-income customers will benefit do not demonstrate that such will be the case.

- Many utilities offer Time of Use rate options to residential customers using interval meters; little customer interest
- RESTRUCTURING STATES: Most abandoned mandatory TOU and other rate design structures associated with generation supply management and assumed that the competitive market would provide such products.
- Utilities typically couple smart metering with the functionality of remote connection and disconnection of the meter; CA results document significant increase in volume of disconnections with AMI; elimination of premise visit increases risk of wrongful or disputed disconnection; health and safety risks
- These new meters may give rise to a host of degraded service options, e.g., prepayment (pay in advance and automatically disconnect when meter is not fed); service limiters
- Dynamic pricing does not "empower" customers; it presents a Hobson's Choice to many low use, low income, and elderly customers who must use electricity during peak hours for health and safety reasons (Chicago heat wave; over 700 deaths, mostly seniors living alone)
- A voluntary approach to dynamic pricing or relying on Peak Time Rebates is preferred approach; PTR has been successfully demonstrated to result is peak load reduction without TOU or CPP
- Smart Grid and smart metering must not be used as a means to impose dramatic changes in retail rate design for residential customers
    - Dynamic and time-based price programs must remain optional on an "opt in" basis
    - Rewards in the form of credits for peak usage reduction should be the preferred approach

      Presentation, July 15, 2010, 2010 National Energy and Utility Affordability Conference

      http://www.energyandutilityconference.org/Assets/2010%20Conference/2010%20Presentations/Plenary%201_Alexander.pdf

      As summarized in

https://sites.google.com/site/nocelltowerinourneighborhood/home/wireless-smart-meter-concerns/going-deep-understanding-the-big-picture-and-real-costs-and-concerns

## Massachusetts Power Selects Schneider Electric to Implement Integrated Smart Grid Solution

Advanced DMS-Based Outage Management Sets Massachusetts Power on Path to Become Smart Utility

October 08, 2013 --

HALIFAX, NS -- (Marketwired) -- 10/08/13 -- Schneider Electric (PINKSHEETS: SBGSY), the global specialist in energy management, announced today that is has been selected by Massachusetts Power to implement an Advanced Distribution Management System (ADMS) based Outage Management System (OMS) as an integrated smart grid solution to improve operational efficiencies and outage management response and restoration.

Currently in the implementation phase, the project will position Massachusetts Power's vision to meet the challenges of increasing consumer demands for sustainable, reliable energy as well as positioning the utility for future advanced smart grid operations. The new solution utilizes the utility's existing investment in Schneider Electric's GIS technology, offering efficient network data and model management, and provides seamless, embedded OMS and DMS technologies. Using integrated voice response, work order management and crew dispatch capabilities, Massachusetts Power will be able to efficiently monitor, analyze, and manage its network of nearly 500,000 customers for more rapid response to power outages.

According to Laurent Vernerey, executive vice president of Schneider Electric's End User Business: "This project represents a new trend in the smart grid industry, the integration of OMS as a seamless application of smart grid solutions to improve operational efficiencies and safety. We are excited to be on the forefront of offering this advanced technology to utilities around the world."

# APPENDIX D

## Precautionary principle – European Commission observations

Incomplete information, inconclusive evidence and public controversy can make it difficult to achieve consensus over the appropriate response to hazardous substances or activities, but these are precisely the sorts of conditions that often demand hard and fast decisions. The precautionary principle is designed to assist with decision-making under uncertainty and is a core principle of EU environmental law, enshrined in Article 191(2) of the Treaty on the Functioning of the EU. The classic definition of 'a precautionary approach' comes from the 1992 Rio Declaration on Environment and Development, which states that:

"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" (UNEP 1992).

In other words, a precautionary approach captures the idea that regulatory intervention may still be legitimate, even if the supporting evidence is incomplete or speculative and the economic costs of regulation are high. Better safe than sorry. In the Communication on the Precautionary Principle from 2000 the European Commission clarified that:

> "Recourse to the precautionary principle presupposes that potentially dangerous effects deriving from a phenomenon, product or process have been identified, and that scientific evaluation does not allow the risk to be determined with sufficient certainty. The implementation of an approach based on the precautionary principle should start with a scientific evaluation, as complete as possible, and where possible, identifying at each stage the degree of scientific uncertainty"
>
> (European Commission, 2000, COM (2000) 1 final).

The European Commission also refers to the need for 'reasonable grounds for concern' about potential risks. Crucially, this means that the principle ought only to be used if a risk is deemed to be plausible. Any regulatory measures introduced as a result of the precautionary principle should also be subject to review in light of new scientific data, and may have to be modified or abolished as new scientific data become available. In this sense, the Communication provides a step-by-step guide to applying the principle; however, it is not prescriptive and is designed to be flexible, allowing for the variety of circumstances in which the principle might operate. The Commission notes that it is ultimately for decision-makers and the courts to flesh out the details.

We therefore advise against uncritical use of its risk assessments. In many cases, the information in its reports and fact sheets is wrong, because the data are based on a misunderstanding of the precautionary principle. By ruling in the Pfizer case, the Commission has been criticized for their scientific committee had misunderstood the precautionary principle and based its statement on false assumptions. SCENIHR's reports on the health risks of EMF show that this problem persists and occurs more generally.

The Commission has announced internal instructions for its scientific committees, but these are inadequate. The appointed scientists have misinterpreted their mandate and seem to believe that it is up to them to determine what level of risk is acceptable to society. Because this viewpoint is concealed by the incorrect reflection of the degree of scientific uncertainty, the problem is very difficult for the decision-makers who are responsible for risk management to detect. Knowledge of how risk management works is required for a risk assessment to be correct. We therefore propose that the working groups be supplemented with legal expertise. They must also be provided with substantially clearer instructions on the conditions of their mission.

# APPENDIX E

## Reported Biological Effects from Radiofrequency Radiation at Low-Intensity Exposure
### (Cell Tower, Wi-Fi, Wireless Laptop and 'Smart' Meter RF Intensities)

| Power Density (Microwatts/centimeter2 - uW/cm2) | | Reference |
|---|---|---|
| As low as ($10^{-13}$) or 100 femtowatts/cm2 | Super-low intensity RFR effects at MW reasonant frequencies resulted in changes in genes; problems with chromatin conformation (DNA) | Belyaev, 1997 |
| 5 picowatts/cm2 ($10^{-12}$) | Changed growth rates in yeast cells | Grundler, 1992 |
| 0.1 nanowatt/cm2 ($10^{-10}$) or 100 picowatts/cm2 | Super-low intensity RFR effects at MW reasonant frequencies resulted in changes in genes; problems with chromatin condensation (DNA) intensities comparable to base stations | Belyaev, 1997 |
| 0.00034 uW/cm2 | Chronic exposure to mobile phone pulsed RF significantly reduced sperm count, | Behari, 2006 |
| 0.0005 uW/cm2 | RFR decreased cell proliferation at 960 MHz GSM 217 Hz for 30-min exposure | Velizarov, 1999 |
| 0.0006 - 0.0128 uW/cm2 | Fatigue, depressive tendency, sleeping disorders, concentration difficulties, cardio- vascular problems reported with exposure to GSM 900/1800 MHz cell phone signal at base station level exposures. | Oberfeld, 2004 |
| 0.003 - 0.02 uW/cm2 | In children and adolescents (8-17 yrs) short-term exposure caused headache, irritation, concentration difficulties in school. | Heinrich, 2010 |
| 0.003 to 0.05 uW/cm2 | In children and adolescents (8-17 yrs) short-term exposure caused conduct problems in school (behavioral problems) | Thomas, 2010 |
| 0.005 uW/cm2 | In adults (30-60 yrs) chronic exposure caused sleep disturbances, (but not significantly increased across the entire population) | Mohler, 2010 |
| 0.005 - 0.04 uW/cm2 | Adults exposed to short-term cell phone radiation reported headaches, concentration difficulties (differences not significant, but elevated) | Thomas, 2008 |
| 0.006 - 0.01 uW/cm2 | Chronic exposure to base station RF (whole-body) in humans showed increased stress hormones; dopamine levels substantially decreased; higher levels of adrenaline and nor-adrenaline; dose-response seen; produced chronic physiological stress in cells even after 1.5 years. | Buchner, 2012 |
| 0.01 - 0.11 uW/cm2 | RFR from cell towers caused fatigue, headaches, sleeping problems | Navarro, 2003 |

| | |
|---|---|
| Stress proteins, HSP, disrupted immune function | Brain tumors and blood-brain barrier |
| Reproduction/fertility effects | Sleep, neuron firing rate, EEG, memory, learning, behavior |
| Oxidative damage/ROS/DNA damage/DNA repair failure | Cancer (other than brain), cell proliferation |
| Disrupted calcium metabolism | Cardiac, heart muscle, blood-pressure, vascular effects |


## Reported Biological Effects from Radiofrequency Radiation at Low-Intensity Exposure
### (Cell Tower, Wi-Fi, Wireless Laptop and 'Smart' Meter RF Intensities)


| Power Density (Microwatts/centimeter2 - uW/cm2) | | Reference |
|---|---|---|
| 0.01 - 0.05 uW/cm2 | Adults (18-91 yrs) with short-term exposure to GSM cell phone radiation reported headache, neurological problems, sleep and concentration problems. | Hutter, 2006 |
| 0.005 - 0.04 uW/cm2 | Adults exposed to short-term cell phone radiation reported headaches, concentration difficulties (differences not significant, but elevated) | Thomas, 2008 |
| 0.015 - 0.21 uW/cm2 | Adults exposed to short-term GSM 900 radiation reported changes in mental state (e.g., calmness) but limitations of study on language descriptors prevented refined word choices (stupified, zoned-out) | Augner, 2009 |
| 0.05 - 0.1 uW/cm2 | RFR linked to adverse neurological, cardio symptoms and cancer risk | Khurana, 2010 |
| 0.05 - 0.1 uW/cm2 | RFR related to headache, concentration and sleeping problems, fatigue | Kundi, 2009 |
| 0.07 - 0.1 uW/cm2 | Sperm head abnormalities in mice exposed for 6-months to base station level RF/MW. Sperm head abnormalities occurred in 39% to 46% exposed mice (only 2% in controls) abnormalities was also found to be dose dependent. The implications of the pin-head and banana-shaped sperm head. The occurrence of sperm head observed increase occurrence of sperm head abnormalities on the reproductive health of humans living in close proximity to GSM base stations were discussed." | Otitoloju, 2010 |
| 0.38 uW/cm2 | RFR affected calcium metabolism in heart cells | Schwartz, 1990 |
| 0.8 - 10 uW/cm2 | RFR caused emotional behavior changes, free-radical damage by super-weak MWs | Akoev, 2002 |
| 0.13 uW/cm2 | RFR from 3G cell towers decreased cognition, well-being | Zwamborn, 2003 |
| 0.16 uW/cm2 | Motor function, memory and attention of school children affected (Latvia) | Kolodynski, 1996 |
| 0.168 - 1.053 uW/cm2 | Irreversible infertility in mice after 5 generations of exposure to RFR from an 'antenna park' | Magras & Zenos, 1997 |
| 0.2 - 8 uW/cm2 | RFR caused a two-fold increase in leukemia in children | Hocking, 1996 |
| 0.2 - 8 uW/cm2 | RFR decreased survival in children with leukemia | Hocking, 2000 |
| 0.21 - 1.28 uW/cm2 | Adolescents and adults exposed only 45 min to UMTS cell phone radiation reported increases In headaches. | Riddervold, 2008 |


| | |
|---|---|
| Stress proteins, HSP, disrupted immune function | Brain tumors and blood-brain barrier |
| Reproduction/fertility effects | Sleep, neuron firing rate, EEG, memory, learning, behavior |
| Oxidative damage/ROS/DNA damage/DNA repair failure | Cancer (other than brain), cell proliferation |
| Disrupted calcium metabolism | Cardiac, heart muscle, blood-pressure, vascular effects |

## Reported Biological Effects from Radiofrequency Radiation at Low-Intensity Exposure
### (Cell Tower, Wi-Fi, Wireless Laptop and 'Smart' Meter RF Intensities)

| Power Density (Microwatts/centimeter2 - uW/cm2) | | Reference |
|---|---|---|
| 0.5 uW/cm2 | Significant degeneration of seminiferous epithelium in mice at 2.45 GHz, 30-40 min. | Saunders, 1981 |
| 0.5 - 1.0 uW/cm2 | Wi-FI level laptop exposure for 4-hr resulted in decrease in sperm viability, DNA fragmentation with sperm samples placed in petri dishes under a laptop connected via WI-FI to the internet. | Avendano, 2012 |
| 1.0 uW/cm2 | RFR induced pathological leakage of the blood-brain barrier | Persson, 1997 |
| 1.0 uW/cm2 | RFR caused significant effect on immune function in mice | Fesenko, 1999 |
| 1.0 uW/cm2 | RFR affected function of the immune system | Novoselova, 1999 |
| 1.0 uW/cm2 | Short-term (50 min) exposure in electrosensitive patients, caused loss of well-being after GSM and especially UMTS cell phone radiation exposure | Eltiti, 2007 |
| 1.3 - 5.7 uW/cm2 | RFR associated with a doubling of leukemia in adults | Dolk, 1997 |
| 1.25 uW/cm2 | RFR exposure affected kidney development in rats (in-utero exposure) | Pyrpasopoulou, 2004 |
| 1.5 uW/cm2 | RFR reduced memory function in rats | Nittby, 2007 |
| 2 uW/cm2 | RFR induced double-strand DNA damage in rat brain cells | Kesari, 2008 |
| 2.5 uW/cm2 | RFR affected calcium concentrations in heart muscle cells | Wolke, 1996 |
| 2 - 4 uW/cm2 | Altered cell membranes; acetycholine-induced ion channel disruption | D'Inzeo, 1988 |
| 4 uW/cm2 | RFR caused changes in hippocampus (brain memory and learning) | Tattersall, 2001 |
| 4 - 15 uW/cm2 | Memory impairment, slowed motor skills and retarded learning in children | Chiang, 1989 |
| 5 uW/cm2 | RFR caused drop in NK lymphocytes (immune function decreased) | Boscolo, 2001 |
| 5.25 uW/cm2 | 20 minutes of RFR at cell tower frequencies induced cell stress response | Kwee, 2001 |
| 5 - 10 uW/cm2 | RFR caused impaired nervous system activity | Dumansky, 1974 |
| 6 uW/cm2 | RFR induced DNA damage in cells | Phillips, 1998 |

| | |
|---|---|
| Stress proteins, HSP, disrupted immune function | Brain tumors and blood-brain barrier |
| Reproduction/fertility effects | Sleep, neuron firing rate, EEG, memory, learning, behavior |
| Oxidative damage/ROS/DNA damage/DNA repair failure | Cancer (other than brain), cell proliferation |
| Disrupted calcium metabolism | Cardiac, heart muscle, blood-pressure, vascular effects |


## Reported Biological Effects from Radiofrequency Radiation at Low-Intensity Exposure
### (Cell Tower, Wi-Fi, Wireless Laptop and 'Smart' Meter RF Intensities)


| Power Density (Microwatts/centimeter2 - uW/cm2) | | Reference |
|---|---|---|
| 8.75 uW/cm2 | RFR at 900 MHz for 2-12 hours caused DNA breaks in leukemia cells | Marinelli, 2004 |
| 10 uW/cm2 | Changes in behavior (avoidance) after 0.5 hour exposure to pulsed RFR | Navakatikian, 1994 |
| 10 - 100 uW/cm2 | Increased risk in radar operators of cancer; very short latency period; dose response to exposure level of RFR reported. | Richter, 2000 |
| 12.5 uW/cm2 | RFR caused calcium efflux in cells - can affect many critical cell functions | Dutta, 1989 |
| 13.5 uW/cm2 | RFR affected human lymphocytes - induced stress response in cells | Sarimov, 2004 |
| 20 uW/cm2 | Increase in serum cortisol (a stress hormone) | Mann, 1998 |
| 28.2 uW/cm2 | RFR increased free radical production in rat cells | Yurekli, 2006 |
| 37.5 uW/cm2 | Immune system effects - elevation of PFC count (antibody producing cells | Veyret, 1991 |
| 45 uW/cm2 | Pulsed RFR affected serum testosterone levels in mice | Forgacs, 2006 |
| 50 uW/cm2 | Cell phone RFR caused a pathological leakage of the blood-brain barrier in 1 hour | Salford, 2003 |
| 50 uW/cm2 | An 18% reduction in REM sleep (important to memory and learning functions) | Mann, 1996 |
| 60 uW/cm2 | RFR caused structural changes in cells of mouse embryos | Somozy, 1991 |
| 60 uW/cm2 | Pulsed RFR affected immune function in white blood cells | Stankiewicz, 2006 |
| 60 uW/cm2 | Cortex of the brain was activated by 15 minutes of 902 MHz cell phone | Lebedeva, 2000 |
| 65 uW/cm2 | RFR affected genes related to cancer | Ivaschuk, 1999 |
| 92.5 uW/cm2 | RFR caused genetic changes in human white blood cells | Belyaev, 2005 |
| 100 uW/cm2 | Changes in immune function | Elekes, 1996 |
| 100 uW/cm2 | A 24.3% drop in testosterone after 6 hours of CW RFR exposure | Navakatikian, 1994 |
| 120 uW/cm2 | A pathological leakage in the blood-brain barrier with 915 MHz cell RF | Salford, 1994 |


| | |
|---|---|
| Stress proteins, HSP, disrupted immune function | Brain tumors and blood-brain barrier |
| Reproduction/fertility effects | Sleep, neuron firing rate, EEG, memory, learning, behavior |
| Oxidative damage/ROS/DNA damage/DNA repair failure | Cancer (other than brain), cell proliferation |
| Disrupted calcium metabolism | Cardiac, heart muscle, blood-pressure, vascular effects |

# Reported Biological Effects from Radiofrequency Radiation at Low-Intensity Exposure
## (Cell Tower, Wi-Fi, Wireless Laptop and 'Smart' Meter RF Intensities)

| Power Density (Microwatts/centimeter2 - uW/cm2) | | Reference |
|---|---|---|
| 500 uW/cm2 | Intestinal epithelial cells exposed to 2.45 GHz pulsed at 16 Hz showed changes in intercellular calcium. | Somozy, 1993 |
| 500 uW/cm2 | A 24.6% drop in testosterone and 23.2% drop in insulin after 12 hrs of pulsed RFR exposure. | Navakatikian, 1994 |

| **STANDARDS** | | |
|---|---|---|
| 530 - 600 uW/cm2 | Limit for uncontrolled public exposure to 800-900 MHz | ANSI/IEEE and FCC |
| 1000 uW/cm2 | PCS STANDARD for public exposure (as of September 1,1997) | FCC, 1996 |
| 5000 uW/cm2 | PCS STANDARD for occupational exposure (as of September 1, 1997) | FCC, 1996 |
| **BACKGROUND LEVELS** | | |
| 0.003 uW/cm2 | Background RF levels in US cities and suburbs in the 1990s | Mantiply, 1997 |
| 0.05 uW/cm2 | Median ambient power density in cities in Sweden (30-2000 MHz) | Hamnierius, 2000 |
| 0.1 - 10 uW/cm2 | Ambient power density within 100-200' of cell site in US (data from 2000) | Sage, 2000 |

| | |
|---|---|
| Stress proteins, HSP, disrupted immune function | Brain tumors and blood-brain barrier |
| Reproduction/fertility effects | Sleep, neuron firing rate, EEG, memory, learning, behavior |
| Oxidative damage/ROS/DNA damage/DNA repair failure | Cancer (other than brain), cell proliferation |
| Disrupted calcium metabolism | Cardiac, heart muscle, blood-pressure, vascular effects |