

Régie de l'énergie / Quebec Energy Board - Docket no. R-3770-2011
Authorization of an investment by Hydro-Quebec Distribution – Advanced Metering Project Phase 1

C A N A D A

RÉGIE DE L'ÉNERGIE / ENERGY BOARD

PROVINCE OF QUEBEC

DISTRICT OF MONTREAL

DOCKET No. R-3770-2011

AUTHORIZATION OF AN INVESTMENT BY
HYDRO-QUEBEC DISTRIBUTION –
ADVANCED METERING PROJECT
PHASE 1

HYDRO-QUEBEC
As Electricity Distributor

Petitioner

-and-

STRATEGIES ENERGETIQUES (S.É.) /
ENERGY STRATEGIES (E.S.)

ASSOCIATION QUEBECOISE DE LUTTE
CONTRE LA POLLUTION ATMOSPHERIQUE
(AQLPA) / QUEBEC ASSOCIATION TO FIGHT
AGAINST AIR POLLUTION

Interveners

**THE STATE OF SCIENTIFIC RESEARCH AS TO WHETHER ADVANCED METERS TRANSMITTING BY
RADIOFREQUENCIES, AS PROPOSED IN THE PRESENT CASE, MAY CONSTITUTE A RISK OF SERIOUS OR
IRREVERSIBLE DAMAGE TO HEALTH**

**EXPERT REPORT
DAVID O. CARPENTER**

Filed by :

Stratégies Énergétiques (S.É.) / Energy Strategies (E.S.)
Association québécoise de lutte contre la pollution atmosphérique /
Quebec Association to Fight Against Air Pollution (AQLPA)

April 30, 2012
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Exhibit SE-AQLPA-7 - Document 1.1

***The state of scientific research as to whether advanced meters transmitting by radiofrequencies, as
proposed in the present case, may constitute a risk of serious or irreversible damage to health***

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EXPERT OPINION SUMMARY

It is my opinion that the state of scientific research sufficiently establishes a risk that meters transmitting by radiofrequencies as proposed in the present file by Hydro-Quebec may constitute a risk of serious as well as irreversible damage to health, through biological effects other than those resulting from heat. Some individuals or categories of individuals are more susceptible to injury than others (children, pregnant women, elderly, persons with illness, electrosensitive individuals, etc).

Such non thermal effects are reviewed in section 5 of this report.

Therefore, there is justification for examining precautionary or prudent measures that could be applied in addition to the current standards (which are based only on biological effects resulting from heat). Discussion and examples of such possible precautionary or prudent measures are provided in sections 6 and 7 of this report.

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1. THE AUTHOR

1. I am a public health physician, educated at *Harvard Medical School*.

2. My *curriculum vitae* has been filed in the present case as Exhibit C-SE-AQLPA-0060, SE-AQLPA-4, Document 3.

It indicates the various positions I held regarding public health, my participation into various international, national, state and local Committees and the Honors, Awards, Fellowships and Grants I received, as well as over 350 major publications, books and other publications.

3. My current title is *Director of the Institute for Health and the Environment* at the *University at Albany* and *Professor of Environmental Health Sciences* within the *School of Public Health*.

4. Formerly, I was the *Dean of the School of Public Health* at the *University of Albany* and the *Director of the Wadsworth Center for Laboratories and Research of the New York State Department of Health*.

5. I served as the *Executive Secretary* to the *New York State Powerlines Project* in the 1980s, a program of research that showed that children living in homes with elevated magnetic fields coming from powerlines suffered from an elevated risk of developing leukemia.

6. After this, I became the spokesperson on electromagnetic field (EMF) issues for New York during the time of my employment in the *Department of Health*.

7. I have published several reviews and have edited two books on the *Biologic Effects of Electric and Magnetic Fields*.

8. I am also a *Co-Editor* and a *Contributing Author* of the *BioInitiative Report: A Rationale for a Biologically-based Public Exposure Standard for Electromagnetic Fields (ELF and RF)*, www.bioinitiative.org.

The *BioInitiative Report* documents bioeffects, adverse health effects and public health conclusions about impacts of electromagnetic radiation (electromagnetic fields including extremely-low frequency ELF-EMF and radiofrequency /microwave or RF-EMF fields).

The public health chapter from this report was subsequently published in a peer-reviewed journal, *Reviews on Environmental Health*, and it and other chapters of the Report were published in the peer-reviewed journal, *Pathophysiology*.

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The BioInitiative Report's « *Preface* », « *Summary for the Public* » and *Synthesis of Conclusions* are filed in the present case as Exhibit C-SE-AQLPA-0076, SE-AQLPA-7, Doc. 5 and that Report is further discussed in section 55 of this present report. The full Report can be accessed at www.bioinitiative.org . The corresponding peer-reviewed scientific articles published in *Pathophysiology* can also be obtained at <http://www.sciencedirect.com/science/journal/09284680/16/2-3> .

9. In 2009, I was invited to present to the *President's Cancer Panel on the subject of powerline and radiofrequency fields and cancer*, and have also testified on this issue before the *United States House of Representatives*. Excerpts from the *Presidential Cancer Panel's Report* are filed in the present case as Exhibit C-SE-AQLPA-0077, SE-AQLPA-7, Doc. 6; that Report is further discussed in sections 33 and 60a of this present report.

10. In sum, I am a public health physician, professor and former public health school Dean with expertise in electrophysiology, low-frequency electromagnetic fields bioeffects, and radiofrequency (RF) and microwave (MW) radiation bioeffects.

2. THE MANDATE AND THE QUESTION SUBMITTED BY THE REGIE DE L'ENERGIE

11. My services have been retained in the present file by Interveners *Stratégies Énergétiques (S.É.) / Energy Strategies (E.S.)* and the *Association québécoise de lutte contre la pollution atmosphérique / Quebec Association to Fight Against Air Pollution (AQLPA)* to submit an expert report regarding Hydro-Quebec's Petition for authorization of its investments for Phase 1 of its Advanced Meters Project, which constitutes present Docket no. R-3770-2011 of the Quebec Regie de l'énergie (Quebec Energy Board).

12. The Quebec Energy Board, in its recent decision no. D-2012-046 of April 20, 2012, specifically asked that my report addresses « *the state of scientific research as to whether advanced meters transmitting by radiofrequencies as proposed by Hydro-Quebec in the present file may constitute a risk of serious or irreversible damage to health* ».

The Quebec Energy Board further indicated that the phrasing of its above question was a reference to the *Quebec Sustainable Development Act*, which defines the *Precautionary Principle* as follows :

6 (j) "*Precaution*": *When there are threats of serious or irreversible damage, lack of full scientific certainty must not be used as a reason for postponing the adoption of effective measures to prevent environmental degradation*

It is further recognized that the *Precautionary Principle* not only applies to Environmental degradation but also to Public Health issues, among others.

3. THE SMART METERS PROPOSED BY HYDRO-QUEBEC

13. I am informed by my clients that the smart meters proposed by Hydro-Quebec in the present file would include two antennas :

- a) a general use antenna for communication between the meter and other surrounding meters and a router using the 900-928MHz frequencies with a power emitter of 27,48 dBm.
- b) a ZigBee card with antenna for eventual communication between the meter and household appliances that would be using the 2400-2483,5 MHz frequencies with a power emitter of 21,20 dBm.

The ZigBee card with antenna would, however, remain dormant in the first years and would only eventually be activated later by Hydro-Quebec. Only the main antenna using the 902-928 MHz frequencies would be activated during the first years. The radiofrequency emissions from that antenna are hereby described as « the Agent ».

My clients inform me that the Landis+Gyr smart meters commissioned by Hydro-Quebec are about 10 cm deep and that the main emitting antenna using the 902-928 MHz frequencies is in the front and side, at 2-3 cm from the exterior of the meter. There is no other barrier preventing a person from approaching and even touching the meter, therefore being at 2-3 cm from the emitting antenna.

14. I am also informed by my clients that said antenna using the 902-928 MHz frequencies would be continuously in use, transmitting approximately 1440 to 2880 pulsed emissions per day.

15. These smart meters would therefore constantly expose persons in the immediate vicinity of the meter.

On that matter, I wish to stress that duration may be an even more potent contributing factor to RF/MW radiation bioeffects than exposure levels. Chronic, such as all-day exposure, is more likely than short and intermittent exposure, such as cell phone use, to produce harmful health effects. Although the exposure levels may be lower, the accumulated exposure over time has the potential to be greater and to cause greater harm.

16. Persons stationed close to the meters, for example when the meters are located inside the kitchen or another room of a dwelling, will receive considerably higher exposure than do others. RF wave reflection on the walls, metal appliances and furniture inside a dwelling further increase RF exposure of its occupants.

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17. I am also informed by my clients that, in most cases, exposure in front of the meters proposed by Hydro-Quebec is substantially higher than behind or on the side of the meters, due to the existence of a reflective metal plate in the back and part of the side of the meter and due to the localization of its emitting antenna.

My clients have provided me with the following table which would represent the maximal power density at 1 m of a meter at various angles on an horizontal plane viewed from above (0° being the front of the meter and 180° being the back of the meter). My clients inform me this table has been translated from the one submitted on page 11 of Hydro-Quebec's report (by Mr. François Robichaud) filed as Hydro-Quebec's Exhibit B-0116, HQD-7, Document 7 (answer to commitment 35) in the present case :

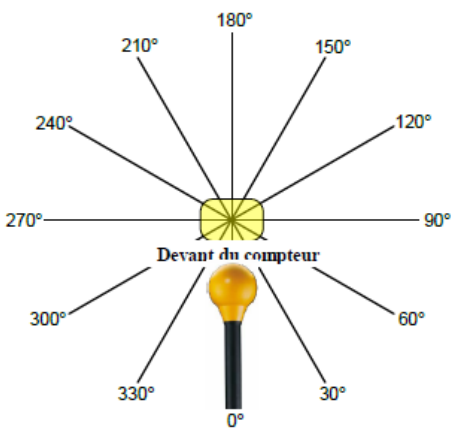
Horizontal plan (View from above) 0° being in front of the meter Meter is at center Measurement device is shown at 0°	Angle (Degree)	Frequency	Maximal power density (at 1 m from meter)
	0°	902,901 MHz	(Highest) 54 680 µW/m ²
	30°	920,604 MHz	38 500 µW/m ²
	60°	912,201 MHz	23 130 µW/m ²
	90°	907,406 MHz	10 090 µW/m ²
	120°	913,396 MHz	5 490 µW/m ²
	150°	908,296 MHz	3 550 µW/m ²
	180°	918,498 MHz	2 010 µW/m ²
	210°	911,257 MHz	4 090 µW/m ²
	240°	925,098 MHz	879,2 µW/m ²
	270°	926,906 MHz	(Lowest) 518,3 µW/m ²
	300°	922,095 MHz	9 540 µW/m ²
	330°	910,088 MHz	26 800 µW/m ²
	360°	912,793 MHz	46 720 µW/m ²

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My clients also inform me of the following similar table contained on page 14 of a report made by YRH (Yves R. Hamel and associates) for Hydro-Quebec and filed as the first part of Exhibit B-0113, HQD-7, Document 4 (answer to commitment 45) in the present case :

Horizontal plan (View from above) 0° being in front of the meter Meter is at center with electrical box behind Measurement device is shown at 0°	Angle (Degree)	Power density (Maximal during transmission) (at 1 m from meter)	Power density (Average during 6 minute observation) (at 1 m from meter)
	0°	(Highest) 55 370 $\mu\text{W}/\text{m}^2$	(Highest) 63,870 $\mu\text{W}/\text{m}^2$
	30°	38 800 $\mu\text{W}/\text{m}^2$	46,850 $\mu\text{W}/\text{m}^2$
	60°	20 440 $\mu\text{W}/\text{m}^2$	28,920 $\mu\text{W}/\text{m}^2$
	90°	5 658 $\mu\text{W}/\text{m}^2$	7,074 $\mu\text{W}/\text{m}^2$
	120°	1 366 $\mu\text{W}/\text{m}^2$	1,706 $\mu\text{W}/\text{m}^2$
	150°	1 633 $\mu\text{W}/\text{m}^2$	1,541 $\mu\text{W}/\text{m}^2$
	180°	3 802 $\mu\text{W}/\text{m}^2$	5,107 $\mu\text{W}/\text{m}^2$
	210°	2 493 $\mu\text{W}/\text{m}^2$	2,864 $\mu\text{W}/\text{m}^2$
	240°	(Lowest) 947 $\mu\text{W}/\text{m}^2$	(Lowest) 0,980 $\mu\text{W}/\text{m}^2$
	270°	1 478 $\mu\text{W}/\text{m}^2$	2,017 $\mu\text{W}/\text{m}^2$
	300°	13 040 $\mu\text{W}/\text{m}^2$	17,630 $\mu\text{W}/\text{m}^2$
	330°	42 330 $\mu\text{W}/\text{m}^2$	57,550 $\mu\text{W}/\text{m}^2$

18. I am also informed by my clients that their witness, Mr. Stephane Belainsky, had made the following observations in his amended report filed as Exhibit SE-AQLPA-0029, SE-AQLPA-2, Document 2 :

- The exterior meters (6 subjects measured, being visits nos. 2, 3, 4, 5, 6 and 7) had a power density averaging in time **42,2 $\mu\text{W}/\text{m}^2$** (taken at 1 m in front of the meter), with peaks averaging **6695 $\mu\text{W}/\text{m}^2$** . These averages do not include an unexplained atypical measurement of one meter (visit no. 1) which had a power density averaging in time 2400 $\mu\text{W}/\text{m}^2$, with a peak of 49800 $\mu\text{W}/\text{m}^2$; a re-measurement of that same meter at a later date (visit no. 1A) however showed a closer to normal power density averaging in time 88 $\mu\text{W}/\text{m}^2$, with a peak of 8484 $\mu\text{W}/\text{m}^2$.
- The interior meters facing occupants (two subjects measured, being visits nos. 8 and 10) had a power density averaging in time had a power density averaging in time **136 $\mu\text{W}/\text{m}^2$** (taken at 1 m in front of the meter), with peaks averaging **19 142 $\mu\text{W}/\text{m}^2$** .
- An additional measurement (visit no. 9) in a children's playroom, **at 3 m behind** a group of 53 meters (located in an adjacent meter room) showed a power density averaging in time **66 $\mu\text{W}/\text{m}^2$** , with a peak of **3198 $\mu\text{W}/\text{m}^2$** .

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I am also informed by my clients that on page 28 of Hydro-Quebec's report (by Mr. François Robichaud) filed as Hydro-Quebec's Exhibit B-0116, HQD-7, Document 7 (answer to commitment 35), measurements taken at 1 m from a residential meter average a power density of **48,64 $\mu\text{W}/\text{m}^2$** , and between **30,76 $\mu\text{W}/\text{m}^2$ and 32,96 $\mu\text{W}/\text{m}^2$** in the case of commercial-institutional-industrial (CII) meters. These measurements are in the same range as those provided above in Mr. Belinsky's report.

My clients inform me that, on page 20 of Hydro-Quebec's report (by Mr. François Robichaud) filed as Hydro-Quebec's Exhibit B-0116, HQD-7, Document 7 (answer to commitment 35), measurements taken inside meter rooms show power densities (which I presume are taken at 1 m) averaging 577,83 $\mu\text{W}/\text{m}^2$, 995,33 $\mu\text{W}/\text{m}^2$, 1053,6 $\mu\text{W}/\text{m}^2$ and 1794,0 $\mu\text{W}/\text{m}^2$. I am informed by my clients that that same report shows on pages 24-27 that, at various locations one meter away outside these rooms, average power densities were measured at 154,40 $\mu\text{W}/\text{m}^2$, 62,35 $\mu\text{W}/\text{m}^2$, 9,95 $\mu\text{W}/\text{m}^2$, 13,69 $\mu\text{W}/\text{m}^2$, 20,59 $\mu\text{W}/\text{m}^2$, 11,28 $\mu\text{W}/\text{m}^2$, 26,15 $\mu\text{W}/\text{m}^2$; the construction materials forming these rooms and their configuration vary and may explain these variations in power densities measured.

19. These results therefore show that :

- Average power densities measured at 1 m from exterior meters do not exceed the exterior-threshold of 1 000 $\mu\text{W}/\text{m}^2$ recommended in the *BioInitiative Report*, which is later described in the present report (save for one atypically high result on one meter which later was re-measured and gave a result below the threshold). We do not have any measurements however at a lesser distance from the meter and are informed that a person may approach and even touch the meter, thus could be located as close at 2-3 cm from the meter.
- Inside meter rooms, average power densities far exceed the interior-threshold of 100 $\mu\text{W}/\text{m}^2$ recommended in the *BioInitiative Report* later described in the present report ; it is however expected that these rooms will not normally be accessed by the public. In one case, the average power density at one meter away from such room is shown to exceed the interior-threshold of 100 $\mu\text{W}/\text{m}^2$ but, in the other cases measured, it is inferior to that interior-threshold.
- More problematic, however, are meters situated inside occupied rooms and facing their occupants (meters in a kitchen, etc.), where measurements show the average power density exceeds the interior-threshold of 100 $\mu\text{W}/\text{m}^2$ at 1 m from the meter. We must also keep in mind that we do not have any results at a lesser distance.

- All the above results are less than the recommended threshold of 6 000 000 $\mu\text{W}/\text{m}^2$ of both FCC and Health Canada. These measurements were however all taken at 1 m or more from the antenna; we do not have any measurements at a lesser distance.

It is to be noted that, at very close distance (inside the interior field from the antenna), extrapolation is not easily feasible from measurements taken at further distance. A real measurement is preferable.

4. STRUCTURE OF THE ANSWER TO THE QUESTION SUBMITTED BY THE REGIE DE L'ENERGIE

20. As indicated above, the Quebec Energy Board has asked me to report on « *the state of scientific research as to whether advanced meters transmitting by radiofrequencies as proposed by Hydro-Quebec in the present file may constitute a risk of serious or irreversible damage to health* ».

21. The answer to this question depends on the level of power density to which the subjects are exposed (itself being dependent on the distance between the source of emission and the subject and the interior or exterior location) and the duration of exposure, and may also vary with other characteristics of the exposure as well as the characteristics of the subjects (adults vs. children, etc.) as indicated in sections 5 and 6 of the present report. The specific characteristics of the advanced meters proposed by Hydro-Quebec in the present file, as communicated to me, were indicated in section 3 of the present report and are further commented in section 7.

Most importantly, the answer to this question depends on whether or not it is recognized that there are sufficient scientific indications of the possibility that radiofrequencies (RF) electromagnetic fields exposure may cause biological and health effects other than those resulting from heat. The scientific community is divided on this issue.

22. In section 5 of the present Report, we enumerate a number of epidemiological and laboratory research linking RF electromagnetic fields exposure with various non-thermal biological effects and their conclusions as well as several meta-analysis of the scientific literature on the subject.

23. In section 6 of the present Report, we elaborate on the lack of unanimity of the scientific community on these non-thermal biological effects and on the emerging notion that Precautionary or Prudent Measures might be appropriate as a means of managing that scientific lack of unanimity, without modifying the existing standards at the moment.

5. EPIDEMIOLOGICAL AND LABORATORY RESEARCH LINKING RF ELECTROMAGNETIC FIELDS EXPOSURE WITH VARIOUS NON-THERMAL BIOLOGICAL EFFECTS

24. It is generally accepted within the relevant scientific community and has been established beyond any reasonable doubt that adverse human health effects occur at far lower levels of RF/MW radiation exposure than those that cause measureable heating, particularly where the wavelength approaches body-part size and thus maximizes absorption, where the wavelength has resonance with the water molecule, where there is a more complex, modulated wave, where there is chronic exposure duration, and where exposed persons lack the capacity voluntarily to remove themselves from the radiation sources. It must, however, be acknowledged that biological effects do not necessarily constitute human health hazards.

25. Some effects are known to occur at several hundred thousand times below the FCC public exposure guidelines and the similar guidelines of Health Canada's Safety Code no. 6 (of 6 000 000 $\mu\text{W}/\text{m}^2$ for the 902-928 MHz bandwidth) which are set based on the assumption, which we believe is incorrect, that there are no adverse health effects at exposures that do not cause easily measureable heating.

It is further to be noted that FCC guidelines also only apply to 30-minute public exposures and Health Canada's Safety Code no. 6 only applies to 6-minute public exposures; they are however being used to infer safety at durations >30 minutes (FCC) and durations >6 minutes (Health Canada's Safety Code no. 6).

26. Exposure to high-frequency RF and MW radiation have been linked to a variety of adverse health outcomes. Some of the many adverse effects reported to be associated with and/or caused by RF/MW radiation include cancer, neurologic, endocrine, immune, cardiac, reproductive and other effects.

27. Studies of isolated cells have shown that RF/MW exposures may cause changes in cell membrane function, cell communication, metabolism, activation of proto-oncogenes, and can trigger the production of stress proteins at exposure levels below the above FCC and Health Canada guidelines. Resulting effects in cellular studies include DNA breaks and chromosome aberrations, cell death including death of brain neurons, increased free radical production, activation of the endogenous opioid system, cell stress and premature aging.

28. Human studies of comparable RF/MW radiation parameters show changes in brain function including memory loss, retarded learning, performance impairment in children, headaches and neurodegenerative conditions, melatonin suppression and sleep disorders, fatigue, hormonal imbalances, immune dysregulation such as allergic and inflammatory responses, cardiac and blood pressure problems, genotoxic effects like miscarriage, cancers such as childhood and adult leukemia, childhood and adult brain tumors, and more.

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29. There is consistent evidence for increased incidence of cancer and other adverse effects in individuals who live near to high-power short-wave, AM, FM and TV transmission towers. This is particularly relevant because, like WI-FI and smart meters, radio and TV transmission towers give continuous, whole-body radiation, not just radiation to the head.

30. In addition, it is to be noted that, should the 2,4 GHz ZigBee antennas of the proposed Hydro-Quebec Landis+Gyr meters be activated in the future, their wavelength, at ~ 12.2 cm or ~ 4.8 inches, would be more absorbable by children's and adults' bodies and brains than radio or TV wavelengths. The harmfulness of such radiation therefore likely exceeds that of radio or TV towers. The 2.4 GHz frequency is similar to that used by a microwave oven. Such frequency was chosen for the oven because of its wavelength and harmonic resonance with the water molecule, to ensure the most efficient absorption by living tissues and effective heating by way of the agitation of water at the molecular level.

31. Like second-hand smoke, EMF and RF/MW radiation involve complex mixtures, where different frequencies, intensities, durations of exposure(s), modulation, waveforms and other factors are known to produce variable effects, often more harmful with greater complexity. Decades of scientific study have produced substantial evidence that EMF and RF/MW radiation may be considered neurotoxic, carcinogenic and genotoxic. Sources of fields and radiation include but are not limited to: power lines, navigational radar, cell phones, cordless phones [or Digitally Encoded Cordless Transmission Devices (D.E.C.T.) phones], cell towers, smart meters and their grids or infrastructure, "smart" boards, meters and grids, WiMax and wireless internet (WI-FI).

32. The RF/MW radiation and low-frequency EMF science that currently exists includes hundreds of studies dating back to the 1920s. On the basis of this vast body of literature, many public health experts, myself included, believe that it is likely society will face markedly increased incidence of neurotoxic effects, neurodegenerative diseases, cancers and genotoxicity in the future, resulting from the extreme and mostly involuntary exposure to RF/MW radiation and EMFs.

33. In public health science, it is generally accepted that vulnerable subgroups exist within any human population. This is also recognized specifically for RF/MW radiation and fields. These groups include children, pregnant women, the elderly, those with preexisting illnesses and/or impairments and some individuals who show electrical hypersensitivity. Children are more vulnerable to RF/MW radiation because of the susceptibility of their developing nervous systems. RF/MW radiation penetrates children's brains more than adult's because children's skulls are thinner, their brains smaller, and their brain tissue is more conductive than those of adults, and since it has a higher water content and ion concentrations. The Presidential Cancer Panel found in 2010 that children « are at special risk due to their smaller body mass and rapid physical development, both of which magnify their vulnerability to known carcinogens, including

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radiation » (pages vii and 98). http://deainfo.nci.nih.gov/advisory/pcp/annualReports/pcp08-09rpt/PCP_Report_08-09_508.pdf. Excerpts from the *Presidential Cancer Panel's Report* are filed in the present case as Exhibit C-SE-AQLPA-0077, SE-AQLPA-7, Doc. 6. It is further discussed in sections 9 and 60a of this present report. Furthermore, should the ZigBee antenna of the proposed Hydro-Quebec Landis+Gyr meters be activated, absorption of RF/MW energy in tissues of the head of children would even be greater due to the similarity between the wavelength at 2.4 GHz size and the children's head.

34. There is also abundant literature showing that some individuals, described as electrosensitive, may encounter symptoms more intense than other individuals.

35. FCC public RF/MW radiation exposure guidelines (and the similar Health Canada Safety Code no. 6 guidelines) are based on the height, weight and stature of a 6-foot tall man, not children or adults of smaller stature. The guidelines do not take into account the unique susceptibility of growing children to RF/MW radiation exposures. Since children are growing, their rate of cellular activity and division is more rapid, and they are at more risk for DNA damage and subsequent cancers. Growth and development of the central nervous system is still occurring well into the teenage years, such that the neurological impairments predictable by the extant science may have great impact upon development, cognition, learning, and behavior.

36. Prenatal EMF exposure has been identified as a risk factor for childhood leukemia and brain cancer, and is associated with miscarriage. Children are largely unable to remove themselves from exposures to harmful substances in their environments. Their exposure is involuntary.

37. When a smart meter is in operation inside a dwelling, persons in the immediate vicinity have no choice but to allow the meter to expose them to microwave radiation that is much higher than exists naturally on Earth.

38. The evidence for harm from RF radiation as a cause of cancer and other diseases continues to grow. And when we focus on MW radiation, particularly pulse-modulated radiation, on long, non-intermittent duration and on more vulnerable subgroups such as children, we see that the cancer outcome is being firmly established.

Amongst the epidemiologic studies showing cancer outcomes, the following are particularly strong.

This first list is of studies where the whole body is exposed to RF radiation.

- a. Dode AC, Leao M, Tejo FdeAF, Gomes ACR, Dode DC, Dode MC, Moreira CW, Condessa VA, Albinatti C and Calaffa WT. *Mortality by neoplasia and cellular*

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telephone base stations in the Belo Horizonte municipality, Minas Gerais State, Brazil. Sci Total Environ 409: 3649-3665:2011, <http://www.sciencedirect.com/science/article/pii/S0048969711005754> and <http://www.ncbi.nlm.nih.gov/pubmed/21741680?dopt=Abstract>. This study shows higher rates of cancer (neoplasia) mortality in people living close to cell phone towers than for people living further away. It is filed in the present case as Exhibit C-SE-AQLPA-0078, SE-AQLPA-7, Doc. 7.

- b. Oberfeld G. Environmental Epidemiology Study of Cancer Incidence in the Municipalities of Hausmannstatten & Vasoldsberg (Austria), 2008. This government-commissioned study found significantly increased cancer risk relative to a lower-exposure reference category, 23x higher for breast cancer and 121x higher for brain tumors, with strong exposure-effect relations. The full 111-page report is available in German at <http://www.hese-project.org/hese-uk/en/papers/hausmannstatten2008.pdf>. We file, as Exhibit C-SE-AQLPA-0079, SE-AQLPA-7, Doc. 8, a brief English summary of this report published at http://www.hese-project.org/hese-uk/en/niemr/hausmannstatten_summary.pdf.
- c. Michelozzi P, Capon A, Kirchmayer U, Forastiere F, Biggeri A, Barca A and Perucci CA. Adult and childhood leukemia near a high-power radiostation in Rome, Italy. Am J Epidemiol. 155: 1098-1103: 2002 <http://aje.oxfordjournals.org/content/155/12/1096.full.pdf> . The authors show that there is a significant elevation of childhood leukemia among residents living near to Vatican Radio, and that the risk declines with distance away from the transmitter (OR 2.2, 1.0-4.1). This article is filed in the present case as Exhibit C-SE-AQLPA-0080, SE-AQLPA-7, Doc. 9.
- d. Ha M, Im H, Lee M, Kim HJ, Kim BC, Gimm YM and Pack JK. Radiofrequency radiation exposure from AM radio transmitters and childhood leukemia and brain cancer. Am J Epidemiol 166: 270-279: 2007 <http://aje.oxfordjournals.org/content/166/3/270.full.pdf+html> . Leukemia and brain cancer in children in Korea were investigated in relation to residence within 2 km of AM radio transmitters. There was a significant elevation in rates of leukemia but not of brain cancer (OR 2.15, 1.00-4.67). This article is filed in the present case as Exhibit C-SE-AQLPA-0081, SE-AQLPA-7, Doc. 10.
- e. Park SK, Ha M, Im HJ. Ecological study on residences in the vicinity of AM radio broadcasting towers and cancer death: preliminary observations in Korea. Int Arch Occup Environ Health. 2004 Aug;77(6):387-94. This study found higher mortality areas for all cancers and leukemia in some age groups in the area near the AM towers.

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- f. Dolk H, Shaddick G, Walls P, Grundy C, Thakrar B, Kleinschmidt I, Elliot P. Cancer Incidence near radio and television transmitters in Great Britain. I – Sutton-Colfield transmitter, and II. AI high-power transmitters. Am J Epidemiol 1997; 145(1):1-9 and 10-17. In the first study, there was a statistically significant increase in cancer; in the second, a small but significant increase in adult leukemia.
- g. Hocking B, Gordon IR, Grain HL, Harfield GE. Cancer incidence and mortality and proximity to TV towers. Medical J of Australia. 165:601-605. At extremely low exposure levels, there was an association between increased childhood leukemia incidence and mortality and proximity to TV towers.
- h. Grayson JK. Radiation exposure, socioeconomic status, and brain tumor risk in the US Air Force: A nested case-control study. Am J Epidemiol 1996; 143:480-6. This study found an association between exposure to ELF and RF/MW radiation and brain tumors.
- i. Szmigielski S. Cancer morbidity in subjects occupationally exposed to high frequency (radiofrequency and microwave) electromagnetic radiation. Sci Total Environ 1996;180:9-17. <http://www.ncbi.nlm.nih.gov/pubmed/8717316> and <http://www.sciencedirect.com/science/article/pii/0048969795049150> This study showed huge increases in leukemia and Non-Hodgkin's lymphomas.
- j. Eger H, Hsagen KU, Lucas B, Vogel P and Voit H. The influence of being physically near to a cell phone transmission mast on the incidence of cancer. Umwelt-Medizin-Gesellschaft 17, 4; 1-7 : 2004. <http://blog.cat/gallery/17983/17983-97698.pdf> Over the period 1994-2004 individuals living within 400 meters of a cell phone tower had three times rates of cancer compared to those living further away.

39. The strongest evidence for harm from RF radiation comes from studies of individuals using cell phone for prolonged periods of time, which gives a localized exposure to the ipsilateral brain (ipsilateral designating the side of the head where the cell phone is being used), auditory nerve and parotid gland in the cheek.

- a. Hardell L, Carlberg M, Soderqvist F and Mild KH. Meta-analysis of long-term mobile phone use and the association with brain tumours. Internat J Oncology 12 : 1097-1103. In ten studies of glioma, cell phone use for more than ten year gave an OR of 1.2 (95%CI=0.8-1.9). For ipsilateral cell phone use for more than 10 year the OR = 2.0 (1.2-3.4). There was also a significant relation for acoustic neuroma and ipsilateral cell phone use for ten years or more, but no relation for meningioma.
- b. Levis AG, Minicuci N, Ricci P, Gennaro V and Gabisa S. Mobile phones and head tumours. The discrepancies in cause-effect relationships in the epidemiological

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studies – how do they arise? Environ Health 2011, 10,59. When studies that were blinded, free from errors and bias were considered cell phone use for more than ten years resulted in a near doubling in ipsilateral glioma and acoustic neuroma.

- c. Myung SK, Ju W, McDonnell DD, Lee YJ, Ksazinet G, Cheng CT and Moskowitz JM. Mobile phone use and risk of tumors: A meta-Analysis. J Clin Oncology 10.1200/JCO.2008.21.6366. Reviewed 465 publications that reported on 12344 cases of cancer and 25572 controls. Risk of developing brain cancer was OR+1.8 for more than ten years use.
- d. The INTERPHONE Study Group. Internatl J Epidemiology 2010; 1-20. Brain tumour risk in relation to mobile telephone use: results of the INTERPHONE international case-control study. While ever vs. never using a cell phone did not increase risk of brain cancer, there was a significant OR= 2.18 for use for ten or more years, OR=1.82 for use for 1640 hours or more and OR=1.31 for more than 270 calls, all for glioma.

It is to be noted that a certain controversy surrounded the publication and interpretation of the Interphone results. At first, the scientific community had difficulty in obtaining all the data from the study in order to peer-review the interpretation submitted by its coordinators. **Scientists associated with the BioInitiative Group even had to publicly request those data from the Interphone Group so they could be peer-reviewed (http://www.bioinitiative.org/freeaccess/documents/final_bio_to_interphone.pdf).** The data was later obtained. The coordinators of the Group however dismissed their own results showing a correlation between exposure and non thermal health effects, arguing various bias affected the credibility of their results. The Interphone Group therefore, in its publication, concluded that the results were not significant and did not attach part of their data to their publication. The BioInitiative Group disagreed with the limited interpretation of their own results published by the InterPhone Group (http://www.bioinitiative.org/freeaccess/press_release/docs/Interphone.pdf).

The WHO's *International Agency for Research on Cancer Monograph Working Group* itself affirmed, in the *Lancet Oncology*, that: « *Although both the INTERPHONE study and the Swedish pooled analysis are susceptible to bias—due to recall error and selection for participation—the Working Group concluded that the findings could not be dismissed as reflecting bias alone, and that a causal interpretation between mobile phone RF-EMF exposure and glioma is possible. A similar conclusion was drawn from these two studies for acoustic neuroma, although the case numbers were substantially smaller than for glioma. Additionally, a study from Japan found some evidence of an increased risk for acoustic neuroma*

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associated with ipsilateral mobile phone use. »
 (<http://www.wirelesswatchblog.org/wp-content/uploads/2011/06/Lancet-June-2011-11.pdf>)

Furthermore, Morgan and als stressed that the Interphone study design led to underestimate the health effects of RF. This comment, which I endorsed with many other colleagues, was already filed as Exhibit C-SE-AQLPA-0048, SE-AQLPA-5, Document 15.

39a. These results globally indicate that while localized RF radiation may cause local cancer, leukemia is the cancer of greatest concern with whole body exposure.

40. Additional studies show neurologic, immune, endocrine, reproductive and cardiac, adverse health effects from low-dose, chronic exposure to RF/MW radiation in humans:

- a. Volkow ND, Tomasi D, Wange GJ, Vaska P, Fowler JS, Teland F, Alexoff D, Logan J and Wong C. Effects of cell phone radiofrequency signal exposure on brain glucose metabolism. JAMA 305 : 808-814 : 2011. In healthy participants and compared with no exposure, 50-minute cell phone exposure was associated with increased brain glucose metabolism in the region closest to the antenna. This shows direct effects of RF radiation on the brain with cell phone use.
- b. McCarty DE, Carrubba S, Chesson AL, Frilor C, Gonzalex-Toledo E and Marino AA. Electromagnetic hypersensitivity : Evidence for a novel nuerological syndrome. Internat J Neurosci 121 : 670-676 : 2011. In a female physician who is electrosensitive, blinded application of EMFs triggered temporal pain, headache, muscle twitching and skipped heartbeats within 100 s of field application. This study was already filed in the present case as Exhibit C-SE-AQLPA-0037, SE-AQLPA-5, Doc. 5.
- c. Papageorgiou CC, Hountala CD, Maganioti AE, Kyprianou MA, Rabavilas AD, Papadimitriou GN, Capsalis CN. Effects of WI-FI signals on the p300 component of event-related potentials during an auditory hayling task. J Integr Neurosci 2011 Jun;10(2):189-202. This study concludes that WI-FI exposure may exert gender-related alterations on neural activity.
- d. Altpeter ES, Roosli M et al. Effect of Short-wave magnetic fields on sleep quality and melatonin cycle in humans: The Schwarzenburg shut-down study. Bioelectromagnetics 27:142-150, 2006. Sleep quality improved and melatonin excretion increased when the transmitter was shut down.

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- e. Abelin T et al. Sleep disturbances in the vicinity of the short-wave broadcast transmitter Schwarzenburg. *Somnologie* 9:203-209, 2005. There is strong evidence of a causal relationship between operation of a short-wave radio transmitter and sleep disturbances in the surrounding population.
- f. Hutter HP et al. Subjective symptoms, sleeping problems, and cognitive performance in subjects living near mobile phone base stations. *Occup Environ Med* 2006;63:307-313, 2006. There was a significant relation of some symptoms, especially headaches, to measured power density, as well as effects on wellbeing and performance.
- g. Preece AW, Georgious AG, Duunn EJ, Farrow SC. *Occup Environ Med* 2007 64:402-8. Compared to control village, there were highly significant differences in the reporting of migraine, headache and dizziness military and cell phone antenna systems.
- h. Robertson HA et al. Low-frequency pulsed electromagnetic field exposure can alter neuroprocessing in humans *J. R. Soc. Interface* (2010) 7, 467–473 doi:10.1098/rsif.2009.0205. A functional magnetic resonance imaging study demonstrated how the neuromodulation effect of extremely low-frequency magnetic fields influences the processing of acute thermal pain. The study concludes that magnetoreception may be more common than presently thought. This study was already filed in the present case as Exhibit C-SE-AQLPA-0043, SE-AQLPA-5, Document 10.
- i. Buchner K, Eger, H. Changes of clinically important neurotransmitters under the influence of modulated RF fields – a long-term study under real-life conditions. *Umwelt-Medizin-Gesellschaft* 24(1):44-57, 2011. There is clear evidence of health-relevant effects, including increase in adrenaline/noradrenaline, subsequent decrease in dopamine from a new MWemitting base station. During counterregulation, trace amine PEA decreased and remained decreased. Clinically documented increases in sleep problems, cephalgia, vertigo, concentration problems and allergies followed the onset of new microwave transmissions.
- j. Eliyahu I, Luria R, Hareuveny R, Margaliot M, Neiran N and Shani G. Effects of radiofrequency radiation emitted by cellular telephones on the cognitive functions of humans. *Bioelectromagnetics* 27: 119-126: 2006. A total of 36 human subjects were exposed to PM MW and were tested on four distinct cognitive tasks. Exposure to the left side of the brain slows left-hand response time in three of the four tasks.
- k. Barth A, Winker R, Ponocny-Seliger E, Mayrhofer W, Ponocny I, Sauter C and Vana N. *Occup Environ Med* 65: 342-345: 2008. A meta-analysis for

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neurobehavioural effects due to electromagnetic field exposure emitted by GSM mobile phones. The authors looked at 19 studies of cognitive function in cell phone users, and found in the meta-analysis that there is evidence for a decreased reaction time, altered working memory and increased number of errors in exposed persons.

- i. Augner C, Hacker GW, Oberfeld G, Florian M, Hitzl W, Hutter J and Pauser G. Effects of exposure to base station signals on salivary cortisol, alphaamylase and immunoglobulin A. *Biomed Environ Scie* 23: 199-207: 2010. This was a human experimental study with exposure to PM MW radiation wherein immune indicators were monitored after five 50-minute sessions. The researchers found dose-dependent changes in cortisol and alpha-amylase.
- m. Avendano C, Mata A, Sanchez Sarimiento CA and Doncel GF. Use of laptop computers connected to internet through WI-FI decreases human sperm motility and increases sperm DNA fragmentation. *Fert Steril*, 2012, In press. In this study human sperm were exposed to WI-FI from a laptop, and were found to show reduced motility after a 4-hour exposure. The results are consistent with other publications (see Agarwal et al., *Fert Steril* 89: 124-128: 2008) that reported that those who use cell phone regularly have reduced sperm count.
- n. Baste V, Riise T and Moen BE (2008) *Int J Epidemiol* 23: 369-377: 2008. Radiofrequency electromagnetic fields: male infertility and sex ratio of offspring. This is a study of Norwegian Navy personnel chronically exposed to RF fields on the job. The rates of infertility were related to level of exposure in a dose-dependent fashion.

41. Many cellular and animal studies, of which the following are but a few, support conclusions of cancer, genotoxicity, neurotoxicity and other health outcomes from RF/MW radiation.

- a. Sinha R. Chronic non-thermal exposure of modulated 2450 MHz microwave radiation alters thyroid hormones and behavior of male rats. *Int. J. Radiation Biol.* 84:6:505-513, 2008. This study concluded that the radiation was sufficient to alter the levels of thyroid hormone as well as emotional reactivity compared to controls.
- b. Nittby H, Grafstrom G, Tian DP, Malmgren L, Brun A, Persson BRR, Salfor LG and Eberhardt J. *Bioelectromagnetics* 29: 219-232: 2008. This study showed cognitive impairment in rats after long-term exposure to PM MW radiation. This study of rats shows that after 2 hours per week for 55 weeks there was impaired memory for objects in exposed as compared to sham animals.

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- c. Kimmel S et al. Electromagnetic radiation: Influences on honeybees (*Apis mellifera*). A significant difference between non-exposed and fully irradiated bees was the result of the influence of high-frequency PM RF/MW radiation.
 - d. Panagopoulos DJ et al. Bioeffects of mobile telephony radiation in relation to its intensity or distance from the antenna. *Int. J Radiat Biol*, 86;(5):345-357, 2010. The PM MW radiations at 900 and 1800 MHz decreased the reproductive capacity by cell death induction, with an increased bioactivity “window” at 10 $\mu\text{W}/\text{cm}^2$, and still evident down to 1 $\mu\text{W}/\text{cm}^2$.
 - e. Everaert J, Bauwens D. A possible effect of electromagnetic radiation from mobile phone base stations on the number of breeding house sparrow (*passer domesticus*). *Electromagnetic Biology and Medicine*, 26:63-72, 2007. Long-term exposure to higher-level low-intensity PM MW radiation negatively affects the abundance or behavior of House Sparrows in the wild.
 - f. Magras I, Xenos T. RF Radiation-Induced Changes in the Prenatal Development of Mice. *Bioelectromagnetics* 18:455-461, 1997. Near almost 100 TV and FM broadcast transmitters, with exposure levels between 0.168 $\mu\text{W}/\text{cm}^2$ and 1.053 $\mu\text{W}/\text{cm}^2$, found in the more exposed groups testicular damage and decreasing size of litters to irreversible infertility.
 - g. Balmori A. Electromagnetic pollution from phone masts. Effects on wildlife, *Pathophysiology* 2009. This large review of wildlife effects concludes, “pulsed telephony microwave radiation can produce effects on nervous, cardiovascular, immune and reproductive systems,” including damage to the nervous system by altering EEG and changes to the blood-brain barrier, disruption of the circadian rhythms (sleep-wake) by interfering with the pineal gland and hormonal imbalances, changes in heart rate and blood pressure, impairment of health and immunity towards pathogens, weakness, exhaustion, growth problems, problems in building the nest or impaired fertility, embryonic development, hatching percentage, genetic and developmental problems, problems of locomotion, promotion of tumors and more.
- 42.** Exposure thresholds for harmful effects are lowered in human populations and individuals when duration is increased.
- 43.** While nearly all the lower frequency bands have already been allocated by public authorities in developed countries for specific types of radio transmissions, and transmission of ever more information content on any given channel requires greater bandwidth, each new deployment undermines further the integrity of the population’s health. Engineers who design these systems have no training that would qualify them to consider the effects on biologic

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systems, which is why public health scientists need to be called in to policymaking prior to contracting and deployment, not after the fact.

44. The following studies explain the mechanisms of interaction between RF/MW radiation and biologic systems at the cellular level.

- a. The cell membrane recognition process -- which includes signal transduction and 'heat-shock protein' release -- was first discerned by Litovitz and his co-workers at Catholic University of America in the mid-1990s.

Below are a few references that make the point.

- i. Litovitz, T., C. Montrose, et al. (1994). "Superimposing spatially coherent electromagnetic noise inhibits field induced abnormalities in developing chick embryos." *Bioelectromagnetics* 15(2): 105-113.
- ii. DiCarlo, A., J. Farrell, et al. (1998). "A simple experiment to study electromagnetic field effects: Protection induced by short term exposures to 60 Hz magnetic fields." *Bioelectromagnetics* 19(8): 498-500.
- iii. Penafiel, L., T. Litovitz, et al. (1997). "Role of modulation on the effect of microwaves on ornithine decarboxylase activity in L929 cells." *Bioelectromagnetics* 18(2): 132-141.
- iv. Dicarlo, A. L., Michael T. Hargis, L. Miguel Penafiel, Theodore A. Litovitz, A. (1999). "Short-term magnetic field exposures (60Hz) induce protection against ultraviolet radiation damage." *International journal of radiation biology* 75(12): 1541-1549.
- v. Litovitz, T., C. Montrose, et al. (1990). "Amplitude windows and transiently augmented transcription from exposure to electromagnetic fields." *Bioelectromagnetics* 11(4): 297-312.
- vi. Litovitz, T., M. Penafiel, et al. (1997). "The role of temporal sensing in bioelectromagnetic effects." *Bioelectromagnetics* 18(5): 388-395.
- vii. Litovitz, T., L. Penafiel, et al. (1997). "Role of modulation in the effect of microwaves on ornithine decarboxylase activity in L929 cells." *Bioelectromagnetics* 18: 132-141.]

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- viii. Litovitz, T., D. Krause, et al. (1993). "The role of coherence time in the effect of microwaves on ornithine decarboxylase activity." *Bioelectromagnetics* 14(5): 395-403.
- b. Cell membrane reaction is lipid peroxidation.
- i. Serban, M. and V. Ni (1994). "Lipid peroxidation and change of plasma lipids in acute ischemic stroke." *Romanian journal of internal medicine= Revue roumaine de médecine interne* 32(1): 51.
- ii. Vileno, B., S. Jeney, et al. (2010). "Evidence of lipid peroxidation and protein phosphorylation in cells upon oxidative stress photogenerated by fullerenols." *Biophysical chemistry*.
- iii. Maaroufi, K., E. Save, et al. (2011). "Oxidative stress and prevention of the adaptive response to chronic iron overload in the brain of young adult rats exposed to a 150 kilohertz electromagnetic field." *Neuroscience*.
- iv. Nelson, S. K., S. K. Bose, et al. (1994). "The toxicity of high-dose superoxide dismutase suggests that superoxide can both initiate and terminate lipid peroxidation in the reperfused heart." *Free Radical Biology and Medicine* 16(2): 195-200.
- v. Alvarez, J. G. and B. T. Storey (1989). "Role of glutathione peroxidase in protecting mammalian spermatozoa from loss of motility caused by spontaneous lipid peroxidation." *Gamete research* 23(1): 77-90.
- vi. Devasagayam, T., K. Bloor, et al. (2003). "Methods for estimating lipid peroxidation: An analysis of merits and demerits." *Indian journal of biochemistry & biophysics* 40(5): 300-308.
- c. Free-Radical Damage :
- i. Ozgur, E., G. Güler, et al. (2010). "Mobile phone radiation-induced free radical damage in the liver is inhibited by the antioxidants n-acetyl cysteine and epigallocatechin-gallate." *International journal of radiation biology*(00): 1-11.
- ii. Gutteridge, J. and X. C. Fu (1981). "Enhancement of bleomyciniron free radical damage to DNA by antioxidants and their inhibition of lipid peroxidation." *FEBS letters* 123(1): 71.

- d. mRNA :
- i. Yan, J. G., M. Agresti, et al. (2009). "Qualitative Effect on mRNAs of Injury-Associated Proteins by Cell Phone Like Radiation in Rat Facial Nerves. *Electromagnetic Biology and Medicine* 28(4): 383-390.
 - ii. Yan, J. G., M. Agresti, et al. (2008). "Upregulation of specific mRNA levels in rat brain after cell phone exposure." *Electromagnetic Biology and Medicine* 27(2): 147-154.
 - iii. Simbürger, E., A. Stang, et al. (1997). "Expression of connexin43 mRNA in adult rodent brain." *Histochemistry and cell biology* 107(2): 127-137.
 - iv. Chen, J., H. C. He, et al. (2010). "Effects of Pulsed Electromagnetic Fields on the mRNA Expression of RANK and CAII in Ovariectomized Rat Osteoclast-Like Cell." *Connective Tissue Research* 51(1): 1-7.
- e. Epigenetic changes.... environmentally induced genetic change:
- i. Migliore, L. and F. Copped (2009). "Genetics, environmental factors and the emerging role of epigenetics in neurodegenerative diseases." *Mutation Research/Fundamental and Molecular Mechanisms of Mutagenesis* 667(1-2): 82-97.
- f. Micronuclei formation :
- i. Tice, R. R., G. G. Hook, et al. (2002). "Genotoxicity of radiofrequency signals. I. Investigation of DNA damage and micronuclei induction in cultured human blood cells." *Bioelectromagnetics*, 23(2): 113-126.
 - ii. Lerchl, A. (2009). "Comments on "Radiofrequency electromagnetic fields (UMTS, 1,950 MHz) induce genotoxic effects in vitro in human fibroblasts but not in lymphocytes" by Schwarz et al. (*Int Arch Occup Environ Health* 2008: doi: 10.1007/s00420-008-0305-5)." *Int Arch Occup Environ Health* 82(2): 275-278.
 - iii. Vijayalaxmi and T. J. Prihoda (2009). "Genetic damage in mammalian somatic cells exposed to extremely low frequency electro-magnetic fields: a meta-analysis of data from 87 publications (1990-2007)." *Int J Radiat Biol* 85(3): 196-213.

- iv. Sannino, A., M. Sarti, et al. (2009). "Induction of adaptive response in human blood lymphocytes exposed to radiofrequency radiation." *Radiat Res* 171(6): 735-742.

g. DNA repair disruption :

- i. Brusick, D., R. Albertini, et al. (1998). "Genotoxicity of radiofrequency radiation. DNA/Genetox Expert Panel." *Environ Mol Mutagen* 32(1): 1-16.
<http://www.ncbi.nlm.nih.gov/pubmed/9707093> and
[http://onlinelibrary.wiley.com/doi/10.1002/\(SICI\)1098-2280\(1998\)32:1%3C1::AID-EM1%3E3.0.CO;2-Q/abstract;jsessionid=426C74204A95D2EAD8182A0C624B7C3F.d03t04](http://onlinelibrary.wiley.com/doi/10.1002/(SICI)1098-2280(1998)32:1%3C1::AID-EM1%3E3.0.CO;2-Q/abstract;jsessionid=426C74204A95D2EAD8182A0C624B7C3F.d03t04)
- ii. Belyaev, I. Y., E. Markova, et al. (2009). "Microwaves from UMTS/GSM mobile phones induce long-lasting inhibition of 53BP1/gamma-H2AX DNA repair foci in human lymphocytes." *Bioelectromagnetics* 30(2): 129-141.
- iii. Sun, L. X., K. Yao, et al. (2006). "[Effect of acute exposure to microwave from mobile phone on DNA damage and repair of cultured human lens epithelial cells in vitro]." *Zhonghua Lao Dong Wei Sheng Zhi Ye Bing Za Zhi* 24(8): 465-467.

h. Immune response suppression :

- i. Lyle, D. B., P. Schechter, et al. (1983). "Suppression of Tlymphocyte cytotoxicity following exposure to sinusoidally amplitude-modulated fields." *Bioelectromagnetics* 4(3): 281-292.
- ii. Elekes, E., G. Thuroczy, et al. (1996). "Effect on the immune system of mice exposed chronically to 50 Hz amplitude-modulated 2.45 GHz microwaves." *Bioelectromagnetics* 17(3): 246-248.
- iii. Dabala, D., D. Surcel, et al. (2008). "Oxidative and Immune Response in Experimental Exposure to Electromagnetic Fields." *Electromagnetic field, health and environment: proceedings of EHE'07*: 105.
- iv. Surcel, D., D. Dabala, et al. (2009). "Free Radicals, Lipid Peroxidation and Immune Response in Experimental Exposure to Electromagnetic Fields." *Epidemiology* 20(6): S118.

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45. As indicated above, the Quebec Energy Board has asked me to indicate if these research show that RF exposure « *may constitute a risk of serious or irreversible damage to health* ».

The above non-thermal biological effects do indeed constitute a risk serious damage to health.

Furthermore, such damage may be irreversible or reversible only with difficulty. For example, cancer may be reversible if treated early, but its treatment may be extremely invasive on the patient and is not always successful. Treatment for brain cancer may leave permanent neurologic impairment, even if the patient survives. Persistent headache and loss of attention may result in impaired learning in children, with life-long consequences. Neurological impairments such as Alzheimer are not reversible and their progression may only be slowed down in certain cases.

6. THE DIVISION WITHIN THE SCIENTIFIC COMMUNITY AND THE EVOLUTION TOWARDS PRECAUTION AND PRUDENCE

46. The scientific community is divided in its acceptance of the numerous research findings like the above showing a link between RF exposure and non-thermal health effects.

In section 6.1, I will discuss this division within the scientific community and how it affects the standard setting organizations.

In section 6.2, I will examine the recent evolution of various organizations towards the adoption precautionary measures, as a manner of taking into account scientific uncertainty even as the standards on RF exposure remain unchanged at the moment.

6.1 The division within the scientific community

47. The numerous research findings showing a link between RF exposure and non-thermal health effects, as those enumerated above in section 5, are denied by those who believe that RF/MW exposures that do not cause measureable heating cannot have biological effects.

48. Many in the physics and engineering communities indeed assume that RF fields are not supposed to affect biological systems other than by heating, because they do not have sufficient energy to break chemical bonds and create charged particles (ions). Electromagnetic fields at frequencies equal or higher than ultraviolet light (such as x-rays and gamma rays, with short wavelengths and high frequencies) are classified as ionizing radiation because they have sufficient energy to create charged particles (ions) by breaking chemical bonds and cause direct damage to DNA, resulting in mutations. It is well accepted that ionizing radiation can cause nonthermal biological effects including genetic mutations and cancer. Nonionizing radiation on the other hand (with long wavelengths and low frequencies, which includes visible light as well as RF and other frequency bands with common applications) is assumed to have only thermal effects. However this view has been shown to not be correct by studies since the 1970s by an accumulation of epidemiological and laboratory research which had clearly demonstrated biological effects and, indeed, human health hazards, at RF/MW exposures that do not have sufficient energy to directly break chemical bonds.

Medical and biological research findings showing nonionizing radiation having non-thermal biological effects are therefore are therefore considered an anomaly under conventional theory.

As mentioned in the research listed in section 5, the evidence for increased risk of brain tumors, acoustic neuromas and parotid gland tumors in individuals who have used a cell phone

for 10 years or more is consistent, and the tumors occur only on the side of the head where the phone is used. There is also strong and consistent evidence for increased risk of leukemia in individuals who live near to high power AM radio transmission towers.

These demonstrated non-thermal biological effects of RF exposure are however not supposed to exist under conventional physics theory.

49. Standards setting organizations aimed at regulating RF exposure have for a long time been dominated by physicists and engineers, often with close ties with the industry, with few input from biological and medical science. As mentioned later in section 6.2, this has only been recently been evolving.

Standards setting organizations also often explicitly take into account the economic impacts of the standards when faced with scientific uncertainty.

Both because of their training and because of their ties with the industry, members of most of these organizations have been reluctant to take the above biological findings into account into the exposure limits they set. At present, the exposure limits set by FCC and Health Canada as well as those set by various other standard setting organizations are based solely on biological effects resulting from heat.

Furthermore, these limits are based on the incorrect biological assumption that body temperatures must increase at least 1°C to lead to potential biological impacts and the impacts of absorbing RF within the band of the electromagnetic spectrum that smart meters use would only be limited to behavioral disruption. These limits do not take into account the scientific research that show tissue heating may result in many adverse health effects other than “behavioral disruption”. These limits also do not take into account the accepted biological fact that every enzyme system in the body is exquisitely sensitive to temperature and may increase activity by even a fraction of a degree increase in temperature. What is defined as “nonthermal” effect is therefore partly a function of our ability to measure the temperature increase.

50. To understand the seriousness of this Agent of PM RF/MW radiation in interaction with populations and individuals, we need to consider some basic facts in addition to the many relevant and reliable studies above. Shortwave, AM, FM, TV, smart meters and cell phone frequencies are harmful to human health even when at low intensity if exposure is continuous or prolonged.

There are only a few of the many studies of RF/MW radiation infrastructure such as base stations that fail to show adverse effects.

51. Standards setting organizations have until now generally refused to accept epidemiological and laboratory research findings linking RF electromagnetic fields exposure with various non-thermal biological effects, as being inconclusive and requiring further research.

The difficulty stems from the fact that, although links have been demonstrated repeatedly between RF electromagnetic fields exposure and non-thermal biological effects, there is *a lack of a comprehensive biological theory explaining why these effects take place*, and therefore *causality* cannot, at the present time, be demonstrated with certainty.

Also in some cases, experimental results could not be duplicated; in some cases attempts to duplicate results showed negative results or variations in the results. A 126-page list of scientific articles on the subject, which was already filed as Exhibit C-SE-AQLPA-0039, SE-AQLPA-5, Doc. 6, illustrates this, by identifying with the letter P those studies that correlated non thermal health incidences with radiation exposure and with the letter N those that not find such correlation. Several of the scientific articles and reports quoted in the present report also comment both on research showing positive results and on research showing negative results.

The coexistence of positive and negative findings is a normal part of the research process; they both indicate that biological systems are complex and that different variables need to be isolated in order to fully understand these systems. Research is still needed in order to determine to what extent non-thermal biological effects may vary with frequency, with modulation and depend on the pulsed (instead of continuous) character of RF emissions. Emissions from smart meters are pulsed and a recent study by Mc Carty et al has shown that certain symptoms may be caused primarily by field transitions (off-on, on-off) rather than the presence of the field itself (This research was already filed as Exhibit C-SE-AQLPA-0037 and is mentioned in section 5 of the present report). There also may be variance between the levels of reaction of different subjects for reasons that still remain to be explained. This is what the research process is about. **In biology and medicine there is nothing that is 100 % proven; our understanding of various illnesses such as cancer and Alzheimer for example is still largely incomplete. We rely on statistical significance and weight of evidence and, therefore, on judgment, when drawing conclusions about health effects.**

Standard setting organizations have so far however generally been reluctant to take into account biological findings showing positive results.

52. For instance, the FCC-appointed guideline-setting Commission, ASTM-IEEE, in 1991 referred in its conclusions to RF/MW radiation, the Agent, as a 'Hazard,' specifically setting a 'Hazard Threshold.'

It had however been discovered that, even amongst the 120 studies chosen by the Committee to prove the validity of its Hazard Threshold, there were 15 studies that concluded adverse effects at levels lower than the Hazard Threshold, thus disproving its validity. Three of these

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studies actually showed adverse effects at less than 10 percent of the Hazard Threshold. FCC did not take those into consideration when setting its guidelines.

53. Industry also largely controls the funding of research in this matter, which represents an additional difficulty.

Anke Huss, Matthias Egger, Kerstin Hug, Karin Huwiler-Müntener and Martin Röösl, in Source of Funding and Results of Studies of Health Effects of Mobile Phone Use: Systematic Review of Experimental Studies, Environmental Health Perspectives Vol.115 No. 1 January 2007 <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1797826/pdf/ehp0115-000001.pdf> addressed the concern as to whether the source of funding of studies of the effects of low-level radiofrequency radiation was associated with the results of studies. They conducted a systematic review of studies of controlled exposure to radiofrequency radiation with health-related outcomes (electroencephalogram, cognitive or cardiovascular function, hormone levels, symptoms, and subjective well-being). They examined that studies funded exclusively by industry were least likely to report a statistically significant result: The odds ratio was 0.11 (95% confidence interval, 0.02–0.78), compared with studies funded by public agencies or charities. This finding was not materially altered in analyses adjusted for the number of outcomes reported, study quality, and other factors. They arrived at the following conclusion :

The National Radiological Protection Board (NRPB 2004) reviewed studies of health effects from radiofrequency (RF) fields and concluded that “scientific evidence regarding effects of RF field exposure from mobile phones on human brain activity and cognitive function ... has included results both supporting and against the hypothesis of an effect.” We found that the source of funding explains some of the heterogeneity in the results from different studies. The association was robust and little affected by potential confounding factors such as sample size, study design, or quality.

They recommend that the interpretation of results from studies of health effects of radiofrequency radiation should take sponsorship into account.

In 2012, the *Union of Concerned Scientists (UCS)* also has published a major report stressing the influence industry sponsors may have in influencing research subjects, research protocols and study design, withholding publication of results or preventing continuation of studies.

6.2 The evolution towards Precaution and Prudence

54. In 2007, the *BioInitiative Report*, to which I participated, was aimed at « *restoring the balance* », by providing a more comprehensive review of the scientific research available, including those research that demonstrated a link between RF exposure and non-thermal biological effects, research that standard setting organizations were failing to properly take into account.

55. Generally speaking, standards setting organizations have not modified their standards on RF exposure subsequent to the *BioInitiative Report* and have expressed the view it was inconclusive. Earlier criticisms of the *BioInitiative Report* have also reproached this review to place too much emphasis on the research that showed positive results and less on those that showed negative results (See: **COMAR Technical Information Statement**, http://www.emfandhealth.com/12265_COMAR_2009.pdf) - We answer to this criticism by referring to the context that the *BioInitiative report* was aimed at « *restoring the balance* » on these research.

What we have seen however in the past few years is an evolution of decision makers towards the application of the *Precautionary Principle*, as a manner of integrating scientific research that links RF exposure to non thermal biological effects, without modifying the standards at the moment.

This evolution towards the application of the *Precautionary Principle* intervenes as further research results continue to become available that confirm these links RF exposure to non thermal biological effects.

These new research were helped in part by the review of earlier scientific literature provided by the *BioInitiative report*.

As mentioned earlier, the public health chapter from the *BioInitiative report* was subsequently published in a peer-reviewed journal, *Reviews on Environmental Health*, and it and other chapters of the *Report* were published in the peer-reviewed journal, *Pathophysiology*. The *BioInitiative Report's* « *Preface* », « *Summary for the Public* » and *Synthesis of Conclusions* are filed in the present case as Exhibit C-SE-AQLPA-0076, SE-AQLPA-7, Doc. 5 and that Report is further discussed in section 8 of this present report. The full Report can be accessed at www.bioinitiative.org. The corresponding peer-reviewed scientific articles published in *Pathophysiology* can also be obtained at <http://www.sciencedirect.com/science/journal/09284680/16/2-3>.

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Furthermore, new meta-analysis strengthen the observations that links between RF exposure and non thermal biological effects do exist. Among others, we mentioned in section 5 the following :

- a. Hardell L, Carlberg M, Soderqvist F and Mild KH. Meta-analysis of long-term mobile phone use and the association with brain tumours. *Internat J Oncology* 12 : 1097-1103. In ten studies of glioma, cell phone use for more than ten year gave an OR of 1.2 (95%CI=0.8-1.9). For ipsilateral cell phone use for more than 10 year the OR = 2.0 (1.2-3.4). There was also a significant relation for acoustic neuroma and ipsilateral cell phone use for ten years or more, but no relation for meningioma.
- b. Myung SK, Ju W, McDonnell DD, Lee YJ, Ksazinet G, Cheng CT and Moskowitz JM. Mobile phone use and risk of tumors : A meta-Analysis. *J Clin Oncology* 10.1200/JCO.2008.21.6366. Reviewed 465 publications that reported on 12344 cases of cancer and 25572 controls. Risk of developing brain cancer was OR+1.8 for more than ten years use.
- c. Barth A, Winker R, Ponocny-Seliger E, Mayrhofer W, Ponocny I, Sauter C and Vana N. *Occup Environ Med* 65: 342-345: 2008. A meta-analysis for neurobehavioural effects due to electromagnetic field exposure emitted by GSM mobile phones. The authors looked at 19 studies of cognitive function in cell phone users, and found in the meta-analysis that there is evidence for a decreased reaction time, altered working memory and increased number of errors in exposed persons.
- d. Vijayalaxmi and T. J. Prihoda (2009). "Genetic damage in mammalian somatic cells exposed to extremely low frequency electro-magnetic fields: a meta-analysis of data from 87 publications (1990-2007)." *Int J Radiat Biol* 85(3): 196-213.

56. Medical and biological experts have started to become more present in various international or national organizations aimed at issuing standards or recommendations.

Standard organizations are starting to become more aware as to the need of ensuring independence of their committee members as well as public representation.

As Maisch (2001) mentioned in *Radiofrequency/Microwave Radiation and the International Agency for Research on Cancer (IARC). The problem of conflict of interest & commercial influence in WHO agencies and the need for public interest representation*, http://www.next-up.org/pdf/who_conflict.pdf , « the IARC requirements (pre 2005) for handling conflict of interest were revised and made more transparent as a direct result of a series of critical articles published in *The Lancet Oncology* and *The Lancet* in 2003 that questioned the credibility of the IARC. Among a number of concerns, the articles highlighted concerns about “the inappropriate

*influence of invited specialists who had links to industry". As a result of the concerns, The Lancet introduced the Policy Watch section that summarized the key findings of every IARC Monograph meeting up to 12 months before the corresponding Monograph was published. As a result of this 'surveillance' of the IARC Monograph process, by 2005 IARC had revised its conflict of interest policy in line with the Lancet's Policy Watch (Collingridge, D., Increased transparency in IARC Monograph programme, *The Lancet Oncology*, Vol. 6, October 2005. [http://www.thelancet.com/journals/lanonc/article/PIIS1470-2045\(05\)70364-8/fulltext](http://www.thelancet.com/journals/lanonc/article/PIIS1470-2045(05)70364-8/fulltext) , Accessed May 3, 2011.). »*

Maisch however contended that inappropriate influence of invited specialists who had links to industry in IARC meetings was still a major issue that needed to be addressed. In his article, he specifically mentioned Dr. Michel Plante of Hydro-Quebec as one of those problematic invited participants that had links with the industry.

57. As early as of 1990, the US Environmental Protection Agency ("EPA") had determined RF/MW radiation a "probable carcinogen".

During that period, reputed author Paul Brodeur created a stir by the publication of a series of articles alleging a cover-up of serious human health effects.

58. In 2011 the World Health Organization's International Agency for Research on Cancer (WHO-IARC) identified RF radiation as a possible human carcinogen.

59. The *American Academy of Environmental Medicine* recently issued a position paper on « Electromagnetic and radiofrequency field effect on human health » and made the following specific recommendations :

- a. An immediate caution on smart meter installation due to potentially harmful RF exposure.
- b. Accommodation for health considerations regarding EMF and RF exposure, including exposure to wireless smart meter technology.
- c. Recognition that electromagnetic hypersensitivity is a growing problem worldwide and
- d. Use of safer technology, including for smart meters, such as hard-wiring, fiber optics or other non-harmful methods of data transmission.

A summarized statement resolved by the *American Academy of Environmental Medicine* was already filed in the present case as Exhibit C-SE-AQLPA-0045, SE-AQLPA-5, Document 12.

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60. Although the existing standards are not being changed, the Parliamentary Assemblies of the European Community and of the Council of Europe both have issued recommendations in favor of a more cautious approach towards RF exposure, referring to the *BioInitiative Report*.

60a. In 2010, the 2008-2009 Annual Report of the U.S. President's Cancer Panel stated that :

Sharp controversy exists in the scientific community as to possible adverse health effects from exposure to low frequency electromagnetic energy. The use of cell phones and other wireless technology is of great concern, particularly since these devices are being used regularly by ever larger and younger segments of the population. At this time, there is no evidence to support a link between cell phone use and cancer. However, the research on cancer and other disease risk among long-term and heavy users of contemporary wireless devices is extremely limited. Similarly, current and potential harms from extremely low frequency radiation are unclear and require further study. (Executive Summary, page iv, Underlined by us)

More generally, the President's Cancer Panel affirmed that:

The prevailing regulatory approach in the United States is reactionary rather than precautionary. That is, instead of taking preventive action when uncertainty exists about the potential harm a chemical or other environmental contaminant may cause, a hazard must be incontrovertibly demonstrated before action to ameliorate it is initiated. [...]

U.S. regulation of environmental contaminants is rendered ineffective by five major problems: (1) inadequate funding and insufficient staffing, (2) fragmented and overlapping authorities coupled with uneven and decentralized enforcement, (3) excessive regulatory complexity, (4) weak laws and regulations, and (5) undue industry influence. Too often, these factors, either singly or in combination, result in agency dysfunction and a lack of will to identify and remove hazards. (Executive Summary, page iii, Underlined by us)

Industry has exploited regulatory weaknesses, such as government's reactionary (rather than precautionary) approach to regulation. (Executive Summary, page viii, Underlined by us)

The President's Cancer Panel issued a call for precautionary action :

At this time, we do not know how much environmental exposures influence cancer risk and related immune and endocrine dysfunction.

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Environmental contamination varies greatly by type and magnitude across the nation, and the lifetime effects of exposure to combinations of chemicals and other agents are largely unstudied. Similarly, the cancer impact of exposures during key “windows of vulnerability” such as the prenatal period, early life, and puberty are not well understood. Nonetheless, while these diverse effects often are difficult to quantify with existing technologies and research methods, in a great many instances, **we know enough to act.**

The Nation Needs a Comprehensive, Cohesive Policy Agenda Regarding Environmental Contaminants and Protection of Human Health.

Environmental health, including cancer risk, has been largely excluded from overall national policy on protecting and improving the health of Americans. It is more effective to prevent disease than to treat it, but cancer prevention efforts have focused narrowly on smoking, other lifestyle behaviors, and chemopreventive interventions. **Scientific evidence on individual and multiple environmental exposure effects on disease initiation and outcomes, and consequent health system and societal costs, are not being adequately integrated into national policy decisions and strategies for disease prevention, health care access, and health system reform.**

Children Are at Special Risk for Cancer Due to Environmental Contaminants and Should Be Protected.

Opportunities for eliminating or minimizing cancer-causing and cancer-promoting environmental exposures must be acted upon to protect all Americans, but especially children. They are at special risk due to their smaller body mass and rapid physical development, both of which magnify their vulnerability to known or suspected carcinogens, including radiation. Numerous environmental contaminants can cross the placental barrier; to a disturbing extent, babies are born “pre-polluted.” Children also can be harmed by genetic or other damage resulting from environmental exposures sustained by the mother (and in some cases, the father). **There is a critical lack of knowledge and appreciation of environmental threats to children’s health and a severe shortage of researchers and clinicians trained in children’s environmental health.**

Continued Epidemiologic and Other Environmental Cancer Research Is Needed.

[...] Meaningful measurement and assessment of the cancer risk associated with many environmental exposures are hampered by a lack of accurate

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measurement tools and methodologies. This is particularly true regarding cumulative exposure to specific established or possible carcinogens, gene-environment interactions, emerging technologies, and the effects of multiple agent exposures. [...]

Support for large, longitudinal studies to clarify the nature and magnitude of cancer risk attributable to environmental contaminants must continue.

The capacity to collect biologic samples at the inception of studies is essential; even if current technologies do not allow these samples to be fully utilized at this time, it must be assumed that such technologies will evolve and enable use of collected biosamples to provide essential study baseline data. Personal health data privacy issues that currently limit research access to data and biosamples will need to be addressed. (Executive Summary, page vi-viii, Underlined by us)

The principal recommendations of the *President's Cancer Panel* are consequently the following :

1. *A precautionary, prevention-oriented approach should replace current reactionary approaches to environmental contaminants in which human harm must be proven before action is taken to reduce or eliminate exposure.*

11. *Public health messages should be developed and disseminated to raise awareness of environmental risks and encourage people to reduce or eliminate exposures whenever possible.*

S1. *It is vitally important to recognize that children are far more susceptible to damage from environmental carcinogens and endocrine-disrupting compounds than adults.*

S3. *Adults and children can reduce their exposure to electromagnetic energy by wearing a headset when using a cell phone, texting instead of calling, and keeping calls brief.*

S7. *Each person can become an active voice in his or her community. To a greater than many realize, individuals have the power to affect public policy by letting policymakers know that they strongly support environmental cancer research and measures that will reduce or remove from the environment toxics that are known or suspected carcinogens [...].*

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The *President's Cancer Panel* also recommends additional funding for research and further development of scientific tools and methods :

5. [...] Methods for long-term monitoring and quantification of electromagnetic energy exposures related to cell phones and wireless technologies are urgently needed given the escalating use of these devices by larger and younger segments of the population and the higher radiofrequencies newer devices produce.

Excerpts from the *Presidential Cancer Panel's Report* are filed in the present case as Exhibit C-SE-AQLPA-0077, SE-AQLPA-7, Doc. 6; that Report was further discussed in sections 9 and 33 of this present report.

61. The World Health Organization's International Agency for Research on Cancer (WHO-IARC)'s 2011 classification of RF radiation as a possible human carcinogen itself opens the door to a more prudent approach even when the existing standards are met.

62. Other national or local organizations have also recommended prudence in various countries.

As an example, Health Canada, although it did not change its standards solely based on health effects, has recommended prudence in RF exposure in the following terms in a memo issued in October 2011 (http://www.hc-sc.gc.ca/ahc-asc/media/advisories-avis/2011/2011_131-eng.php), even when its own existing standards are met :

The International Agency for Research on Cancer's (IARC) recent classification of RF energy as "possibly carcinogenic to humans" is an acknowledgement that limited data exists that suggests RF energy might cause cancer. At present, the scientific evidence is far from conclusive and more research is required.

Health Canada reminds cell phone users that they can take practical measures to reduce RF exposure. The department also encourages parents to reduce their children's RF exposure from cell phones since children are typically more sensitive to a variety of environmental agents. As well, there is currently a lack of scientific information regarding the potential health impacts of cell phones on children.

What consumers can do:

- Limit the length of cell phone calls
- Replace cell phone calls with text messages or use "hands-free" devices
- Encourage children under the age of 18 to limit their cell phone usage

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62a. On April 25, 2012, the British independent Advisory Group on Non-ionising Radiation (AGNIR), commissioned by the British Health Protection Agency (HPA) arrived at the conclusion that there was still no « *convincing evidence* » that RF field exposures below guideline levels cause health effects in adults or children. Nevertheless, the British Health Protection Agency (HPA) notes that « *AGNIR considers there are still limitations to the published research that preclude a definitive judgment. In particular, AGNIR refers to possible effects on the electroencephalogram (recorded electrical signals from the brain) that have been reported at exposure levels similar to the highest ones that can occur when using mobile phones. AGNIR cautions that these effects have not been conclusively established, and considers it is unclear whether they would have any health consequences.* ».

The British Health Protection Agency (HPA) also notes that « *AGNIR concludes that, although some positive findings have been reported in a few studies, overall the evidence does not suggest that using mobile phones causes brain tumours or any other type of cancer. The data, however, are essentially restricted to periods of less than 15 years from first exposure because mobile phones have only been in widespread use for that long. AGNIR considers it will be important to continue monitoring the evidence over the coming years, including that from national brain tumour trends, which have so far given no indication of any risk* » in AGNIR's view.

The British Health Protection Agency (HPA) reminds that a previous UK's Independent Expert Group on Mobile Phones (IEGMP) recommended a precautionary approach to mobile phone technologies (the Stewart Report), a recommendation that HPA had accepted. HPA concludes on April 25, 2012 that « *the continuing possibility of: (a) biological effects, although not apparently harmful, occurring at exposure levels within the ICNIRP guidelines, and (b) the limited information regarding cancer effects in the long term, together support continuation of the UK's long-standing precautionary approach to mobile phones. While technology has developed substantially over the ten years since the IEGMP report, the principles behind the IEGMP recommendations should continue to be observed. Excessive use of mobile phones by children should be discouraged, while adults should make their own choices as to whether they wish to reduce their exposures, but be enabled to do this from an informed position.// Measures that could be taken to reduce exposures were described in the IEGMP report and in the subsequent Mobile Phones and Health 2004 report, but the technology continues to develop, which alters the options available. Moving the phone away from the body, as when texting, results in very much lower exposures than if a phone is held to the head. Also, the use of the more recent 3G mode of transmission instead of the older 2G mode will produce much lower exposures. Other options to reduce exposure include using hands-free kits, keeping calls short, making calls where the network signals.* »

The British Health Protection Agency (HPA)'s April 25, 2012 statement is available at http://www.hpa.org.uk/webw/HPAweb&HPAwebStandard/HPAweb_C/1317133825459.

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The initial IEGMP Report (Stewart Report) is available at : www.iegmp.org.uk.

The AGNIR Report of 2012 which led the British *Health Protection Agency (HPA)*'s to nevertheless maintain a precautionary approach is available at : http://www.hpa.org.uk/webc/HPAwebFile/HPAweb_C/1317133827077 .

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63. In the *BioInitiative Report*, we had recommended, as a precautionary or prudent measure, to limit RF exposure to a maximal power density of 1000 $\mu\text{W}/\text{m}^2$ outside and 100 $\mu\text{W}/\text{m}^2$ inside, even though there is no certainty of a complete absence of risk even under these limits, pending further research. These limits were therefore a reasonable assessment, given the possible risks already identified by current research.

Meeting these precautionary or prudent limits may be accomplished even as the existing standards remain unchanged for the moment. As further discussed, precautionary or prudent measures are, by definition, additional to existing standards as a means for managing scientific uncertainty or as interim measures during the process that could lead, in the future, in changing the standards.

These recommendations are the result of several scientific observations including those mentioned in the following graphs :

Cell Phone Frequency Studies Reporting Bioeffects and Adverse Health Effects Below FCC Safety Limits (Power Density)

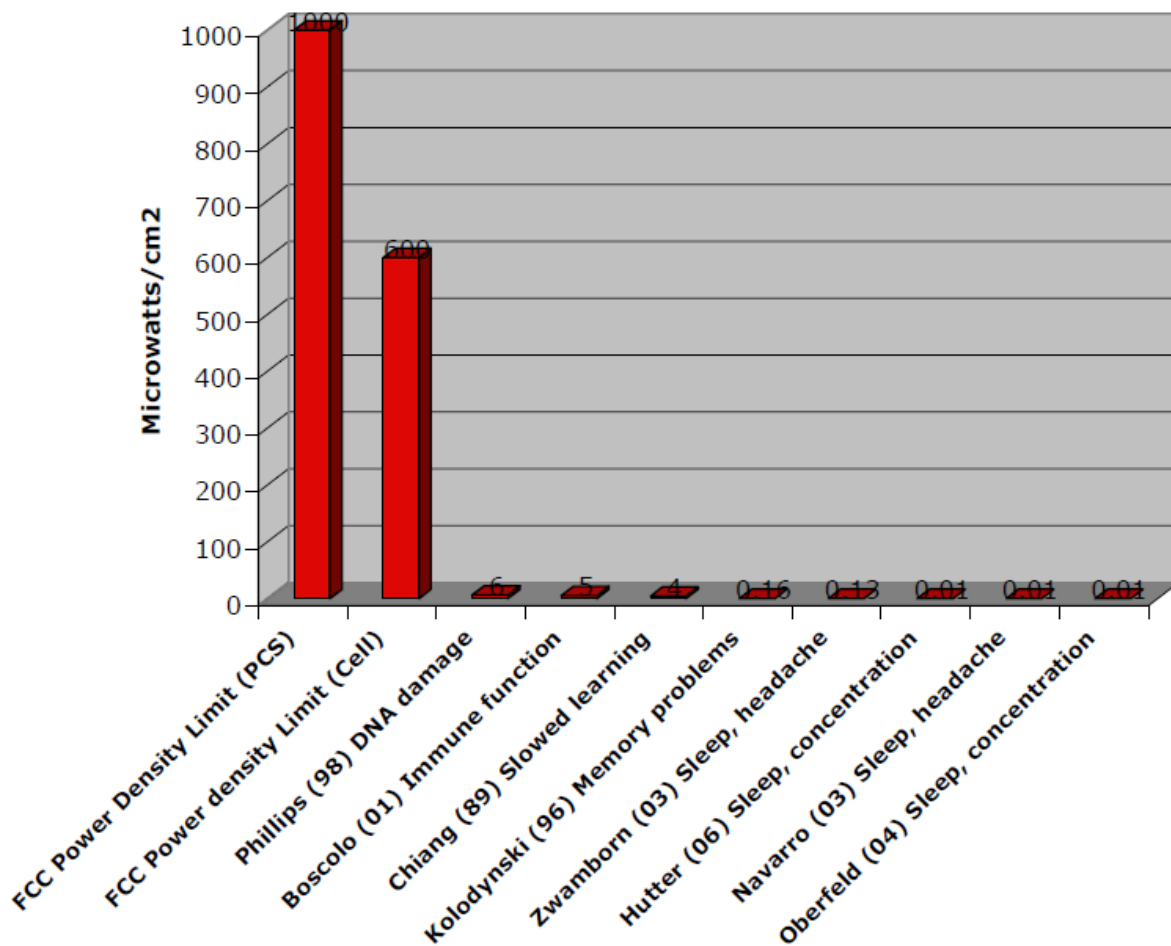


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SAR Studies at Cell Phone Frequencies Reporting Bioeffects and Adverse Health Effects Below FCC Safety Limits

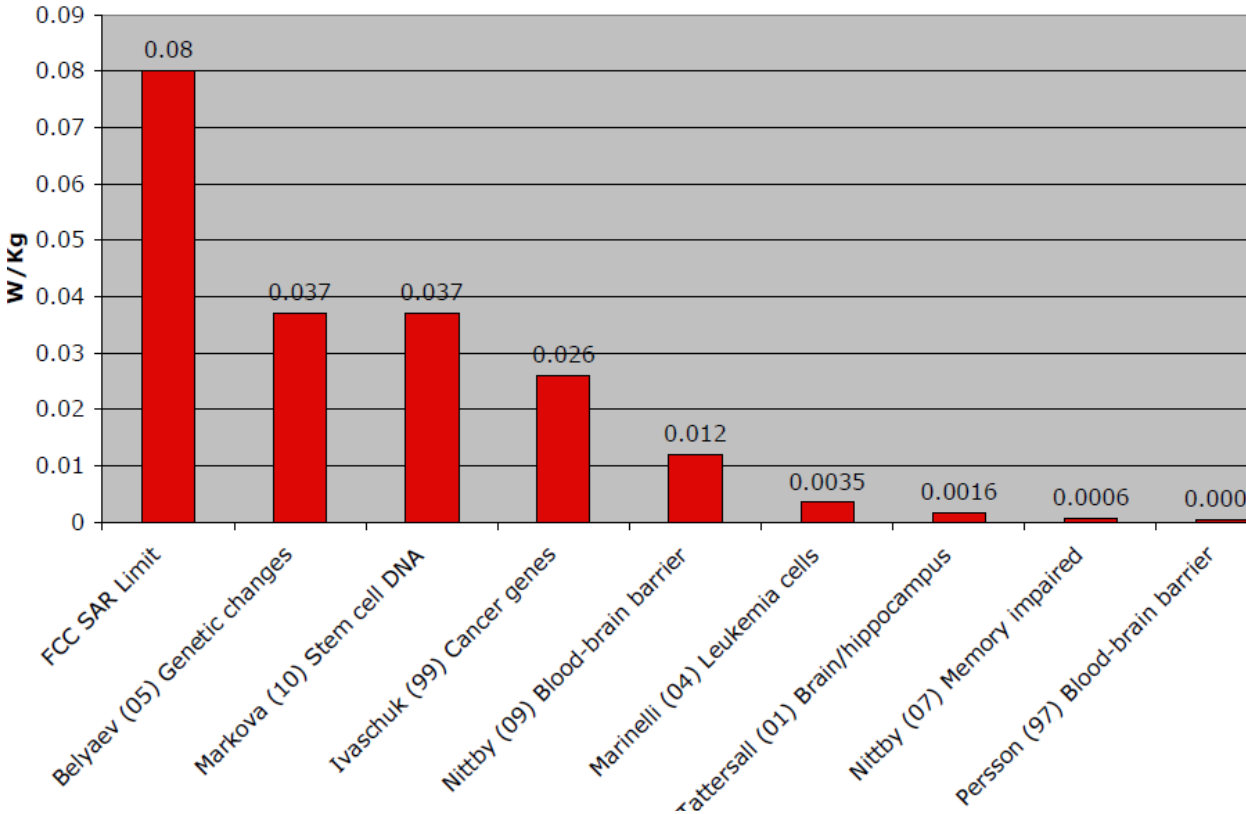
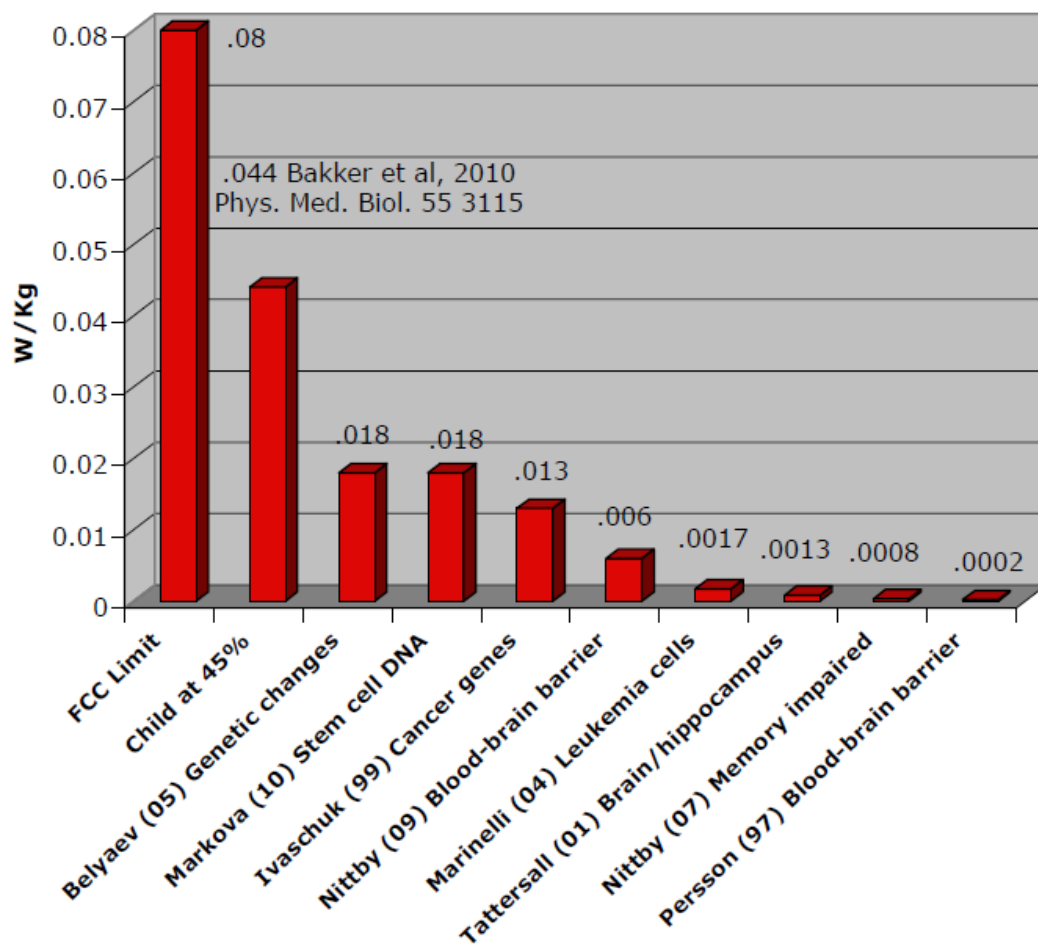


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SAR Studies at Cell Phone Frequencies Reporting Bioeffects and Adverse Health Effects (Children absorb 45% more RF)



64. In the history of public health, there are numerous examples of the serious consequences that were incurred as a result of officials' omission to take proper precautionary measures after initial scientific observations showed early warning. See a major review in : Late lessons from early warnings: the precautionary principle 1896-2000, published by the EEA (European Environment Agency), http://www.eea.europa.eu/publications/environmental_issue_report_2001_22.

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65. In its *Draft Precautionary Framework for Public Health Protection* of 2003 (http://www.who.int/peh-emf/meetings/archive/Precaution_Draft_2May.pdf), the World Health Organization insists (on page 4) that precautionary measures are not aimed at becoming a substitute for standard setting. Standards must be set on scientific certainty or consensus, while precautionary measures manage uncertainty.

According to the *Draft Precautionary Framework* of the World Health Organization (which refers, on this, to the European Commission Communication on “The Precautionary Principle”, February 2000, http://europa.eu.int/eur-lex/en/com/cnc/2000/com2000_0001en01.pdf), when an uncertainty or a risk is identified, the option selected as a precautionary measure should be a) proportional to the desired level of protection, b) non-discriminatory in its application, c) consistent with the measures already adopted in similar circumstances or using similar approaches, d) based on an examination of the potential benefits and costs of action or lack of action (including where appropriate and feasible, an economic cost/benefit analysis), e) subject of review, in the light of subsequent scientific data and f) when possible, assign responsibilities for collecting such new scientific data.

The *Draft Precautionary Framework* of the World Health Organization is filed as an annex to the present report (Exhibit C-SE-AQLPA-0066, SE-AQLPA-7, Document 2).

66. In its March 2000 *Backgrounder on Electromagnetic Fields and Public Health* (http://www.who.int/docstore/peh-emf/publications/facts_press/EMF-Precaution.htm), the World Health Organization had also developed the notion that precautionary measures are of a different nature than standards, the former being a form of uncertainty or risk management. In addition to the notion of Precautionary Principles, it accepted the lesser notion of Prudent Avoidance, being defined as taking simple, easily achievable and low cost avoidance measures, even in the absence of a demonstrable risk. On the Precautionary Principle itself, the Backgrounder also referred to the February 2000 European Commission guidelines mentioned above.

The World Health Organization *Backgrounder on Electromagnetic Fields and Public Health* is filed as an annex to the present report (Exhibit C-SE-AQLPA-0067, SE-AQLPA-7, Document 3).

67. In 2003, the Canadian government issued a *Framework for the application of precaution in science-based decision making about risk* (<http://www.pco-bcp.gc.ca/docs/information/publications/precaution/Precaution-eng.pdf>), which referred to similar principles.

The *Framework* identified five *General Principles of Application of Precaution* :

Exhibit SE-AQLPA-7 - Document 1.1

The state of scientific research as to whether advanced meters transmitting by radiofrequencies, as proposed in the present case, may constitute a risk of serious or irreversible damage to health

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- ❑ The application of precaution is a legitimate and distinctive decision-making approach within risk management
- ❑ It is legitimate that decisions be guided by society's chosen level of protection against risk.
- ❑ Sound scientific information and its evaluation must be the basis for applying precaution; the scientific information base and responsibility for producing it may shift as knowledge evolves.
- ❑ Mechanisms should exist for re-evaluating the basis for decisions and for providing a transparent process for further consideration.
- ❑ A high degree of transparency, clear accountability and meaningful public involvement are appropriate.

According to this document, the *Precautionary Measures* should be designed around 5 principles :

- ❑ Precautionary measures should be subject to reconsideration, on the basis of the evolution of science, technology and society's chosen level of protection.
- ❑ Precautionary measures should be proportional to the potential severity of the risk being addressed and to society's chosen level of protection.
- ❑ Precautionary measures should be non-discriminatory and consistent with measures taken in similar circumstances.
- ❑ Precautionary measures should be cost-effective, with the goal of generating (i) an overall net benefit for society at least cost, and (ii) efficiency in the choice of measures.
- ❑ Where more than one option reasonably meets the above characteristics, then the least trade-restrictive measure should be applied.

The Canadian government *Framework for the application of precaution in science-based decision making about risk* is filed as an annex to the present report (Exhibit C-SE-AQLPA-0068, SE-AQLPA-7, Document 4).

67a. In application of the Precautionary Principle, in November 2009, an International Scientific Panel on Electromagnetic Field Health Risks issued the following resolution in Seletun, Norway (the Seletun resolution) :

The Seletun Scientific Panel takes note of international scientific reviews, resolutions and recommendations documenting scientific and public health evidence on EMF exposures;

The Seletun Scientific Panel notes that complete “consistency” of study findings is not to be expected, and it should not be interpreted as a necessary precondition for a consensus linking EMF exposure to health impacts. “Consistency in nature does not require that all or even a majority of studies find the same effect. If all studies of lead showed the same relationship between variables, one would be startled, perhaps justifiably suspicious” (Needleman HL. Making models of real world events: the use and abuse of inference. Neurotoxicol Teratol 1995;17: 241-2; discussion 249-51);

The Seletun Scientific Panel acknowledges that some, but not all, of these exposures support preventative and precautionary action, and the need for more stringent public health limits;

The Panel takes note of international scientific resolutions and expressions of concern including the Salzburg, Catania, Freiburger Appeal, Helsinki, Irish Doctors (IDEA), Benevento, Venice, London, and Porto Alegre Resolutions (2000-2009);

The Panel is guided by previously recommended target limits for EMF exposure in the BioInitiative Report (2007) and the London Resolution (2009);

The Panel urges governments to adopt an explicit statement that —the standard for judging and acting on the scientific evidence shall be based on prudent public health planning principles rather than scientific certainty of effect (causal evidence). Actions are warranted based on limited or weak scientific evidence, or a sufficiency of evidence – rather than a conclusive scientific evidence (causation or scientific certainty) where the consequence of doing nothing in the short term may cause irreparable public health harm, where the populations potentially at risk are very large, where there are alternatives without similar risks, or where the exposures are largely involuntary;

The Seletun Scientific Panel urges governments to make explicit that the burden of proof of safety rests with the producers and providers of EMF-producing technologies, not with the users and consumers. [...]

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EMF exposures should be reduced now rather than waiting for proof of harm before acting. This recommendation is in keeping with traditional public health principles, and is justified now given abundant evidence that biological effects and adverse health effects are occurring at exposure levels many orders of magnitude below existing public safety standards around the world; [...]

It is established that the combined effects of chemical toxins and EMF together is greater than either exposure alone;

The Panel encourages 'auto-off switches' for mobiles (cells) and PDAs that automatically turn off the device when placed in a holster;

The Panel strongly discourages the technology that allows one mobile (cell) phone to act as a repeater for other phones within the general area. This can increase exposures to EMF that are unknown to the person whose phone is 'piggy-backed' upon without their knowledge or permission;

The Panel recommends the use of telephone lines (land-lines) or fiber optic cables for SmartGrid type energy conservation infrastructure.

Utilities should choose options that do not create new, community-wide exposures from wireless components of SmartGrid-type projects. Future health risks from prolonged or repetitive wireless exposures of SmartGrid-type systems may be avoided by using telephone lines or fiber-optic cable. The Panel endorses energy conservation but not at the risk of exposing hundreds of millions of families in their homes to a new, involuntary source of wireless radiofrequency radiation.

(Seletun Resolution, already filed as Exhibit C-SE-AQLPA-0044, SE-AQLPA-5, Doc. 11 and as Exhibit C-ACEFO-0027).

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7. PRECAUTIONARY AND PRUDENT MEASURES THAT MAY BE APPLICABLE IN THE CONTEXT OF THE PRESENT CASE

68. As mentioned in section 3, results on Hydro-Quebec's Landis+Gyr proposed meters have showed the following :

- Average power densities measured at 1 m from exterior meters do not exceed the exterior-threshold of $1\,000\ \mu\text{W}/\text{m}^2$ recommended in the *BioInitiative Report*, which is later described in the present report (save for one atypically high result on one meter which later was re-measured and gave a result below the threshold). We do not have any measurements however at a lesser distance from the meter and are informed that a person may approach and even touch the meter, thus could be located as close at 2-3 cm from the meter.
- Inside meter rooms, average power densities far exceed the interior-threshold of $100\ \mu\text{W}/\text{m}^2$ recommended in the *BioInitiative Report* later described in the present report ; it is however expected that these rooms will not normally be accessed by the public. In one case, the average power density at one meter way from such room is shown to exceed the interior-threshold of $100\ \mu\text{W}/\text{m}^2$ but, in the other cases measured, is inferior to that interior-threshold.
- More problematic however are meters situated inside occupied rooms and facing its occupants (meters in a kitchen, etc.), where measurements show the average power density exceeds the interior-threshold of $100\ \mu\text{W}/\text{m}^2$ at 1 m from the meter. We must also keep in mind that we do not have any results at a lesser distance.
- All the above results are inferior to the recommended threshold of $6\,000\,000\ \mu\text{W}/\text{m}^2$ of both FCC and Health Canada. These measurements were however all taken at 1 m or more from the antenna; we do not have any measurements at a lesser distance.

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69. One of the precautionary or prudent measures that could be examined in the present case would consist in using hard wired technology instead of wireless communication in deploying the smart meters. (California Council on Science and Technology's report issued in 2011 under the title "Health Impacts of Radiofrequency from Smart Meters" also envisioned the possibility of deployment of hard-wired smart meters throughout California, but only as a retrofit option to be considered if requirements evolve at a later date. To that, I had answered it would be easier and less costly to install hard-wired smart meters to begin with). It is however not the purpose of my present report to determine if, in view of the costs and benefits of deploying hard-wired smart meters and in view of the extent of the problems identified in the previous section, such option would be appropriate in accordance with the previously-stated guidelines on Precautionary and Prudent Measures.

Alternate precautionary or prudent measures to be examined could also include, among others :

- Deploying hard-wired technology at least in the most problematic cases, such as when the meters are situated inside a residence, facing its occupants or when the more fragile population is involved (children, pregnant women, elderly, persons with illness, etc).
- Moving to the outside those problematic interior meters (or at least moving the antenna outside if feasible).
- Positioning the meters and antennas in order to ensure a proper safety distance, so that both the maximal exposure standards and the *BioInitiative* prudent maximal exposure recommendations are complied with (both inside and outside). As seen earlier, the principal problem to be resolved is with interior meters facing occupants.

As a further alternative, an opting out option may also be considered. But, in some cases, such an option will not resolve the issue, such as when a person is exposed to RF emissions from a meter not his own. An example of this situation occurs when meters from several different clients are collocated inside the apartment of one of them.

Here again, I stress that it is not the purpose of my present report to determine if, in view of their costs and benefits, the above measures would be appropriate in accordance with the previously-stated guidelines on Precautionary and Prudent Measures.

8. CONCLUSIONS

70. It is consequently my opinion that the state of scientific research sufficiently establishes a risk that meters transmitting by radiofrequencies as proposed in the present file by Hydro-Quebec may constitute a risk of serious as well as irreversible damage to health, through biological effects other than those resulting from heat. Some individuals or categories of individuals are more susceptible to injury than others (children, pregnant women, elderly, persons with illness, etc).

Such non thermal effects are reviewed in section 5 of this report.

Therefore, there is justification for examining precautionary or prudent measures that could be applied in addition to the current standards (which are based only on biological effects resulting from heat). Discussion and examples of such possible precautionary or prudent measures are provided in sections 6 and 7 of this report.

Dated this 14th day of May, 2012



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