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Subject: Re: FortisBC AMI Project No. 3698682
Attachments: BC0130124_Isaac.pdf; Email from IJ.pdf
Importance: High

Please find attached the report of Isaac Jamieson upon which we intend to rely in these proceedings. The report is being filed late for reason that the author had technical difficulties with assembly and transmission of the document which was only provided to us today. Attached also is the author's email of January 24, 2013, substantiating the claim of technical difficulties.

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On 2013-01-24, at 5:46 PM, David M. Aaron wrote:

Please find attached my further correspondence of today's date.

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<BCUC12.pdf>

From: Isaac Jamieson <isaac.jamieson@live.co.uk>
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David,

Apologies in taking so long to get back to you. The document I have been putting together got corrupted as it was being finalised, and I have had to stay up for virtually the last two and a half days to repair its chapters, which will now be sent individually. Hope it is still of use.

Please let me know how matters stand.

Best regards, Isaac

with regard to FortisBC Inc. Application for a Certificate of Public Convenience and Necessity for the Advanced Metering Infrastructure Project, Project No.3698682



Comments on Health, Human Rights, Environmental and Security Concerns
With regard to the FortisBC Inc. Application for a Certificate of Public Convenience and Necessity for the
Advanced Metering Infrastructure Project, Project No.3698682

Prepared for

The British Columbia Utilities Commission (BCUC)

This report has been prepared by the author in the full knowledge that it is his duty to assist the BCUC
and not to serve as an advocate for any other party.

The author has acted in conformity with that duty in the preparation of this report and confirms that he
will act in conformity with that duty when giving any oral or written testimony in connection with his
expert opinions.

Prepared by

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24th January 2013

Disclaimer:

The comments on this report are intended to help advance knowledge in the areas discussed and
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1.1 Introduction

It is recognised that health risks may exist with regard to new technologies, and that health impact assessments are required as a matter of best practice.

“Systematic assessment of the health impact of a rapidly changing environment - particularly in areas of technology, work, energy production and urbanization - is essential.” WHO (1986).

1.1.1 The need for health impact assessments on smart meter roll outs

Numerous public health and safety complaints have already arisen worldwide with regard to wireless utility smart meters. The results of an online survey by the EMF Safety Network (which ran from July 13th to September 2nd 2011) are shown below. 78% of respondents were from California, with 93% of them over 40 years old, 43% of them over 60 years old and 73% of them women. 49% of the respondents were said to be ‘electrosensitive’ (Halteman 2011). From the results shown it appears possible that at least some BC citizens’ health may be put at risk as a result of exposure to radiofrequency and microwave emissions from smart meters (Table 1.1).

Table 1.1 Health & Smart Meter safety survey (Halteman 2011)

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

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

Similar symptoms to those shown above have been noted in peer-reviewed research investigating the associations between increased radiofrequency and microwave exposures and health.

As an example, Santini et al. (2002) conducted a questionnaire survey study on 530 individuals (270 men, 260 women) living in the vicinity, or far away from cell phone base stations on 18 non-specific health symptoms. They found a significant ($p < 0.05$) increase in health complaint frequencies from those living in the vicinity of cell phone base stations (as compared to those living > 300 m or not exposed to base station) as follows: till 300 m for tiredness; 200 m for headache, sleep disturbance, discomfort, etc.; 100 m for irritability, depression, dizziness, loss of memory, libido decrease, etc. Women

were shown to complain significantly more often than men ($p < 0.05$) of depression, discomfort, headache, loss of appetite, nausea, sleep disturbance, and visual perturbations.

Those authors stated that “in view of radioprotection, minimal distance of people from cellular phone base stations should not be < 300 m.” Other examples of relationships indicated between health effects and exposure levels below those presently thought safe by many are given below:

1.1.2 Bavarian Study

Eger & Jahn (2010) investigated the possibility of whether a relationship exists between 940 MHz and 1850 MHz RF/microwave radiation exposures and health symptoms. In that work, 251 adults in Selbitz, Bavaria took part in a health survey in 2009 before the data collected was assessed (taking into account the levels of RF/microwave radiation they were exposed to from a base station and DECT phones), as determined by measurements at residential location and questionnaire. The residents were then classified into exposure groups.

Table 1.2 Specific Health Symptoms and RF/microwave radiation (n = 180) (Eger & Jahn 2010).

Comparison of 1.17 V/m & 0.7 V/m exposure groups	<i>p</i>
Sleep problems	0.001 = highly significant
Symptoms of depression	0.001
Headaches	0.001
Cerebral affections	0.001
Concentration difficulties	0.001
Joint problems	0.001
Infections	0.001
Skin problems	0.001
Cardiovascular problems	0.001
Auditory system, Disturbance of equilibrium	0.001
Visual problems	0.001
Gastrointestinal problems	0.001
Dizziness	0.01 = significant
Nosebleeds	0.01

A significant dose-response relationship was often observed in Eger & Jahn (2010)’s work, with many of the symptoms exhibiting a dose-response relationship to RF/microwave exposure similar to those documented by respondents to the EMF Safety Network smart meter survey (Halteman 2011). In Eger & Jahn’s work, 251 adults in Selbitz, Bavaria took part in a health survey in 2009 before the data collected was assessed (taking into account the levels of RF/microwave radiation they were exposed to from base station and DECT phones), as determined by measurements at residential location and questionnaire. The residents were then classified into exposure groups.

Eger & Jahn’s results demonstrate that a significant relationship can exist between individuals’ mean exposure levels and reported health symptoms, including sleep problems. Clear trends were shown for decreasing symptom scores in relation to decreasing mean RF/microwave exposure levels. Such findings would appear to indicate that increasing background RF/microwave radiation, as would occur through the roll out of a RF/microwave AMI structure (and the adoption of smart appliances that communicate wirelessly), may prove detrimental to sleep quality when exposures rise beyond a particular (yet to be determined) threshold.

The QUEBEB study (Berg et al. 2007) also investigated if health symptoms could be associated with RF/microwave exposure levels. It appears that that particular study did not find any significant relationships between exposure and health symptoms because the highest measurement found was 1 V/m, with 99% of the measurements being below 0.34 V/m. Whilst less than 1% of those in the QUEBEB study were exposed to RF/microwave radiation above 0.34 V/m, 82 out of the 251 participants in Eger & Jahn’s study (32.7% of the group) were exposed to fields above 0.7 V/m. “High exposure groups as found in Selbitz did basically not occur in the samples of the German Mobile Phone Programme. To a certain degree, this has to do with the method of random sampling and leads to a systematic underestimation of the risk for population groups with higher exposures,” Eger & Jahn (2010).

Talking about their findings of a dose-response relationship with regard to RF/microwave exposures, Eger & Jahn (2010) declared, "Even if in legal terms, this is not yet proof for an individual-specific evidence of damage, **the presented investigations make it clear that the conclusions drawn by the federal regulation maker ... according to which no health risk is to be expected below [their] exposure limits ... are scientifically and legally unjustifiable.**"

1.1.3 Spanish study

Earlier research in Spain had also shown a relationship between raised microwave exposures and health effects. In that work, Oberfeld et al. (2004) undertook a health survey ($n = 97$) in the vicinity of two GSM 900/1800 MHz cell phone base stations. **The electric field strengths and power densities recorded in the bedrooms assessed were divided into the following tertiles (low exposure 0.02-0.04 V/m (0.0001-0.0004 $\mu\text{W}/\text{cm}^2$), intermediate exposure 0.05-0.22 V/m (0.0006-0.0128 $\mu\text{W}/\text{cm}^2$) and high exposure 0.25-1.29 V/m (0.0165- 0.4400 $\mu\text{W}/\text{cm}^2$).**

All models demonstrated statistically significant associations between measured electric fields in the microwave range and 13 out of 16 health-related symptoms. The adjusted (age, gender, distance) logistic regression model they used showed **statistically significant positive exposure-response associations between electric field strengths and the following variables: cardiovascular problems; loss of appetite; difficulty in concentration; depressive tendency; feeling of discomfort; dizziness; fatigue; headaches; irritability; nausea, loss of memory; sleeping disorder; and visual disorder.** The inclusion of distance, which might be a proxy for the occasionally raised "concerns explanation", did not alter the model substantially.

Table 1. 3 Age, gender and distance adjusted model (Oberfeld et al. 2004).

Health Outcome	0.05-0.22 V/m (0.0006-0.0128 $\mu\text{W}/\text{cm}^2$)			0.25-1.29 V/m (0.0165- 0.4400 $\mu\text{W}/\text{cm}^2$)		
	OR	95%-CI	p	OR	95%-CI	p
Difficulty in Concentration	8.27	2.01 – 34.01	0.0034	19.17	4.91 – 74.77	0.0001
Feeling of Discomfort	4.29	1.14 – 16.15	0.0314	10.90	3.16 – 37.56	0.0007
Sleeping Disorder	10.39	2.43 – 44.42	0.0016	10.61	2.88 – 39.19	0.0008
Irritability	3.12	0.91 – 10.68	0.0704	9.22	2.86 – 29.67	0.0009
Depressive Tendency	39.41	4.02 – 386.40	0.0016	59.39	6.41 – 550.11	0.0016
Loss of Appetite	6.66	0.62 – 71.52	0.1175	27.53	3.07 – 247.03	0.0030
Loss of Memory	2.35	0.62 – 8.89	0.2090	7.81	2.27 – 26.82	0.0031
Headaches	5.99	1.50 – 23.93	0.0113	6.10	1.80 – 20.65	0.0050
Dizziness	2.98	0.62 – 14.20	0.1712	8.36	1.95 – 35.82	0.0117
Visual Disorder	2.48	0.65 – 9.44	0.1830	5.75	1.68 – 19.75	0.0186
Cardiovascular Problems	9.42	0.93 – 95.07	0.0572	17.87	1.96 – 162.76	0.0333
Nausea	5.92	0.60 – 58.68	0.1288	12.80	1.48 – 110.64	0.0499
Skin Disorder	7.04	1.06 – 46.62	0.0429	8.22	1.39 – 48.51	0.0628
Hearing Disorder	3.89	0.99 – 15.21	0.0510	1.63	0.45 – 5.95	0.1285
Gait Difficulties	1.32	0.30 – 5.84	0.7114	2.07	0.57 – 7.50	0.5211

The symptoms associated with increased exposure are in line with those reported by Navarro et al. (2003), Hutter et al. (2002), Santini et al. (2002) and Johnson-Liakouris (1998). Oberfeld et al. (2004) stated that in their own work "The odds ratios are quite high having small p- values. Some kind of selection bias cannot be ruled out, ... but that would affect more or less all cases and therefore affect the odds ratios not substantially. The introduction of the reversed distance to the nearest base station, which might serve as a surrogate for the sometimes claimed "concerns explanation" for health related symptoms attributed to mobile phone base stations, did not alter the odds ratios substantially and the OR associated with the measured electric fields remained at their high level."

Oberfeld et al. (2004) further stated that "the findings of this study might be of great importance for Public Health and should be taken seriously. Further epidemiological studies are warranted but do not preclude measures to reduce microwave exposures ... now. Based on the data of this study the advice would be to strive for levels not higher than 0.02 V/m for the sum total, which is equal to a power density of 0.0001 $\mu\text{W}/\text{cm}^2$..., which is the indoor exposure value for GSM base stations proposed on empirical evidence by the Public Health Office of the Government of Salzburg in

2002 [See also : Website of the Public Health Office, Environmental Health, Government of Salzburg, Austria: www.salzburg.gv.at/umweltmedizin (in German)].

The preceding research of Navarro et al. (2003), conducted by part of the same main group as Oberfeld et al. (2004), had measured the electric field levels in the microwave range in the bedrooms of 97 participants in Spain. Their statistical analysis revealed significantly higher symptom scores in 9 out of 16 symptoms in the group with 0.65 V/m exposure compared to the control group which had an exposure level of 0.2 V/m, both as an average mean. They reported significant correlation coefficients between the measured electric field strengths and fourteen out of sixteen health related symptoms.

1.2 Potential Health Concerns related to smart meters

1.2.1 Cancer

"Cancer is the world's leading cause of death, followed by heart disease and stroke. ... cancer also has the greatest economic impact from premature death and disability of all causes of death worldwide. ... balancing the world's global health agenda to address cancer will not only save millions of lives, but also billions of dollars," ACS (2010).

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

Despite the optimistic reassurances by some, the potential dangers of RF/microwave radiation as related to cancer is recognised by industry. As an examples:

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

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

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

1.2.1.1 Cancer in Canada

According to the Canadian Cancer Society (2012), "Cancer is the leading cause of premature death in Canada ... [It was estimated that an] estimated 186,400 new cases of cancer (excluding about 81,300 non-melanoma skin cancers) and 75,700 deaths [would] occur in Canada in 2012. In 2007, cancer surpassed cardiovascular disease (heart and cerebrovascular) as the leading cause of death in Canada."

“The impact that cancer has on the lives of patients, their families, and the health care system cannot be overstated. The long-term emotional, physical, and psychological strain on individuals diagnosed with cancer—and their families—is profound. ... The cost of cancer care also places a heavy burden on the health care system. One estimate finds that over the next 30 years, 2.4 million workers will get cancer and 872,000 will die from the disease. Meanwhile, **cancer will cost the Canadian economy an estimated \$177.5 billion in direct health care costs, \$199 billion in corporate profits, \$250 billion in taxation revenues, and \$543 billion in wage-based productivity.**” The Conference Board of Canada (2013).

“An estimated 2 out of 5 Canadians is expected to develop cancer during their lifetimes (40% of Canadian women and 45% of men). An estimated 1 out of every 4 Canadians is expected to die from cancer (24% of Canadian women and 29% of men),” Canadian Cancer Society (2012).

1.2.1.2 Radiofrequency and microwave emissions and cancer

Whilst there is growing anecdotal evidence on the effects of RF/microwave emissions from smart meters on health, no proper research appears to have been undertaken to date. As this is the case, examples are given of other studies assessing the possible effects of similar types of radiation on animals and individuals as related to cancers. Whilst a number of studies (including the examples given below) indicate a link between inappropriate exposures to some EMF regimes and negative health effects; it is important to recognise that not all studies do so, and that with proper forethought beneficial field regimes can also be created (Jamieson et al. 2010).

Eger et al. (2004) found increased risk of malignant tumours in individuals exposed to radiation from mobile phone base stations. Their work, covering the period 1999-2004, indicated that after 5 years, risk of malignant blastoma for those in the vicinity of the phone mast was 3 times that of individuals living further away (Eger et al. 2004). (Earlier animal tests by Repacholi et al (1997) found long-term (up to 18 months) intermittent exposure to pulsed 900 MHz fields resulted in significantly enhanced probability of cancer in cancer-prone mice).

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

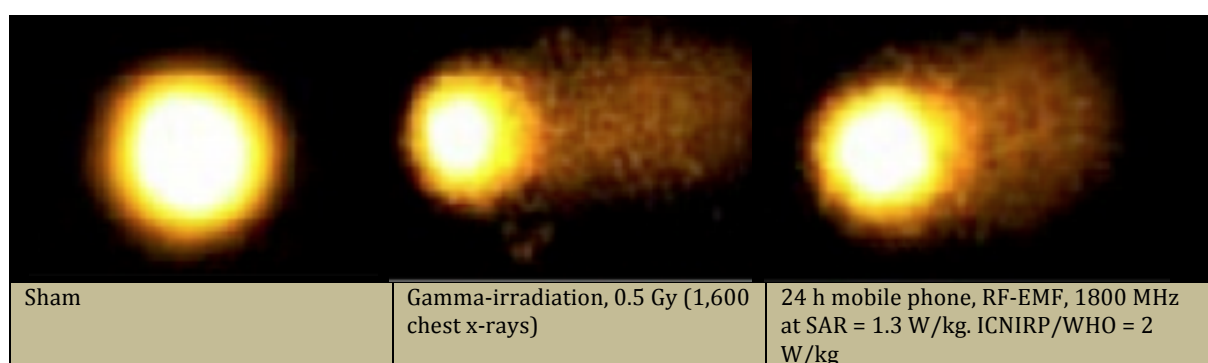


Image source: Adlkofer (2004).

Figure 1.1 Comet Assay - a typical picture after RF-EMF-exposition of HL60 leukaemia cells

RF/microwave exposure - at levels that can be experienced everyday - can cause DNA damage (Figure 1.1), which can be a precursor of cancer (De Iuliis et al. 2009, Adlkofer 2004).

An association has also been noted between increased incidences of childhood leukaemia & mortality through RF/microwave exposures at power densities of $8 \mu\text{W}/\text{cm}^2$ (Hocking et al. 1996); an exposure level lower than that created by some single wireless smart meters, and considerable less than levels being advocated as safe by Health Canada (2009)'s Safety Code 6.

For additional details on studies which indicate that long-term low intensity RF/microwave exposures may provoke cancer growth please refer to the review document by Yakymenko et al. (2011) and also the work of the BioInitiative Working Group (2012).

1.2.2 Alzheimer's disease and other dementias

Worldwide it has been suggested that the rise in Alzheimer's disease and other dementias may be the "Most Significant Health Crisis of the 21st Century." The number of people with dementia is predicted to double by 2030 and more than triple by 2050 (ADI 2010). In 2010 the worldwide costs of dementia were set to exceed 1% of global GDP, at US \$604 billion. "... The costs of caring for people with dementia are likely to rise even faster than the prevalence..." ADI (2010).

Dementia is one of the World's most costly illnesses. Interventive measures, including the creation of improved EMF exposure guidelines (present author's comments), which reduce risk are likely to save Governments' substantial outgoings.

1.2.2.1 Canada's dementia epidemic

"Canada is facing a dementia epidemic and needs to take action now. Approximately 500,000 Canadians have dementia today. It is the most significant cause of disability among Canadians over the age of 65 and it already costs Canadian society many billions of dollars each year. Forecasts show that within 20 years, worldwide prevalence will increase two-fold... Canada too, can expect a several-fold increase in dementia in the coming decades," Alzheimer Society (2010).

"Canada has no plan to cope with the impact of this devastating disease," Alzheimer Society of Canada (2011).

"The predicted surge in dementia cases will certainly overwhelm Canada's health care system unless specific and targeted action is taken. Canada must act now," Richard Nakoneczny, Volunteer President Alzheimer Society of Canada (Alzheimer Society 2010).

1.2.2.2 British Columbia's dementia epidemic

"In British Columbia, more than 70,000 people are living with Alzheimer's disease and other dementias. If nothing is done that figure is expected to more than double to 177,000 British Columbians living with the disease," Alzheimer Society British Columbia (2011).

1.2.2.3 Alzheimer's - diabetes connection

In 2005 it was suggested that Alzheimer's disease could in fact be better categorised as Type 3 diabetes (Steen et al. 2005). As noted by Dr Suzanne M. de la Monte, a neuropathologist and professor of pathology at Brown Medical School, "... *many of the unexplained features of Alzheimer's, such as cell death and tangles in the brain, appear to be linked to abnormalities in insulin signalling. This demonstrates that the disease is most likely a neuroendocrine disorder, or another type of diabetes. ... In the most advanced stage of Alzheimer's, insulin receptors were nearly 80% lower than in a normal brain,*" Dyer (2005).

It is already known that people with adult onset diabetes (Type 2 diabetes) are twice as likely to develop Alzheimer's disease (Alzheimer Society British Columbia 2010). Refer also to section 'Diabetes'.

1.2.2.4 EMFs and dementia

Research in Sweden and the USA has indicated a link between occupational exposures to EMFs and Alzheimer's disease (Davanipour et al. 2007, Feychting et al. 2003, Sobel et al. 1996). It has also been indicated that there is a dose-response link between environmental exposures to EMFs and senile dementia and Alzheimer's disease (Davanipour & Sobel 2009, Huss et al. 2009). [Refer also to Section 13 of the BioInitiative Report 2012 (BioInitiative Working Group 2012) for details of research documenting links between ELF magnetic fields and Alzheimer's disease risk at levels often well below those presently permitted by Health Canada's Safety Code 6 (Health Canada 2009)].

Microwave radiation: Very weak microwave radiation can change the shape of cellular proteins in the brain causing them to clump together into formations that resemble pathological fibrils associated with this disease (MWN 2003). Earlier animal research by Dr Sam Koslov, who was the Director of the Applied Physics Laboratory at John Hopkins University in the US, led him to accidentally discover that exposing chimpanzees to repeated low-level non thermal microwave exposures produced clinical Alzheimer's disease - lack of funding prevented his findings being followed up at that time (Becker 1990).

1.2.2.5 Alzheimer's disease and the extracellular signal-regulated kinase (ERK) connection

Phosphorylation of ERK

In the work of Friedman et al. (2007), which provided a detailed molecular mechanism for electromagnetic-irradiation-induced mitogen-activated protein kinases (MAPK) activation, substantial phosphorylation of ERK was demonstrated for 875 MHz radiation at a power density of 100 $\mu\text{W}/\text{cm}^2$ – Health Canada's present guidelines suggest that at that frequency 583.3 $\mu\text{W}/\text{cm}^2$ is 'safe. Phosphorylation (the metabolic process of introducing a phosphate group into an organic molecule (which can cause marked health effects) also occurred as a result of irradiating the Rat1 and HeLa cells being tested at the even lower power densities.

At 5 $\mu\text{W}/\text{cm}^2$ - the lowest of the intensities tested - a 1.4-fold increase in phosphorylation was recorded in Rat1 cells and a 2-fold increase in HeLa cells. At 30 $\mu\text{W}/\text{cm}^2$, a 2.2-fold increase was shown in Rat1 cells and 2.7-fold increase in the HeLa cells. At 110 $\mu\text{W}/\text{cm}^2$ the increase was very near to maximal phosphorylation, which was shown to be induced by exposure to the microwave radiation at an intensity of 310 $\mu\text{W}/\text{cm}^2$. Similar results were found when frequencies of 800, 875 and 950 MHz were assessed. Additionally, Friedman et al. (2007) demonstrated that irradiation for 2 minutes was enough to exert the full effect on the phosphorylation of ERK.

Comment: The intensities at which biological effects were recorded are substantially below the present safety limits of Health Canada's Safety Code 6 (2009) for uncontrolled environments – this may need urgent downward revision to help reduce the Canadian population's risk of Alzheimer's disease.

It would appear prudent to assess the effects of exposure to the radiation created by the metering system proposed by FortisBC on the phosphorylation of ERK, as phosphorylation is known to be a risk factor in Alzheimer's disease, and other chronic ailments. It would also appear prudent to assess at what actual exposure levels ERK increases are no longer registered, for the 900 MHz and 2.45GHz frequencies proposed for the present FortisBC metering proposal.

1.2.2.6 ERK and abnormal accumulation of highly phosphorylated tau

As noted by Perry et al. (1999), the abnormal accumulation of highly phosphorylated tau and neurofilament proteins can be caused by activation of ERK. Guise et al. (2001) additionally demonstrated that activation of ERK could induce both tau phosphorylation and apoptosis (programmed cell death).

Activated ERK can cause excessive tau phosphorylation - in Alzheimer's disease, tau proteins have phosphorous attached to them, which enables them to aggregate in groups. When those groups get large enough, they form into the neurofibrillary tangles seen in the disease. Perry et al. (1999)'s work demonstrated that *"activated ERK is specifically increased in the same vulnerable neurons in [Alzheimer's disease] that are the site of oxidative damage and abnormal phosphorylation."*

It appears that tau phosphorylation – which as shown above can be caused as a result of even very low level exposures to RF/microwaves (present author's comment) - also has a significant role in apoptosis (programmed cell death), through enhancing disruption of microtubules which then leads to apoptotic bodies (small sealed membrane vesicles created from cells going through cell death) being formed.

This indicates that apoptosis and neurodegeneration are connected (Guise et al. 2001). It is hypothesised by the present author that when apoptotic bodies are absorbed by phagocytes at the sites of tau phosphorylation in the brain, they may also cause lower levels of oxygen in those regions as a result of increased in oxygen-uptake by phagocytes required to deal with them (through respiratory bursts). This may increase the chances of localised hypoxia in such areas, further enhancing the likelihood for damage.

Comment: As Guise et al. (2001) further demonstrated that inhibition of ERK activation can reduced both tau phosphorylation and neuronal apoptosis (P < 0.001), thereby reducing risk of Alzheimer's disease and/or slowing its progression; it would appear to investigate additional ways to inhibit its activation.

1.2.2.7 Increased risk and peroxynitrite production

Increased risk of these is linked to increased production of peroxynitrite*, which can damage a wide variety of molecules in cells (including proteins and DNA). Its production can be increased by RF/microwave radiation (Friedman et al. 2007). [*Increased peroxynitrite production is also linked to increased risk of cancer, chronic heart failure, chronic inflammatory diseases, circulatory shock, diabetes, myocardial infarction, stroke, myocardial infarction & stroke (Pacher et al. 2007)].

1.2.2.8 Best practice, the precautionary principle and future research

One way of helping reducing the risk and proliferation of the Alzheimer's disease epidemic that is sweeping Canada, and the rest of the World, would appear to be the creation of more onerous best practice 'electromagnetic hygiene' measures that would help reduce the risk of Alzheimer's disease and other illnesses. The cost of implementing such measures is negligible compared to the cost of doing nothing and could lead to the creation of new generations of more biologically safe technologies being developed.

As FortisBC already appears to be highly committed to ensuring that its metering system is safe, taking such factors as discussed above into account, and 'investing in prevention' would appear the next obvious step and would be in keeping with The Provincial Health Officer's Special Report and its 'ActNow BC – Population Health Promotion Strategies' (Kendall 2010).

Canada is facing a dementia epidemic and needs to act now.

Encouragingly, research by Arendash et al. (2010) indicates that unmodulated microwaves might be able to mitigate the effects of Alzheimer's. However, as the health effects of both these and modulated

microwaves (as experienced when using cell phones or through exposure to emissions from smart/advanced meters) have yet to be adequately researched, caution is required.

1.2.2.8.1 Canadian intervention strategies on Alzheimer's disease.

To date four interventions have been developed by Canada's Alzheimer Society (2010) to reduce dementia incidence, each of which appears of considerable value and merit. It appears that two of these in particular may be negatively impacted by FortisBC's present plan for a wireless advanced metering infrastructure:

1.2.2.8.1.1 Intervention 1: Prevention – Increase in Physical Activity

The first intervention focuses on increasing the physical activity of all Canadians over 65, who are already moderately to highly active, and without dementia, by 50%. It is reckoned that such an intervention would diminish the number of individuals with dementia, thereby reducing pressure on informal caregivers, community care services and long-term care facilities (Alzheimer Society 2010). This prevention measure has been found to produce significant savings in direct health costs, indirect costs associated with dementia, unpaid caregiver opportunity costs and the amount of care required from informal caregivers throughout the simulation timeframe.

Comment: Exposure to microwaves, at levels below those emitted by FortisBC's proposed smart meters, have been indicated as causing poor sleep quality, weakness and fatigue (*this is discussed later in the Chapter*) - such health conditions would be likely to reduce individuals' willingness and efficiency to increase their levels of physical activity.

1.2.2.8.1.2 Intervention 2: Prevention – A Program to Delay Dementia Onset

The second intervention scenario focuses on the impact of a hypothetical prevention program intended to "delay the onset of dementia by approximately two years." This would combine various 'promising' evidence-based strategies, including following a healthy diet and lifestyle. As with the first scenario, it is intended that this would both help reduce the number of people living with dementia and significantly reduce the pressures placed on Canadian healthcare resources (Alzheimer Society 2010).

Comment: It has been indirectly indicated from the above that exposure to low levels of electromagnetic radiation, similar to that emitted by some smart meters (and also the higher levels of RF/microwave radiation often emitted by some present day technologies) may increase the likelihood of individuals' succumbing to Alzheimer's, and other dementias, and speed their downward progression when diagnosed. **Arbitrarily increasing individuals' exposure to increased levels of RF/microwaves 24/7 appears unwise until further testing can adequately prove the safety of such systems and/or develop safe systems.**

In 'Rising Tide: The Impact of Dementia on Canadian Society' (Alzheimer Society 2010), five essential components for a 'National Dementia Strategy' are given:

1. "Accelerated investment in all areas of dementia research, including Biomedical, Clinical, Quality of Life, Health Services and Knowledge Translation; ..."

Comment: It is proposed that accelerated investment should be undertaken on the possible effects of radiofrequencies and microwave exposures on dementia risk to enable the appropriateness of wireless smart metering (and present day use of RF/microwave emitting technologies) to be determined.

3. "Increased recognition of the importance of prevention and early intervention for these diseases, for both health care professionals as well as the general public;"

Comment: Properly assessing the actual risks of radiofrequency and microwave exposures on dementia appears important as a means of early intervention and potential reduction for both health care professionals as well as the general public.

4. "... increased use of accepted frameworks or "best practices" in chronic disease prevention and management, ..."

Comment: The creation of generally lower levels of exposure to electromagnetic fields is a form of "best practice". Increasing individuals' exposure to a recognised Class 2B carcinogen is not.

5. "Strengthening Canada's dementia workforce by:
- a. increasing the availability of specialists ... with specialized knowledge of dementia;
 - b. improving the diagnostic and treatment capabilities of all frontline professionals;
 - c. making the best use of general and specialized resources through inter-professional collaboration;
 - d. supporting patient self-management and caregiver participation ...
 - e. leveraging the capabilities of the voluntary sector through investment and training."

Comment:

- a. Specialized knowledge of dementia indicates that even low levels of exposure to RF/microwaves may increase risk.
- b. Taking into account the effects of electromagnetic fields exposure on individuals through the adoption of improved 'electromagnetic hygiene' protocols and assessments may greatly help improve the diagnostic and treatment capabilities of all frontline professionals.
- c. Agreed. Inter-professional collaboration is essential, particularly with regard to avoiding or mitigating potential dementia risks and aiding their management. **New ways of thinking are required.** FortisBC could greatly help with such a collaboration - it has already made great efforts to try to ensure that its proposed metering system is safe and 'biologically friendly'.
- d. Helping patient self-management and caregiver participation with improved ways to increase life quality will greatly help to strengthen Canada's dementia workforce.
- e. The capabilities of the voluntary sector can be enhanced through investment in reducing risk factors, and training the voluntary sector how to reduce exposure to such risks - including it is proposed those created by RF and microwave emitting technologies.

The present cost of Alzheimer's disease and other dementias to the Canadian economy is astronomical and will continue to rise, substantially exceeding the cost of adopting more biologically-friendly metering systems and technologies.

1.2.3 Autism

Around thirty years ago, the prevalence of autism was 4-5 out of every 10,000 births (1 in 2,000 to 2,500). Since then it has dramatically increased. In 2004 the Autism Society Canada estimated that approximately 1 in 200 Canadian children had an Autism Spectrum Disorder (ASD). It was estimated at that time that there were over 100,000 individuals with ASD in Canada, with an additional 3,000 cases being identified annually. It was additionally indicated that there had been a 150% increase in the number of reported cases in the previous six years (Autism Society Canada 2004).

The number of individuals diagnosed with ASD appears to have spectacularly increased since then. In a recent overview conducted for the US Centres for Disease Control and Prevention on the prevalence of Autism Spectrum Disorders; it was indicated that as of 2008 one in 88 children may have ASD. Comparisons with earlier surveillance years indicated an estimated 23% increase from 2006 and an estimated 78% increase from 2002. Approximately one in 54 boys and one in 252 girls living in the ADDM [Autism and Developmental Disabilities Monitoring] Network communities used for that study were identified as having ASDs (Baio 2012).

“Evidence from recent California studies indicates that improved knowledge of ASD does not account for the staggering rise in the number of reported cases ... ; the number of people receiving a diagnosis of autism is on the increase,” Autism Society Canada (2004).

1.2.3.1 The Price of Autism

The Autism Society Canada (2004), discussing the work of Jarbrink & Knapp (2001) and Jacobson et al, (1998), which suggested that a person not receiving effective ASD treatments and supports would accumulate a lifetime average cost of \$2 million, stated that at that rate, Canada's provinces and territories would be cumulatively “spending about \$4.6 billion each year on autism services (special education costs, group homes, institutionalization etc), much of which is not supported by evidence-based research. With what we do know from evidence-based research, the lifetime costs of assisting a person with autism can be cut by 50% if he/she receives an early diagnosis, effective treatments, and adequate family supports ...”

Research by Knapp et al. (2007) proposed that the lifetime costs for someone with high-functioning autism is £3.1 million (C\$4.9 million) and the lifetime costs for someone with low-functioning autism is £4.6 million (C\$7.3 million).

Autism Speaks (2012) found that the annual costs of autism are nearly twice as high on average for children and adults with intellectual disability than for those without intellectual disability, with costs of \$2.3 million in the USA and £1.5 million in the UK (C\$ 2.4 million) for those impacted by intellectual disability compared with over \$1.4 million in the USA and £917,000 (C\$1,452,000) in the UK for those without intellectual disability.

Even if the costs can be cut by 50% through appropriate actions, as suggested above by the Autism Society Canada (2004), the costs are still astronomical. It is in the financial interests of governments and taxpayers to seek to reduce the risk factors of autism as they become aware of them. Under “the polluter pays principle” it is also in the best interests of utilities to ensure that they do not contribute to the problem through ‘wilful blindness’.

1.2.3.2 The RF/microwave exposure hypothesis

Kane (2004) proposed that electromagnetic pollution may be a risk factor for ASD. Whilst there are likely to be a number of potential factors that could in part be responsible for any increases that may actually have arisen; his hypothesis is worthy of further study, particularly as anecdotal evidence suggests exposure to lower field regimes may reduce the risk and severity of such conditions and their cost to national economies.

The reasoning behind his hypothesis is “... that human exposures to RF radiation have become pervasive during the past 20 years, whereas such exposures were uncommon prior to that time,” and that the increased fetal or neo-natal exposures that could have occurred as a result of such variations may be a driver of increased incidence. Lathe (2009) notes that, in the absence of firm data demonstrating that RF/microwave radiation cannot influence brain tissue, Kane's hypothesis is plausible.

Research indicating why such a theory should be taken seriously has been conducted for an unpublished pilot study by Dr Dietrich Klinghardt MD, PhD. Measurements of power densities taken in the sleeping areas where women with autistic children slept when they were pregnant [0.011-0.171 $\mu\text{W}/\text{cm}^2$] (n = 290) were found to be higher than those measured in the sleeping areas where women with healthy children slept when they were pregnant [0.0005-0.0040 $\mu\text{W}/\text{cm}^2$] (n = 12).

Measurements were also taken by Klinghardt (2008) in the sleeping areas of healthy children [$\leq 0.0067 \mu\text{W}/\text{cm}^2$] (n = 14) and those with autism [0.0087-0.1480 $\mu\text{W}/\text{cm}^2$]. The levels of emissions created by smart meters can be above those indicated in Klinghardt's work as being a possible cause for concern.

Of interest too is a related study of 13,159 children by Divan et al. (2008), which found a 54% higher chance of children having emotional and social problems at school age if their mothers used mobile phones (exposed them to raised levels of RF/microwave radiation) during pregnancy.

Also of interest is an animal study by Tamir et al. (2012), which indicates that fetal exposure to 800-1900 MHz radiation can affect both neurodevelopment and behaviour. In that work it was shown that mice exposed to such radiation tended to be more hyperactive and exhibit reduced memory capacity.

Professor Hugh S. Taylor, who was involved in that research, attributed the changes to an effect of microwave exposure during pregnancy on the development of neurons in the prefrontal cortex region of the brain, and noted that attention deficit hyperactivity disorder (ADHD) in humans (which is also characterized by inattention and hyperactivity) is a developmental disorder associated with neuropathology localized primarily to the same brain region (Yale School of Medicine 2012).

It appears prudent to determine if raised EMF exposures do increase autism risk, and if so how new generations of 'bio-friendly' technology may mitigate, or even reverse, such risk.

"We want a world fit for children, because a world fit for us is a world fit for anyone', ... Everyone is implicated in shaping the world for children whether or not we are conscious of what we are doing. So for our sake as well as theirs, everyone must work together to improve our world. ..." Canadian CRC 2004).

1.2.4 Concentration, memory or learning problems

In the analysis of online survey on smart meters by the EMF Safety Network (Halteman 2011) documented at the beginning of this discussion document, 34.6% of the 318 respondents stated that either they, or members of their home, had suffered from concentration, memory or learning problems after the installation of smart meters.

Associations between exposure to raised electromagnetic fields and memory function have also been indicated in peer-reviewed research:

1.2.4.1 The hippocampus

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

Animal research by Odaci et al. (2008) has shown that **exposing pregnant rats to 900 MHz microwave radiation (created by a mobile phone in talk mode for 1 hour daily) for the duration of the pregnancy resulted in far fewer nerve cells being present in this part of the brain in offspring ($p < 0.01$). This will have effects on learning and memory - the proposed FortisBC wireless smart meters operate in the 902-928 MHz range.**

Salford et al. (2003) additionally reported that exposing rats to 915 MHz RF/microwave regimes from cell phones for 2 hours produced highly significant ($p < 0.002$) evidence of neuronal damage in the hippocampus and other parts of the brain.

1.2.4.2 Memory function – animals

Research by Fragopoulou et al. (2009) demonstrated that exposing mice for approximately 2 hours per day to 900 MHz RF/microwave radiation from a cell phone for 4 days caused cognitive deficits in spatial learning and memory. In that study, the exposed mice were shown to be less proficient in transferring learned information to the following day, and exhibited deficits in consolidation and/or retrieval of learned information.

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

Narayanan et al. (2009), undertaking tests on 10-12 week old male rats, found exposing them to the 900/1800 MHz RF/microwave radiation of 50 missed calls a day from a mobile phone daily for 4 weeks induced behavioural changes though the exact cause of these undetermined. The rats exposed to RF/microwave radiation took longer to undertake tasks, had poorer spatial navigation and exhibited poorer memory function than those unexposed.

Offspring of rats exposed to 900 MHz cell phone radiation 1 hour daily during pregnancy had far fewer nerve cells in part of brain used for consolidating information from short-term to long-term memory ($p < 0.01$) (Odaci et al. 2008).

2.4 GHz: Research undertaken by Wang & Lai & (2000) indicated that exposure to some 2.45 GHz microwave regimes may affect memory. In that work, the long-term memory and navigational skills of rats appeared negatively influenced by one hour of exposure to 2.45 GHz radiation (pulse width 2ms, 500 pulses/s, average power density of $2,000 \mu\text{W}/\text{cm}^2$) as compared to the unexposed control group. Whilst some studies by others failed to replicate this work (MMF 2005), the need for caution is indicated.

A later study by Li et al. (2008), found exposing rats to a 2.45 GHz pulsed RF/microwave field at an average power density of $1,000 \mu\text{W}/\text{cm}^2$ for 3 hours daily for up to 30 days resulted in significant deficits in spatial learning and memory performance in the exposed rats. It would appear appropriate for tests on lower levels of exposure to also be assessed.

1.2.4.3 Memory function – humans

Research by Chiang et al. (1989) found that individuals, including children, exposed to microwave power densities $\geq 10 \mu\text{W}/\text{cm}^2$ had lower scores in memory function tests than controls in low field environments ($p < 0.01$). [The visual reaction time of exposed groups was also delayed (or tended to be delayed) in groups exposed to such levels compared to control groups].

Research by Maier et al. (2004), investigated the effects of pulsed electromagnetic fields (902 MHz pulsed at 217 Hz) on cognitive processes in humans. They discovered 9 out of 11 participants (81.8%) demonstrated worse results in auditory discrimination performance upon RF/microwave exposure as compared to control conditions ($p = 0.0105$).

Earlier work by Leitgeb & Schröttner (2003, 2002) had demonstrated that there may be strong inter-individual differences in the sensitivity towards RF/microwave exposure. (It is suggested by the present author that this may in part be due to differences in autonomic reactivity).

Poorer memory retention was found by Santini et al. (2002) for individuals living within 100 m of a base station ($p < 0.05$). Increased incidence of concentration difficulties found in the vicinity of base stations by Bortkiewicz et al. (2004). Significant associations found between field exposure & concentration problems at levels below $0.1 \mu\text{W}/\text{cm}^2$ (Hutter et al. 2006).

Eger & Jahn (2010), comparing groups exposed to either 1.17 V/m or 0.7 V/m 940 MHz and 1850 MHz RF/microwave regimes, found a highly significant ($p < 0.001$) relationship between the higher of these exposures and concentration problems.

Wi-Fi radiation at levels of 0.49V/m were found to alter brain activity & attention in humans performing memory tasks by both Papageorgiou et al. (2011) and Maganioti et al. (2010).

1.2.5 Depression

“More than one in five (22 per cent) of Canadian employees report they are currently suffering depression (14 per cent diagnosed) while an additional 16 per cent report having experienced depression previously, according to the latest national Ipsos Reid survey tracking depression in the workplace,” Great-West Life Centre for Mental Health (2012).

Depression is Canada’s leading cause of disability (BC’s Physicians 2009).

“As many as 870,000 British Columbians may experience a major depressive episode in their lifetime, taking into account the current provincial population (O’Neil, 2009) and lifetime prevalence rate of 19.7% ... annually more than 300,000 British Columbians had seen a physician for problems related to depression or anxiety, with the highest rates during midlife and late life ... Depression is first among diseases of global disease burden and is the number one cause of years of life lived with disability for both males and females ... The result is an enormous public health burden that exceeds other common sources of morbidity and mortality—more than heart disease, stroke, diabetes, and other common diseases ...” BC’s Physicians (2009).

Table 1.4 Heightened risk of medical illness for people with depression

Medical condition	Risk level
Alzheimer’s disease	1.71 to 2.67 times the rate for general population
Cancer	1.35 to 1.88 times the rate for general population
Diabetes (type 2)	Depression is an independent risk factor
Epilepsy	4 to 6 times the rate for general population
Obesity	Childhood or adolescent depression is a predictor of obesity
Stroke	2.6 times the rate for general population

Source: Mental Illness & Addiction in Canada, Mood Disorders Society of Canada, 2007. Second Edition. Cited by BC’s Physicians (2009).

For high-income countries such as Canada, major depressive disorders are the leading cause of burden of disease, responsible for the loss of over 10 million disability adjusted life years. In Canada “... the burden of depression is greater than the burden caused by common diseases such as heart attack, stroke, and diabetes,” (BC’s Physicians 2009). Levels of depression are increasing in BC, as is the percentage of active long-term disability claims with depression as the primary diagnosis (Bilsker et al. 2004).

“The economic impact of depression is further amplified because so many of those suffering from depression are of working age, and the impact of depression on job performance is strongly associated with absenteeism and decreased productivity ... Such costs have been estimated at \$2.6 billion per year for Canada ... **For an average British Columbia company with 500 employees, yearly costs of untreated depression are nearly \$1.4 million in lost work days and reduced productivity ...**” (BC’s Physicians 2009).

“Combined, primary and secondary depression have an impact on about 35% of all active long-term disability claims. The occurrence of secondary depression is often associated with a decreased likelihood to return to work while on disability. One study found that the greatest predictor of not returning to work was the presence of depression in the worker; 84% who did not return to work were diagnosed with depression as a comorbid condition ...” (Bilsker et al. 2004).

1.2.5.1 Relationship between depression and EMF exposures

Several studies have indicated a possible link between increased exposures to radiofrequencies and microwaves and likelihood of depression. If this is proven to be true, it could further justify the additional expense of creating a meter network that is more biologically friendly.

Eger & Jahn (2010) found a highly significant dose-response relationship between the RF/microwave field strengths encountered at residential locations and depression ($p < 0.001$). In their study, the mean radiation exposure level of the highest exposure group (1.2 V/m) was substantially higher than that recorded in other work. Increasing individuals' exposures through encouraging the use of wireless technologies (emitting a Class 2B carcinogen) will further increase risk.

Santini et al. (2002) found an increase in depression for people living within 100 m of a base station (under raised field regimes), as opposed to in lower field regimes. Women were particularly affected ($p < 0.05$). Increased incidence of depression also noted under similar circumstances by Bortkiewicz et al. (2004).

Depression, which can substantially heighten the risk of some medical illness (BC's Physicians 2009), is additionally noted as being one of the possible symptoms of 'Electromagnetic Hypersensitivity.'

Oberfeld et al. (2004) noted depressive tendency was associated with exposures to 900/1800 MHz radiation levels of 0.25-1.29 V/m (0.0165-0.4400 $\mu\text{W}/\text{cm}^2$) compared to levels of 0.05-0.22 V/m (0.0006-0.0128 $\mu\text{W}/\text{cm}^2$) ($p = 0.0016$). The levels at which increased depressive tendency was noted were lower than those created by wireless smart meters.

1.2.6 Diabetes

Background: "The prevalence of diabetes has reached epidemic proportions. ... Diabetes is one of the major causes of premature illness and death worldwide. Non-communicable diseases including diabetes account for 60% of all deaths worldwide." World Diabetes Foundation (2010). **It has been proposed by some scientists that inappropriate exposures to manmade electromagnetic fields may in part be responsible for this increase.**

The total acute care inpatient hospital costs for all age groups in Canada during 2004/2005 for Diabetes Mellitus was \$283,900,000. At present it is one of the twelve leading causes of death in British Columbia, with it being responsible for 3% of all mortalities (Kendall 2010). Its incidence is increasing significantly.

If current trends in the rate of incidence and mortality from Diabetes Mellitus in British Columbia continue, the sustainability of its publicly funded health care system is likely to become severely strained. The crude prevalence rate is expected to increase from the 5.2% found in 2003/2004 to 8.1% in 2015/2016 - a 55% increase (Kendall 2010, BC Provincial Health Officer 2005).

"People with diabetes experience much higher rates of hospitalization for other conditions often associated with diabetes ... These conditions are sometimes direct complications of diabetes (such as chronic renal disease, lower limb amputations, etc.) but are often co-morbid conditions (co-existing medical conditions) related to many of the lifestyle-influenced risk factors that lead to the development of Type 2 diabetes (e.g., high blood pressure, heart disease, heart attacks, heart failure, etc.)," BC Provincial Health Officer (2005).

1.2.6.1 Diabetes prevention

The BC Provincial Health Officer (2005)'s report and the Ministry of Health (2008)'s evidence review on chronic disease prevention and the BC Provisional suggests modifiable risks factors for diabetes (type 2) are: being overweight/obese; smoking; and physical inactivity. It is indicated that

exposures to radiowaves and microwaves, even at relatively low intensities may also be categorised as risk factors for this conditions.

1.2.6.2 Electromagnetic risk factors for diabetes

Some scientific research indicates that exposure to RF/microwaves is a modifiable risk factor for diabetes, with risk increasing with exposures to inappropriate field regimes.

Rouleaux formation: As an example of research indicating how risk may increase under raised electromagnetic field regimes; dark field microscopy has indicated that some field regimes may cause clumping of red blood cells (Figure 1.2) similar to that found with diabetics (*and also found with individuals with heart conditions and cancer patients*) (Havas 2010).



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

Figure 1.2 Rouleaux formation when exposure to EMF

Rouleaux formation, as shown above (where blood cells stack together) is often a precursor to many serious diseases and can occur when blood is exposed to inappropriate electromagnetic field regimes.

It may be appropriate to assess the effects of exposures to different smart meter regimes on blood parameters using this technique. It is further suggested that exposure scenarios should also replicate situations where individuals are likely to be additionally exposed to RF/microwave radiation from smart appliances.

1.2.6.3 High-Frequency Voltage Transients

The research of Havas (2006), Milham (2010) and Milham & Morgan (2008) is of interest with regard to the possible health effects of smart meters' high-frequency voltage transients (HVFT) - *electromagnetic energy that deviates from a pure mains-frequency sine wave and contains both harmonic and transient components* - as their past work has investigated the apparent affects of HVFT on health.

HVFT can be created by the switched mode power supply (SMPS) of smart meters abd carried on domestic wiring.

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

1.2.7 Electromagnetic Hypersensitivity (EHS)

This is known by a variety of terms including 'Electrosensitivity' (ES), 'Electrohypersensitivity' (EHS), and 'Idiopathic Environmental Intolerance with Attribution to Electromagnetic Fields' (IEI-EMF).

The WHO began investigating EHS after Dr Gro Harlem Brundtland, their Director General (and former Prime Minister of Norway) announced she had EHS before she retired.

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

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

Depression – *discussed elsewhere in present document.*

Dizziness: In the online survey on smart meters by the EMF Safety Network (Halteman 2011), 25.8% of the 318 respondents stated that either they or members of their family had suffered from disorientation, dizziness, or balance problems after the installation of smart meters.

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

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

Headache disorders – *discussed elsewhere in present document.*

Irritability: In the online survey on smart meters by the EMF Safety Network (Halteman 2011), 43.1% of the 318 respondents stated that either they or members of their family had suffered from stress, anxiety or irritability since the installation of smart meters.

Santini et al. (2002) noted an increase in individuals complaining of irritability when living within 100 m of a base station, as opposed to further away or not exposed to radiation from a base station ($p < 0.05$). Bortkiewicz et al. (2004) also noted that increased complaints of irritability in individuals close to base stations. Simonenko et al., (1998) found occupational exposures of $1.0 \mu\text{W}/\text{cm}^2$ were associated with increased irritability.

Memory deficits – refer also to 'Concentration, memory or learning problems' elsewhere in the present section.

1.2.7.1 Incidence of Electromagnetic Hypersensitivity

A Swiss survey by Rösli et al. (2004), investigating symptoms of ill-health ascribed to EMF exposure, revealed that individuals most often related their symptoms to exposure to RF/microwave radiation from mobile phone base stations (74%), followed by use of mobile phones (36%), cordless

phones (29%) and exposure to power lines (27%). The most common mitigative measure taken by the respondents was to avoid exposures.

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

EHS symptoms often only become apparent in many individuals when exposed to higher field regimes. (This occurrence is also evident in online testimonials on smart meters. [Refer to - EMFSN (2013)].

In addition to the psychosomatic responses that can occur, the extent to which differences in autonomic system regulation between individuals may influence results has yet to be fully taken into account – present author's comment.

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

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

It is estimated by Schreier et al. (2006) that approximately 5% of the Swiss population may be EHS. If a similar fraction were affected in British Columbia, this would amount to approximately 231,129 individuals.

In California the figure is estimated to be 3.2% (Levallois et al. 2002).

EHS has become officially fully recognised as a functional impairment in Sweden since 2007. It is not regarded as a disease (Johansson 2010). Survey studies indicate that around 230,000 – 290,000 Swedish adults (out of a population of 9,000,000) – approximately 2.5% to 3.2% of the population - report a variety of symptoms when in contact with manmade sources of EMFs (Miljöhälsorapport 2001). **If BC had a similar proportion of EHS to Sweden this would amount to approximately 115,564 to 147,922 individuals.**

The work of Eger & Jahn (2010) and Oberfeld et al. (2004) also indicate a highly significant dose-response relationship between the RF/microwave field exposures and symptoms reported by many EHS individuals.

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

Legal precedents: In 2011, the Labour Court in Madrid, Spain declared that hypersensitivity, caused in part by exposure to RF/microwaves, can cause permanent disability. The ruling is unique in this regard and sets a precedent for future conditions related to EHS. The verdict issued on May 23rd of that year awarded the college professor, who has been permanently incapacitated, a permanent disability pension at 100% of his base salary rate.

1.2.8 Headache disorders

In the online survey on smart meters by the EMF Safety Network (Halteman 2011), 40.9% of the 318 respondents stated that either they or members of their family had suffered from headaches after the installation of smart meters.

Associations between exposure to raised electromagnetic fields and headaches have also been indicated in peer-reviewed research:

Eger & Jahn (2010) recorded a highly significant dose-response relationship between residential locations and headaches when comparing high field and low field 940 MHz and 1850 MHz exposure groups – mean exposures levels of 1.17 V/m compared to 0.70 V/m ($p < 0.001$).

Santini et al. (2002) noted an increase in individuals, particularly women, complaining of headaches when living within 200 m of a base station as opposed to further away, or not exposed to radiation from a base station ($p < 0.05$).

Bortkiewicz et al. (2004) also found incidence of headaches related to exposure and distance to base station. This was found for both those who associated their condition with being in proximity to the base station and those who did not.

Simonenko et al. (1998) too found an association between increased incidence of headaches and increased exposure. In that work an association was indicated at power densities of $1.0 \mu\text{W}/\text{cm}^2$.

Hutter et al. (2006) revealed a significant link ($p < 0.017$) between headaches and exposures to power densities $>0.05 \mu\text{W}/\text{cm}^2$ (maximum $0.41 \mu\text{W}/\text{cm}^2$) compared to $\leq 0.01 \mu\text{W}/\text{cm}^2$.

1.2.9 Infertility

There is need to urgently address possible effects of increased 24/7 radiofrequency and microwave exposures on fertility levels.

1.2.9.1 Animals

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

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

1.2.9.2 Humans

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

A pilot study by Agarwal et al. (2009) also revealed a significant reduction in sperm motility and sperm vitality as a result of exposure to such radiation. Additionally, **Santini et al. (2002) found a significant loss in libido for subjects within 100 m of a base station ($p < 0.05$).** Davoudi et al. (2002) tested men who had normal spermiograms ($n = 13$). They were tested 5 days after not carrying or using mobile phones, then tested 4 weeks later (after carrying mobile phones on their belts and using them 6 hours per day for the 5 days before their final test). Increased exposure to RF/microwaves (through mobile phone use) was indicated as possibly reducing sperm motility by 32.3% ($p = 0.01$).

In research by De Iuliis et al. (2009), purified human spermatozoa exposed to raised levels of RF/microwave radiation exhibited significantly reduced sperm motility and vitality. Significantly elevated DNA fragmentation and mitochondrial generation of reactive oxygen species were found to occur after exposure ($p < 0.001$). [DNA fragmentation is linked to reduced fertilisation & embryo quality, miscarriage & increased illness in offspring - including childhood cancer (Avendaño et al. 2010, Aitken & De Iuliis 2007)]. They concluded that their own research indicated that **there were “clear implications for the safety of ... [increased RF/microwave exposures to] males of reproductive age, potentially affecting both their fertility and the health and wellbeing of their offspring.”**

The radiation from laptop computers using Wi-Fi is three times greater than without Wi-Fi and 7-15 times greater than conditions without computer. Avendaño et al. (2012), has shown that exposure of human sperm to 2.4 GHz Wi-Fi radiation from laptop computers caused significant decreases in sperm motility ($p < 0.01$) and increases in sperm DNA fragmentation ($p < 0.01$).

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

At present many types of smart meter and smart appliance would increase exposure to RF/microwave radiation indoors and outdoors 24/7. Research urgently needs to be undertaken to determine how metering regimes may impact on human health and fertility.

1.2.10 Obesity and overweight

Obesity and overweight are on the rise - obesity is a global epidemic. “Evidence is now emerging to suggest that the prevalence of overweight and obesity is increasing worldwide at an alarming rate. ... [They] represent a rapidly growing threat to the health of populations in an increasing number of countries. Indeed they are now so common that they are replacing more traditional problems ... as the most significant causes of ill-health. ...” WHO (2000).

Obesity and overweight are modifiable risk factors for many serious ailments including: breast cancer; colorectal cancer; coronary heart disease, hypertension, heart failure and stroke; diabetes (Type 2); high blood pressure; osteoarthritis; psychological problems/mental disorders; renal and bladder stones; urinary incontinence & sleep disorders (NIH 2011, Kendall 2010, Ministry of Health 2008, WHO 2000).

In Canada in 1997, the total direct cost of obesity was estimated to be between \$2.1-\$11 billion (equivalent to \$64.4-\$343.4 per capita) (Kendall 2010).

The annual cost of obesity related illnesses to the BC healthcare system is around \$380 million dollars. Presently 36.3% of females and 52.8% of all males in BC who are 18+ are either obese or overweight (Kendall 2010). It is important to reduce the risk factors that may lead to this state of affairs. **After productivity losses due to obesity are factored in (taking absenteeism, disability and premature death into account); the total annual figure increases to approximately \$730-\$830 million (Select Standing Committee on Health 2004).**

Obesity is the second highest preventable contributing cause of mortality in BC after cigarette smoking. It is estimated that annually around 2,000 British Columbians die prematurely as a result of obesity-related illnesses. Individuals who are obese or overweight are additionally more likely to die prematurely from all causes of death than individuals with healthy body weights (Kendall 2010).

1.2.10.1 Risk factors and trends

Poor quality sleep, as can be created by exposure to inappropriate RF/microwave regimes – *Refer to section on 'Fatigue/sleep deprivation' in current Chapter*– is a contributory factor to obesity. Sleep debt can increase fatigue levels making individuals less prone to exercise. It can also increase levels of the hormone grehlin thereby stimulating appetite (Taheri et al. 2004).

Obesity and overweight are linked to declining levels of physical activity (National Heart Forum 2007).

It is recognised by WHO (2000) that priority should be given to evaluation of the relative cost-effectiveness of different management strategies aimed at both '*prevention and treatment of excess weight gain.*' It is proposed by the present author that one potential management strategy worth testing may be the possible benefits of exposures to low field environments.

1.2.11 Physical inactivity as a contributing factor to health problems

The WHO (2002) estimates that approximately 3% of the disease burden carried by developed countries are as a result of physical inactivity. It is proposed by the present author that part of this may be due to individuals feeling weak or fatigued.

Physical inactivity is a major contributing factor to obesity, and a recognized risk factor for over twenty chronic diseases and conditions including: breast cancer; colon cancer; coronary heart disease; back pain; anxiety; depression symptoms; obesity and overweight; osteoarthritis; mental illness; stress; type 2 diabetes; falls; hypertension; osteoporosis; and stroke (Kendall 2010, Medibank 2008, Forum 2007, Coleman & Walker 2004, DH 2005, National Heart WHO 2002). In excess of 20% of stroke incidence in developed countries is as a result of physical inactivity.

1.2.11.1 Economic burden of physical inactivity in Canada

In Canada, the total economic burden due to physical inactivity - through both direct and indirect costs - was estimated in 1999 to be around \$9.16 billion annually, or \$300.4 per capita (Kendall 2010). Research by Katzmarzyk et al. (2000) investigating the economic burden of physical inactivity in Canada indicated that a 10% reduction in physical inactivity would lessen health care costs attributable to it by 7%, leading to an annual national health care cost avoidance for Canada of \$150 million.

1.2.11.2 Economic burden of physical inactivity in British Columbia

"Physical inactivity costs the British Columbian economy an additional \$362 million each year in indirect productivity losses due to premature death and disability. Adding direct and indirect costs, the total economic burden of physical inactivity in British Columbia is estimated at \$573 million annually," Colman & Walker (2004).

The British Columbia Ministry of Health notes that physical inactivity is a modifiable risk factor related to the following chronic conditions: lower back pain, colorectal cancer, breast cancer, diabetes (Type 2), coronary heart disease, heart failure, stroke and hypertension (Kendall 2010).

"The prevalence of British Columbians (12+) classified as active or moderately active in their leisure time has dropped significantly, from 59.9 per cent in 2003 to 57.7 per cent in 2007/2008; however, BC's level remains the highest in Canada," Kendall (2010).

Colman & Walker (2004), extrapolating the data of Katzmarzyk et al. (2000) for British Columbia, suggest that for BC the annual cost avoidance attributable to a 10% reduction in physical inactivity would be \$49.4 million (through \$18.3 million savings in direct healthcare

costs and \$31.1 million savings through gains in economic productivity). It is estimated that such a reduction in physical inactivity might be responsible for saving 139 lives in BC annually and prevent 385 potential years of life being lost annually in BC (Kendall 2010).

As noted by the Office of the Provincial Health Officer “Physical activity can benefit British Columbians of all ages and positively impacts the musculoskeletal, cardiovascular, respiratory and endocrine systems. Physical activity contributes to reducing levels of overweight and obesity. Research shows that there is a direct link between the level of physical activity that people engage in and their well-being and lifelong health,” (Kendall 2010).

In British Columbia it is estimated that 15% of heart disease, 10% of hypertension, 11% of breast cancer, 14% of colon cancer, 16% of Type 2 Diabetes, 19% of stroke and 18% of osteoporosis cases are attributable to physical inactivity (Colman & Walker 2004).

1.2.11.3 Possible effects of radiofrequency and microwave radiation on physical activity

As the work of Altpeter et al., (1997, 1995) indicates that exposure to power densities of 0.002 $\mu\text{W}/\text{cm}^2$ could result in fatigue and weakness (along with sleep disorders, joint & limb pain, abnormal blood pressure, nervousness and digestive problems), and wireless smart meters can emit power densities higher than that, it would appear that caution may be required with regard to their use.

Simonenko et al., (1998) found that higher levels of exposure of 1.0 $\mu\text{W}/\text{cm}^2$ were associated with reports of fatigue and weakness *(in addition to insomnia, headaches, dizziness, indigestion, irritability, chest pain, and difficulty breathing).*

The EMF Safety Network online survey found that, out of the 318 respondents who responded to the health section of the survey, 34.3% declared that either they or members of their family reported fatigue, muscle or physical weakness after the installation of smart meters (Halteman 2011).

It appears important to further determine to what extent, if any, the increased exposures to RF/microwave radiation from FortisBC's proposed smart metering system might contribute to a continuing reduction in physical activity levels in British Columbia.

1.2.12 Risk of falls – Inappropriate EMF exposures may contribute to risk of falls

General statistics: Falls are the main cause of death for those 65 years and older (Murphy 2000). Every year over 30% of older people have falls (Hausdorff et al., 2001), with falls proving to be a major cause of injuries and trauma-related hospital admissions (Alexander et al. 1992). Scott et al. (2010), citing the World Health Organization (2008), note that the *“psychological impact of a fall may [additionally] result in a post fall syndrome that includes dependence on others for daily activities, loss of autonomy, confusion, immobilization and depression.”*

Canadian statistics: *“Falls are the leading cause of injury related hospitalizations among seniors ... [They] are the cause of most hip fractures among seniors and 20% die within a year of the fracture,”* Public Health Agency of Canada (2005). It is likely that approximately 1.4 million Canadian seniors fell at least once during 2005 (Scott et al. 2010).

The direct annual healthcare costs for fall related injuries for this age group was \$2.0 billion in 2004, with this annual cost being projected to rise to \$4.4 billion by 2031 (SmartRisk 2010).

1.2.12.1 Risk of falls – contributing factors

Reduced sleep quality – *refer also to section on 'Insomnia' for details of studies and anecdotal evidence documenting RF/microwave effects on sleep quality.*

Insomnia has been proven to increase the risk of falls in older people (Brassington et al. 2000). Preliminary data from Stone et al. (2004) shows that impaired sleep increases the risk of falls in senior women, and an association between insomnia and increased the risk of hip fractures has been indicated in some studies (Fitzpatrick et al. 2001). Additionally, research by Avidan et al. (2005) has determined that it is treated and untreated insomnia, and not hypnotic medications, that are predictors of falls.

Fatigue, weakness and reduced muscle tone

It is proposed that fatigue, weakness and reduced muscle tone, in addition to sleep problems and physical inactivity, are all likely potential contributors to the risk of falling.

Exposure to some RF/microwave radiation regimes are linked with fatigue and insomnia (Eger & Jahn 2010, Hutter et al. 2006, Bortkiewicz et al. 2004, Santini et al. 2002). Research by Altpeter et al., (1997, 1995) indicated that exposure to power densities of $0.002 \mu\text{W}/\text{cm}^2$ resulted in fatigue and weakness in subjects (*along with sleep disorders, abnormal blood pressure, nervousness, digestive problems, joint pain and limb pain*). Similar research by Simonenko et al., (1998) investigating the effects of occupational exposures of $1.0 \mu\text{W}/\text{cm}^2$ indicated that they too could cause fatigue and weakness in subjects (along with headaches, dizziness, indigestion, irritability, chest pain and difficulty breathing).

Past research has additionally indicated that exposure to 0.1-100 MHz radiation – *as can be created by some BPL* - may weaken human muscle strength (Ott 1982). Other frequencies, such as those proposed for the present FortisBC AMI system were untested.

Comment: As recognised by the BC Falls and Injury Prevention Coalition (BCFIPC), it is important to find ways to reduce the rate, frequency, severity and risk of falls among seniors in British Columbia (Scott et al. 2010). It is also important to properly evaluate potential new risks as they become apparent, so that potential causes and/or contributors to likelihood of falls are not inadvertently increased through changes in policy, and so that necessary interventions are taken where appropriate as awareness of them arises.

6.1.1 Sleep problems

Lack of sleep may be a causal factor in premature ageing, high blood pressure, diabetes, obesity, depression and other mental health problems, and can also tax the immune system (Ackermann et al. 2012).

Research by Altpeter et al., (1997, 1995) indicated that exposure to power densities of $0.002 \mu\text{W}/\text{cm}^2$ resulted in sleep disorders in subjects (along with abnormal blood pressure, digestive problems, fatigue, joint & limb pain, nervousness and weakness). Similar research by Simonenko et al., (1998) suggested that human occupational exposures of $1.0 \mu\text{W}/\text{cm}^2$ could result in insomnia (along with headache, dizziness, indigestion, irritability, chest pain, difficulty breathing, fatigue and weakness). It is interesting to note that many of these symptoms were reported by respondents to the EMF Safety Network online survey.

In that research it was documented that out of the 318 respondents who responded on health matters, for 49.1% of them, either they or members of their family, reported sleep disturbances after the installation of smart meters (Haltzman 2011).

1.2.12.2 Poor sleep quality as a risk factor

“Sleep loss and sleep disorders affect an individual’s performance, safety, and quality of life. Almost 20 percent of all serious car crash injuries in the general population are associated with driver sleepiness, independent of alcohol effects. Further, sleep loss and sleep disorders have a significant economic impact. The high estimated costs to society of leaving the most prevalent sleep disorders untreated are far more than the costs that would be incurred by delivering adequate treatment (and reducing risk factors – present author’s comment). Hundreds of billions of dollars a year are spent on direct medical costs associated with doctor visits, hospital services, prescriptions, and over-the-counter drugs related to sleep problems. Compared to healthy individuals, individuals suffering from sleep loss, sleep disorders, or both are less productive, have an increased health care utilization, and an increased likelihood of accidents,” Colten & Altevogt (2006).

1.2.12.3 Sleep problems and work-related injuries

1.2.12.3.1 International research

Sleep-related fatigue is indicated as an independent risk factor in work-related injuries and fatalities worldwide; it is therefore important to investigate claims that the introduction of advanced metering systems and related technologies may increase risk of sleep fatigue.

As noted by Swaen et al. (2003), “Occupational accidents are responsible for a significant proportion of worker absenteeism and disability.” As an example of this, they note, citing McDonald (2000), that in 1992 in the USA alone it has been estimated that occupational accidents cost approximately \$145 billion compared to \$26 billion from all occupational illnesses. The detrimental effects of sleep-related fatigue are far greater than many realise.

A large-scale 20-year prospective study of 47,860 individuals, by Åkerstedt et al. (2002), found that those self-reporting disturbed sleep were nearly twice as likely to die in a work-related accident (OR = 1.89, 95% CI 1.22–2.94). Additionally they found “Difficulties in sleeping during the last two weeks’ was associated with increased risk of having a fatal occupational accident, as was being male and having non-daytime work. The contribution by gender to accident mortality is well established ... Men, as a rule, have a higher accident risk.”

Swaen et al. (2003) studied a cohort of over 7,000 workers and found a dose-response relationship between sleep-related fatigue and injuries. After adjustment for other risk factors, highly fatigued workers were shown to have a 70% increased likelihood of being involved in accidents than those reporting low fatigue levels. “For fatigue, the adjusted relative risk for being injured in an occupational accident was 1.69 (95% CI: 1.03 to 2.78) when comparing workers scoring in the highest tertile on the CIS, with workers scoring in the lowest tertile.” Incidence of occupational accidents was also shown to be influenced by low to moderate levels of fatigue.

1.2.12.3.2 Canada

Research by Kling et al. (2010) investigated the association between self-reported sleep problems and risk of work injuries among Canadian workers. They found, “Canadian workers are at an increased risk for injury at work associated with sleep problems ... the number of injuries attributable to sleep problems is higher in women. An increased risk for work injuries associated with trouble sleeping is found in most job classes. Within the Canadian workplace up to 23,000 worker injuries could be prevented with the placement of effective interventions. Future research should investigate methods of preventing both sleep problems in workers as well as work injuries associated with sleep problems.”

1.2.12.4 Sleep-related fatigue and road accidents

“Sleepiness is a significant, and possibly growing, contributor to serious motor vehicle injuries,” US Institute of Medicine Committee on Sleep Medicine and Research (Colten & Altevogt 2006).

1.2.12.4.1 General trends

Worldwide, the public health burden of sleep-related fatigue injuries from drowsy driving is significantly increasing. In 2005, the National Sleep Foundation recorded that self-reported drowsy driving had increased from 51% in 2001 to 60% in 2005. Additionally, and very worryingly, over 10% of those who took part in the survey reported that at least 1 to 2 days per month they had either nodded off or fallen asleep whilst driving (NSF 2005). In the UK, long-term sleep deprivation increases the likelihood of motor vehicle accidents greatly, with driver fatigue being responsible for almost 20% of traffic accidents (DfT 2011).

Connor et al. (2002) found that, independent of the effects of alcohol and other potential confounding factors, almost 20% of all serious car crash injuries were associated with driver sleepiness. Pack et al. (1995) noted that the effect of driver sleepiness on vehicle accidents was comparable in magnitude to that from driver alcohol consumption; with fall-asleep crashes (where the driver was asleep or fatigued) and alcohol-related crashes being shown to be similar in terms of both serious injuries (13.5% and 17.8% of all crashes, respectively) and fatalities (1.4% and 2.1% of all fatalities, respectively).

That figures cited above could be greatly reduced by eliminating/reducing the causes of, and contributors to, driver sleepiness.

It is proposed that the possible role of environmental exposures of RF/microwave radiation (including those from advanced metering systems) as a factor reducing sleep quality and encouraging fatigue should be investigated more fully as a potential contributor to vehicle accidents where driver fatigue is a contributing factor.

1.2.12.4.2 Road accidents in Canada

In Canada, the annual social costs of road accidents in terms of property damage, medical treatment, rehabilitation, lost productivity and loss of life are in tens of billions of dollars (Transport Canada 2011).

Vanlaar et al. (2008) found that around 15% of Canadian drivers in their study had admitted to falling asleep whilst driving with the previous year. 60% of respondents admitted to driving whilst fatigued. The CCMTA state that around 20% of fatal road accidents involve driver fatigue (figure calculated by eliminating other possible causes such as alcohol impairment, unsafe passing, speeding, etc.) (CCMTA, 2010) [Thiffault, P. (2011) Human Factors in Heavy Vehicle Collisions, presentation to CCMTA. November 2010. ?] (Transport Canada 2011).

1.2.12.4.3 Road Safety Strategy (RSS) 2015

Like the two national road safety programs before it, which helped successfully reduce the number of fatalities and serious injuries from road collisions, Road Safety Strategy (RSS) 2015 is aiming to make Canada's roads the safest in the World. Its strategies are intended to focus, amongst other things, on best practices, contributing factors, policy/legislation, technology and information/data for research and evaluation (Transport Canada 2011).

“Canada has seen an incredible improvement in road safety over the past 40 years, with fatalities being reduced by 60%. Yet, despite this improvement, a person dies every four hours or is admitted to

hospital every 90 minutes as a result of a traffic collision. Our challenge is to move toward zero fatalities and serious injury collisions, where the price of mobility is not death or disability," Transport Canada (2011).

Acute sleepiness can make a considerable contribution to the burden of injuries from motor vehicle crashes. As previously documented, sleep problems have already been reported by a large number of respondents after smart meter roll-outs (Haltzman 2011).

As noted by the UK Department for Transport "The only real cure for sleepiness is proper sleep." (DfT 2005).

Comment: It would appear prudent to determine through appropriate biological testing and sleep studies whether smart metering systems (and wireless smart appliances) in their present formats are likely to contribute to this burden. If they do, it would appear wise to investigate the adoption/development of more suitable metering alternatives and infrastructures.

1.2.12.5 Anecdotal evidence of sleep problems

Adverse health effects on sleep quality have already being claimed after the roll outs of some RF/microwave emitting utility meters (EMFSN 2013, KCRA 2011). Some examples are given below:

1. The following are excerpts from a letter sent to the CPUC judge overseeing smart meter proceedings in California:

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

Prior to this I knew nothing about smart meters and had no idea that they could impact human health. ... I have spent the past 22 days living out of my car, finding shelter at various friends' homes in the evening. ... I am exhausted, frightened, and do not know where to turn," Gregory (2011).

2. The following comments about how the new wireless utility Smart Meters have [apparently – present author's comment] affected people's health were sent to the EMF Safety Network, or publicly posted. Most are posted anonymously. ...

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

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

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

For details of other smart meter health complaints please refer to: EMFSN (2013), Smart Meter Health Complaints, EMF Safety Network, http://emfsafetynetwork.org/?page_id=2292

1.3 Health Promotion – Making things better

There is a need for 'biologically friendly' meter regimes that enhance health and wellbeing.

"The concept of health promotion is positive, dynamic and empowering which makes it rhetorically useful and politically attractive. ... Further developmental work is clearly required ..."WHO (2009) / HPI (1986).

There are a number of health promotion initiatives that have been instigated by the World Health Organization (WHO) to provide incentives to achieve the target of 'Health For All' through improved health promotion and the creation and adoption of healthier technologies and environments.

"Systematic assessment of the health impact of a rapidly changing environment - particularly in areas of technology, work, energy production and urbanization - is essential," WHO (1986).

It appears vital for BC to ensure that additional appropriate health impact assessments are undertaken on the technologies proposed for smart meters, smart grids and related equipment, so that they are made as 'biologically friendly' and resilient as possible to enable people to lead healthy and safe lives.

Further details on health promotions initiatives can be found in Appendix B. From the literature that has been reviewed for this current study, it is apparent that creating healthier electromagnetic environments is of benefit to everyone.

1.4 RF exposure: at home – studies (Q44.10) & vulnerability (Q44.7)

Document: CSTS IR No. 2 - Questions 44.10 and 44.7

Comment on Question 44.10: "Most exposure to cell transmitters, cell phones and radio transmitters occurs while the object of exposure is moving, during the day. Most exposure to smart meters will be while people are at home sleeping. What studies were reviewed that would pertain to the latter pattern and circumstance of exposure? What consideration is being given to people who are in one location, e.g. their home, all day every day, e.g. mothers with young children, the elderly and the disabled?" Response: "It is not clear that the two assumptions regarding exposure are valid generalizations or inferences about exposure of the population to radiofrequency fields. Research on potential effects radiofrequency exposures has not indicated that members of these groups would not be protected under compliance with Safety Code 6."

The two assumptions made in Question 44.10 may not be considered valid generalisations because the levels of exposure are also dependent on time and activities undertaken. For example, depending on exposure time and individuals' lifestyles, exposure to EMF from cell phones and cordless phones at home may also be as high as (if not higher) than experienced outdoors. Likewise, exposure to EMF emitting from smart meter is not always limited to the night-time, and exposure levels will vary depending how close an individual is to the smart meter. For those who spend most of their time at home exposure can occur a large proportion of the time. Whilst the usage of cell phones is a matter of choice, and not undertaken continuously 24/7, the radiation from smart meters is released in bursts at intervals of around a minute throughout the whole day.

Indoor exposure time to EMF can be longer than initially assumed, as most people spend most of their time indoors. The total average time spent inside buildings has been found as high as 86%-89% in North America, with a large proportion of that time being spent at home (Leech et al. 2002, 1996, Klepeis et al. 2001, Wiley et al. 1991). In the first Canadian Human Activity Pattern Survey (CHAPS) conducted in the 1990s in four cities (Toronto, Vancouver, Edmonton and Saint John, New Brunswick), Leech et al. (2002, 1996) reported that people in 2,381 households spent 88.6% of their time indoors with approximately 66% of their time being spent at home. These results are similar to those found in the US EPA National Human Activity Pattern Survey (NHAPS) of 9,386 individuals (Klepeis et al. 2001), and the California Air Resources Board (CARB) study of 2,962 people (Wiley et al. 1991).

Some groups of population, such as the infirm, people with disability, older people, pregnant women, young infants and mothers with young children tend to spend more time at home. **Studies (Leech et al. 2002, 1996, Klepeis et al. 2001) suggest that children under the age of 11 spend more time inside their houses than did adults. For example, similar to the US NHAPS survey, the CHAPS survey found that Canadian children spent 72% of their time at home compared to 66% for that of adults (Leech et al., 2002).** Similar to those studies in North America, a small-scale German study (Dörre 1997) found that toddlers spent 75% of their time at home, whilst a large-scale German survey of 11,918 people (Brasche & Bischof, 2005) reported figures 73% time spent at home for pre-school children and 81% for older people.

Therefore, their involuntary exposure time to the RF/microwave radiation emitting from smart meters and other proposed RF/microwave emitting AMI components can be longer than expected by some.

The second CHAPS survey, which included around 4,900 Canadians in seven cities (Health Canada 2010), was expanded to include questions on changes in behaviour of Canadians (e.g., change in lifestyle due to increased access to personal computers and technological advances). It is suggested from that work that the information on time spend indoors from those studies (i.e. Health Canada 2010, Leech et al. 2002) can be used to define the exposure of Canadians to EMF including vulnerable groups of population and to improve the accuracy of risk assessment for a variety of possible acute and chronic health effects known or suspected to be associated with EMF exposures.

The effects of the ongoing roll out of microwave-emitting smart appliances has received little attention, though as shown from above, it is likely that many will be exposed to their emissions for long periods of the day. The public health consequences of this appear not to have been considered.

The proposed adoption of wireless data transmission technology by FortisBC, instead of wired alternatives, would appear to indicate to industry that it is acceptable to have microwave emitting smart appliances transmitting 24/7 in individuals' homes instead of giving them reason to create more biologically friendly alternatives (which may also lower their potential future liabilities).

Smart Appliances

The range of smart appliances and devices includes: coffee makers, cooker, dishwashers, microwave ovens, standard ovens, thermostats, toasters, tumble dryers, washing machines, water heaters, freezers and refrigerators (Table 1. 5). Smart electric sockets also exist for offices and home use.

Table 1. 5 Predicted global market for smart appliances in 2015 (Zypryme 2010)

Appliance	Projected figures given in US dollars.
Clothes washers	\$3,542,000,000
Refrigerators	\$2,693,000,000
Clothes dryers	\$2,236,000,000
Dishwashers	\$1,354,000,000
Freezers	\$1,166,000,000
Other smart appliances	\$4,184,000,000

A number of commentators and consumers take issue with the 'need' for some appliances to be smart. As an example, one US pilot study has shown that consumers do not want utilities to tell them when to do the laundry or use the dishwasher (Ansell 2010).

Increased exposure to RF/microwave emissions 24/7 may in particular prove a problem in studio and bachelor apartments due to the high concentrations of equipment often within very limited space. These matters need to be addressed, especially as related to the possible effects of their RF/microwave emissions on potentially vulnerable individuals, such as children, pregnant women, the elderly, and those with debilitating conditions.

Unlike FortisBC, it appears that at least some manufacturers have little concern over the number of data bursts their equipment may make. As an example, one brand markets smart electric socket extensions that emit RF/microwave radiation at 2.4 GHz during their operation at a typical time interval of 10 seconds down to 1 second if required. [It is additionally reported that often the cheaper appliances of a number of companies advocating the use of smart technology presently have poor energy performance(Hunn 2011)].

Comment on Question 44.7: "Are some persons more vulnerable to RF exposures than others?" Response: "Research has not indicated that some people are more vulnerable to the effects of RF exposure than others at levels below the recommended exposure limits. ..."

It is recognised by the International Commission on Non-Ionizing Radiation Protection that "... children, the elderly, and some chronically ill people might have a lower tolerance for one or more forms of [non-ionising radiation] exposure than the rest of the population." (ICNIRP 2002)," and on Question 44.8: "Are children more vulnerable to RF exposures than adults? Response: Children are not more vulnerable to the potential effects of RF exposures at levels below the guidelines. The guidelines have factored in the relative size of children compared to adults. Potential exposures from the proposed AMI meters are far below the recommended exposure limits."

Children are more vulnerable to RF/microwave exposures than most adults. Pregnant women, immune compromised individuals and the elderly are also more vulnerable. Becker (1990) noted that *"fetal or newborn brain cells are particularly sensitive to electromagnetic field exposure."*

It is recognised by the International Commission on Non-Ionizing Radiation Protection that *"... children, the elderly, and some chronically ill people might have a lower tolerance for one or more forms of [non-ionising radiation] exposure than the rest of the population."* (ICNIRP 2002).

Professor Yury Grigoriev, Chairman of the Russian National Committee on Non-Ionizing Radiation Protection and Member of the World Health Organization's International Advisory Committee on EMF and Health states that as exposures have increased it is now necessary to develop new standards related to children's exposures to RF/microwave radiation. "The potential health risk for children is very high and creates a completely new problem we urgently need to address. As noted by the WHO: "Children are different from adults. Children have a unique vulnerability. As they grow and develop, there are 'windows of susceptibility': periods when their organs and systems may be particularly sensitive to the effect of certain environmental threats" (WHO 2003)."

1.5 Prolonged customer proximity to meter - what if located outside bedroom? (Q16.3) & Meter location – bedroom walls (CSTS IR2, Q43.3)

Document: CSTS IR No. 1 – Question 16.3 and CSTS IR No. 2 - Question 43.3

Comment on Question 16.3: “Has FortisBC considered that a meter (or a bank of meters in the case of an apartment complex) may be located on the exterior wall of a bedroom? How does this consideration affect the likelihood that a customer may be in close proximity to a meter for prolonged periods of time?” **Response:** “Please refer to the response to CSTS IR No. 1 Q16.2. FortisBC notes that a bank of meters does not materially change the level of emissions as governed by Safety Code 6, and as such does not require a different consideration with respect to any perceived health effects resulting from the implementation of the project.” **Response:** “Please refer to the response to CSTS IR No. 1 Q16.2. FortisBC notes that a bank of meters does not materially change the level of emissions as governed by Safety Code 6, and as such does not require a different consideration with respect to any perceived health effects resulting from the implementation of the project.”

Reference is made by the present author to the reported case of severe die off of a bush that was reported after the installation of wireless smart meters. It was reported that none of the other plants or trees in the area (further away from the units) were affected, which appears to suggest that the emissions from smart meters, in this case a bank of meters may be biologically active. Refer also to the Chapter on ‘Environmental Concerns.’

Comment for on QCSTS IR No. 2, Question 43.3: “Does FortisBC know how many meters will be placed on bedroom walls, mere inches from heads of the beds of the occupants?” **Response:** “No, although any exposure in such circumstances is expected to be below the applicable Safety Code 6 limits.”

Gustavs (2012a) reports that in EMF surveys she has undertaken in individual bedrooms where there is a wireless smart meter attached to the exterior wall behind which someone tries to sleep, peak microwave power density exposure levels across the bed may range from 0.01 to 0.15 $\mu\text{W}/\text{cm}^2$. She notes that “... the EMF Working Group of the Austrian Medical Association recommends to keep peak levels of radio-frequency radiation in bedrooms below 0.001 $\mu\text{W}/\text{cm}^2$, preferably below 0.0001 $\mu\text{W}/\text{cm}^2$. ”

In addition to bedrooms, increased exposure to RF/microwave emissions 24/7 may in particular prove troublesome in studio and bachelor apartments. A challenge that is likely to become further exacerbated in future due to a high number of smart appliances that are likely in future to be contained within a very limited space.

1.6 RF emission frequency – overnight suspension

Document: CSTS IR No. 2 - Question 35.1

Comment on Question 35.1: “If billing data will transmit only 2 or 3 times per day, then why do the proposed AMI meters emit RF once every minute or so on a 24/7 basis? Can RF emissions be suspended overnight while residents are sleeping?” **Response:** “The meters communicate more frequently than required for the transmission of consumption data in order to transmit high-priority information such as power outages and tamper alerts, as well as control and command messages integral to the efficient operation of a meshed network. The meters also transmit keep-alive messages typical of many data transmitting

systems, and these transmissions cannot be omitted without compromising the wireless network. These intermittent transmissions are typical of other messaging systems, such as Wifi, which typically beacons 10 times per second compared to the proposed smart meters keep-alive period of greater than a minute at steady-state."

If fibre optics were used instead of RF/microwaves for data communication these RF/microwave emissions would be avoided. It is usual for many other types of RF/microwave emitting devices to be switched off overnight.

1.7 EMF risks – relevance of frequency, duration of RF emissions and fluctuation of RF levels

Document: CSTS IR No. 1, Question 17.1

Comment on Question 17.1: "In evaluating the EMF risks posted by the proposed meters, does FortisBC consider it important to consider the following specifics? A. The frequency and extent of fluctuation of RF levels? B. The duration of each instance of an RF emission? C. The frequency with which an RF emission occurs?" **Response:** The factors that FortisBC considers important in evaluating EMF exposure are described in the referenced section of the Application, Exhibit B-1, Section 8.4.2, p134-135. All items listed above are considered in determining compliance with Health Canada Safety Code 6."

It seems odd that in evaluating the EMF risks of the proposed meters, little consideration has apparently been given to feed-back from individuals who are said to have experienced health problems after the introduction of smart meters (EMFSN 2013). It appears likely that the emissions from the smart meters of the people who stated that they had experienced health problems may also comply with the requirements of Health Canada Safety Code 6.

The review conducted for this present commentary has found evidence of numerous biological effects at levels substantially below those considered safe in that guideline. The frequencies that FortisBC propose to use in its AMI have additionally been indicated as being biologically active at relatively low intensities.

1.8 RF exposure – consideration of extent and amount of situation in RF levels, frequency of occurrence of RF emissions, and speed at which turn on/off.

Document: CSTS IR No. 1 - Question 19.1

Comment on Question 19.1: "In evaluating the nature of RF exposure, what consideration has FortisBC and/or Exponent given to the extent and amount of fluctuations in RF levels, the frequency with which instances of RF emissions occur and the speed at which the emissions are flashing on and off? **Response:** "The exposure characteristics of the RF signals from the FortisBC AMI meters were considered from the perspective of Safety Code 6 compliance and more generally with respect to the relevant scientific literature."

The review conducted for this present commentary has found evidence of numerous biological effects in scientific literature at levels substantially below those considered safe in Safety Code 6. These are discussed in detail in this present Chapter and the Chapter on 'Environmental Concerns'. As noted above, the frequencies that FortisBC propose to use have additionally been indicated as being biologically active at relatively low intensities.

In addition to doctors, scientists and health agencies abroad raising concerns about the risks of increased exposures, it has been noted by the communications industry, ICNIRP and the UK's Health Protection Agency (HPA) that RF/microwave radiation may be unsafe. As examples:

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

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

It has also recently been reported that as a result of health concerns, Mr. Didier Bellens, who runs Belgacom, the largest telecommunications company in Belgium, "Has now chosen to do without WiFi on the 27th floor of Belgacom where his office is situated, he also chooses to do without a cell phone; only taking calls on the office's land line," (Burrell 2013).

"... the possibility of harm from exposures [to low levels of radio frequency radiation] insufficient to cause important heating of tissues cannot yet be ruled out with confidence. Furthermore, the anxieties that some people feel when this uncertainty is ignored can in themselves affect their well-being." Sir William Stewart (Chairman), Mobile Phones and Health: A report from the Independent Expert Group on Mobile Phones, (The Stewart Report 2000).

Paolo Vecchia, Chairman for ICNIRP, commented in 2008 that **"the ICNIRP guidelines [which are similar to Safety Code 6 guidelines – present author's comment] are neither mandatory prescriptions for safety, the "last word" on the issue nor are they defensive walls for Industry or others."** (Vecchia 2008).

1.9 RF exposure: frequency (Q61.2), limits (Q61.3), RF LAN and ZigBee (61.4)

Document: BCSEA IR No. 1 - Questions 61.2, 61.3 and 61.4

Comment on Question 61.2: "Confirm that Figure 1 shows various sources of RF Exposure that are at different frequencies and therefore the potential health consequences of the various sources do not necessarily correspond to the indicated RF Exposure." "Response: All RF exposures shown in Figure 1 are well below Health Canada exposure limits irrespective of the frequency of the sources. Safety Code 6 states: "The exposure limits in Safety Code 6 are based upon the lowest exposure level at which scientifically-established human health hazards occur. Safety factors have been incorporated into these limits to add an additional level of protection for the general public and personnel working near RF sources." (Safety Code 6, 2009, p. 7).

A number of effects have been scientifically established, and the implications of these have led to a number of scientists, and foreign health agencies, advocating the need for the adoption of more onerous standards. The permitted exposure levels in the Canada are substantially higher than those permitted in many other countries, including China, Bulgaria, Italy, Poland, Switzerland and Russia.

As an example, much scientific research has been undertaken in Russia with regard to chronic and cumulative health risks from RF/microwave radiation. Russia's standards are based on detailed research covering a period of over 60 years, and include the findings of chronic exposure experiments, etc., which provide the database that its uses for its standardisation. In addition to chronic exposures, Russian standards take into account the effects of non-thermal levels; chronic exposures; and the establishment of 'working levels' instead of 'threshold levels' (Grigoriev 2010).

Comment on Question 61.3: “Please provide a table and graph showing the various sources of RF Exposure as a ratio of the corresponding exposure limit, and include cell phone exposure referred to on p.A-5.” Response: “... The chart does not show the comparison to the cell phone signal, as it is difficult to show cell phone signal on the same scale as the other sources (due to the cell phone’s much greater RF signal strength). ... Based on a 1.8 minute call and a typical cell phone SAR of approximately 1 W/kg, cellphone signal would be approximately 20% of the Health Canada Safety Code 6 limit.”

The proliferation of systems that use microwave radiation for communication, which the proposed adoption of wireless data communication by FortisBC may indirectly encourage, appears potentially ill-advised, as it has recently been categorised as a Class 2B carcinogen.

It appears highly likely that wireless laptops, cell phones and similar devices, which can emit high levels of radiation, will (unless suitable public health guidance is given) be used to an even greater degree by individuals wishing to talk electronically to smart appliances and devices. Such increased exposures may have detrimental health consequences to the citizens of BC.

Comment on Question 61.4: “What do the authors intend to convey by showing RF Exposure from “Earth” and “Human Body” at levels equal to or higher than RF Exposure from RF-Lan and ZigBee? Is the implication that RF Exposure from RF-Lan and ZigBee are at levels lower than natural background levels?” Response: “Figure 1 shows that RF Exposure from RF-Lan and ZigBee are at levels lower than natural background levels.”

The data on the chart appears very misleading. As examples:

The natural background level for all microwave frequencies, according to (Powerwatch 2007), is 0.000,000,000,1 $\mu\text{W}/\text{cm}^2$. Powerwatch (2007) additionally state that the average cosmic background radiation level at 1800 MHz, the operational frequency for WiMax, which FortisBC is intending to use for its Wide Area Network (WAN) (Refer to 63.0), is approximately 0.000,000,000,000,001 $\mu\text{W}/\text{cm}^2$.

The level of exposure quoted by FortisBC at a distance of 0.5 metres from 2.4 GHz ZigBee radio whilst it is on 1% duty cycle (as indicated in data provided in Table 2 of Exhibit B-1, Appendix C-5) is 0.13 $\mu\text{W}/\text{cm}^2$. The peak power density is given as 31 $\mu\text{W}/\text{cm}^2$ measured at a distance of 20 cm during active transmission (not accounting for duty cycle) (Data from Response to Question 57.7).

The EMF emissions from the human body are of quite different character to the man-made radiations they are being compared against. Heat radiation, whether it is of the Earth or from human, is a randomly distributed radiation with a broad frequency spectrum. The RF/microwave radiations emitted by bodies are ‘broadband’ and not periodically pulsed which appears to be a major determinant of biological relevance.

An alternative chart for comparison, created by BEMRI.org (2012) is shown in Figure 1.3.

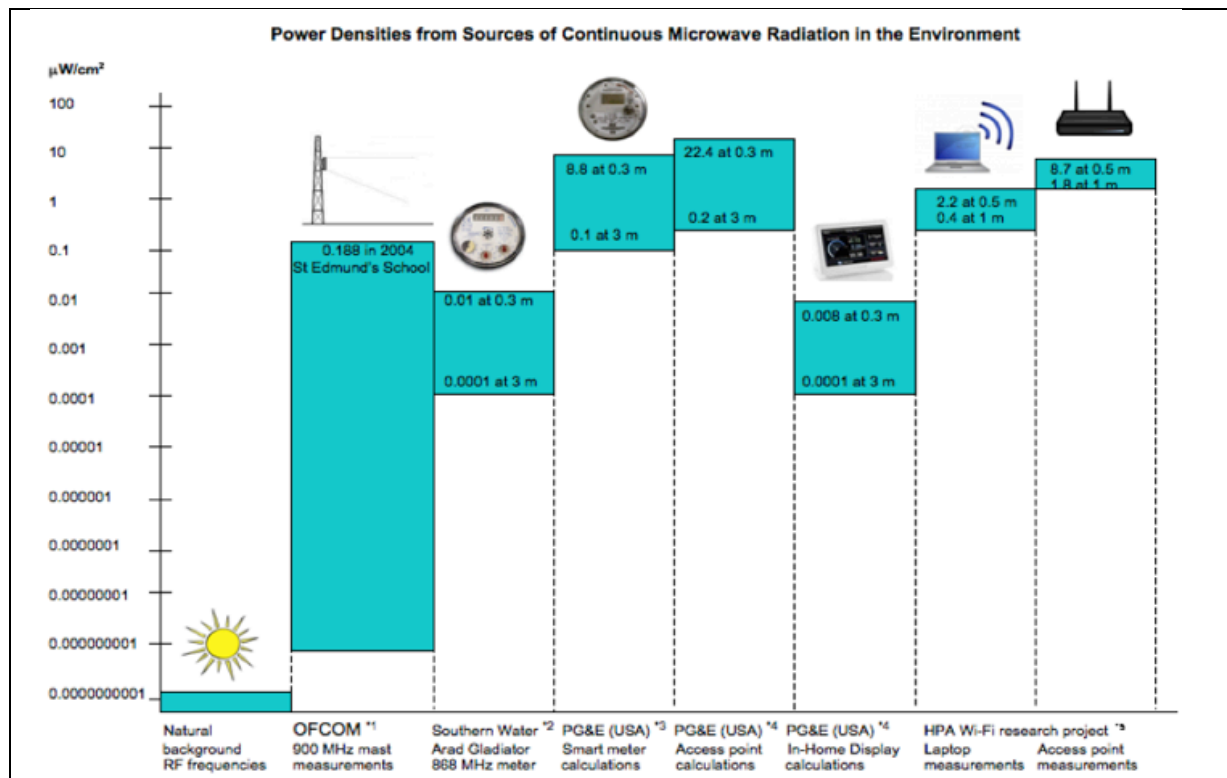


Figure 1.3 Microwave emissions from different sources (Image source: BEMRI.org, 2012).

1.10 Health Canada Safety Code 6: protection from RF exposure (Q64.1)

Document: BCSEA IR No. 1 - Question 64.1

Comment on Question 64.1: “Can it be said that Health Canada Safety Code 6 is intended to protect only against thermal consequences of RF exposure? Or is Health Canada Safety Code 6 intended to protect against any levels of RF exposure?” Response: “No. Safety Code 6 also states that “For frequencies from 3 to 100 kHz, the predominant health effect to be avoided is the unintentional stimulation of excitable tissues, since the threshold for electrostimulation in this frequency range will typically be lower than that for the onset of thermal effects.” (p. 9). ...”

The switched mode power supply (SMPS) of smart meters can create high-frequency voltage transients (HFVT), in the 4-60 kHz range, on indoor wiring. Tests have shown that frequencies in this range, at intensities lesser than those measured on the wiring, can cause adverse health effects. This is discussed in detail elsewhere in this present section.

Comment on Question 64.1: “... At present, there is no scientific basis for the premise of chronic and/or cumulative health risks from RF energy at levels below the limits outlined in Safety Code 6. Proposed effects from RF energy exposures in the frequency range between 100 kHz and 300 GHz, at levels below the threshold to produce thermal effects, have been reviewed. At present, these effects have not been scientifically established, nor are their implications for human health sufficiently well understood. Additionally, a lack of evidence of causality, biological plausibility and reproducibility greatly weaken the support for the hypothesis for such effects. Thus, these proposed outcomes do not provide a credible foundation for making science-based recommendations for limiting human exposures to low-intensity RF energy.” (Safety Code 6, 2009, p. 9)”

A number of effects have been scientifically established, and their implications for human health have led to a number of scientists, and foreign health agencies, advocating the need for the adoption of more onerous standards (Grigoriev 2010, Chiang 2009, WHO 2009, Pilette 2008, USG 2008, McKeown 2007, Oberfeld 2003, Polish Minister of the Environment 2003, SanPiN 2003, Vecchia 2003, WHO 2002a, SAEFL 2000, Sage 2000, Ministry of Health of the Ukraine 1996).

1.11 US exposure guidelines & CCST Report

1.11.1 Exposure guidelines in the USA

Exposure guidelines in the USA are similar to those in Safety Code 6. Commentaries on these are provided below:

United States Environmental Protection Agency commentary on FCC guidelines:

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

The US EPA stated that since its comments were submitted to the FCC in 1993:

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

The US EPA also declared that:

- exposures complying with the FCC’s guidelines are usually presented as “safe” by many RF/microwave operators and service providers in spite of uncertainties over possible risks from intermittent non-thermal exposures.

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

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

It is recognised in the USA that “... there is no federally developed national standard for safe levels of exposure to radiofrequency (RF) [microwave] energy, ...” US Federal Communications Commission (FCC 2011).

1.11.2 Health impacts from smart meters – the CCST Report

The California Council on Science and Technology (CCST) found that “*The FCC standard provides an adequate factor of safety against thermally induced health impacts of smart meters and other electronic devices in the same range of RF emissions.*” It also noted that “**in some of the studies reviewed, contributors have raised emerging questions from some in the medical and biological fields about the potential for biological impacts other than the thermal impact that the FCC guidelines address.**” “Non-thermal effects ... including cumulative or prolonged exposure to lower levels of RF emissions, are not well understood. Some studies have suggested non-thermal effects may include fatigue, headache, irritability, or even cancer....” (CCST 2011). The CCST suggests additional research and monitoring are required to help better document and understand non-thermal effects.

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

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

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

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

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

Maret (2011) goes further on this topic, stating that there is a large body of scientific literature describing several key mechanisms for non-thermal effects. He cites early reports by Frey (1993), Hyland (2000) and Lai (2000) on the potential health effects on non-thermal EMFs, then mentions that many relevant scientific findings are covered by the BioInitiative Working Group (2007) [which has since been updated as the BioInitiative Report 2012 (BioInitiative Working Group 2012)], and that in 2010 the European Journal of Oncology published an entire monograph outlining non-thermal effects of EMFs (Giuliani & Soffritti 2010).

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

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

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

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

Unlike the FCC standard, the above guidelines (along with those for Austria, Lichtenstein, Belgium (Brussels, Wallonia, Flanders), Bulgaria, Luxembourg, Ukraine, Switzerland, Hungary, Italy and Paris, France) take into account children, pregnant women, the elderly, and those with debilitating conditions.

1.12 Exposure standards/guidelines & literature discussing non-thermal effects.

Fortis' responses to questions on non-thermal effects:

CSTS IR2, Q22.1: ... FortisBC has not considered following an **unofficial** 'standard' that has not been accepted by Health Canada or provincial health agencies."

CSTS IR1 Q20.1: ...The basis and provisions of Safety Code 6 are **similar to** standards developed by many other national and international scientific, health, and governmental agencies."

CSTS IR1 Q20.2: "FortisBC is not aware of any **science-based**, generally accepted "non-thermal standard".

WKCC IR2, Q32: ...The position of FortisBC is not based upon its own interpretation of **individual studies**; rather FortisBC relies upon regulations,..."

From the FortisBC's responses shown above, it appears that it may be unaware of the fact that a number of foreign countries follow far more stringent science- and evidence-based EMF guidelines than Canada does, i.e. Russia, China, Austria (Salzburg Health Dept), Poland, Lichtenstein, Belgium (Brussels, Wallonia, Flanders), Bulgaria, Luxembourg, Ukraine, Switzerland, Hungary, Italy, and Paris, France. Their guidelines suggest that adequate protection from radiofrequency fields and microwaves is not provided solely by compliance with thermally based exposure limits.

A comparison between the exposure levels permitted by these official standards and ICNIRP's permitted exposure (which is similar to that of Canada's Safety Code 6) is shown in Figure 1.4 (Jamieson 2012b).

There are numerous peer-reviewed scientific studies indicating that non-thermal biological effects can arise at exposure levels well below those categorised as safe by the Health Canada's Safety Code 6.

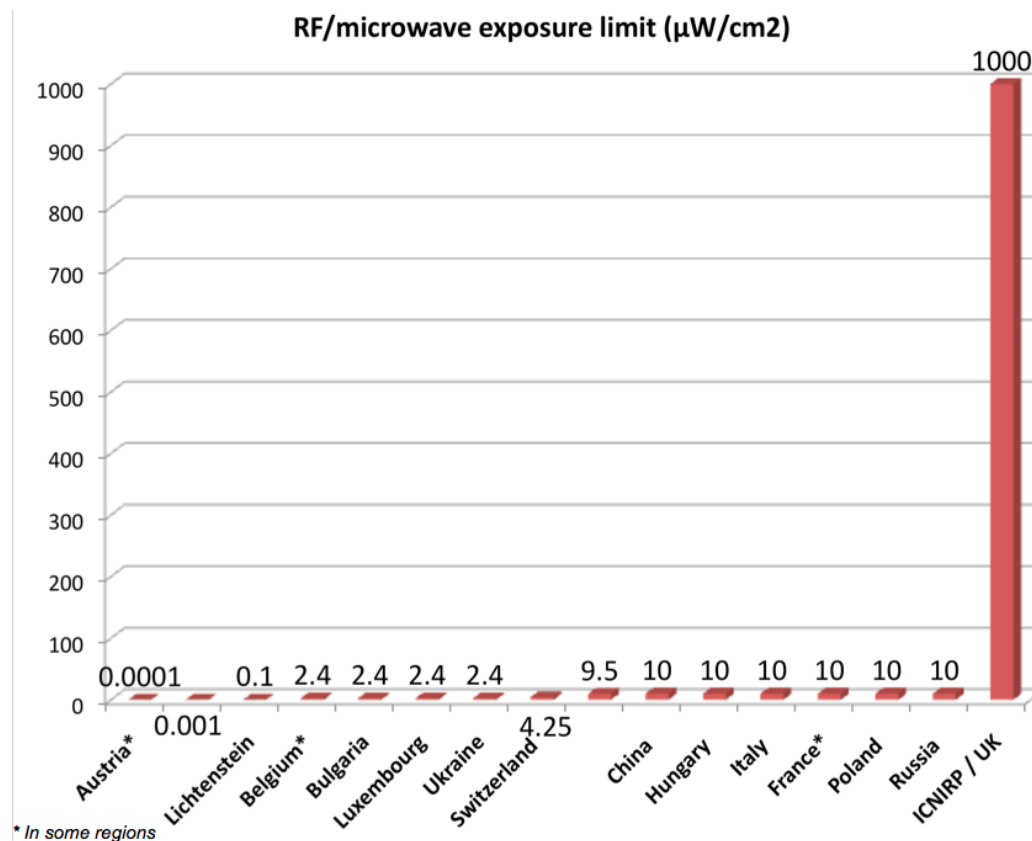


Figure 1.4 Comparison between exposure levels permitted in other countries & ICNIRP levels used in UK (Jamieson 2012b).

As shown in the response to the above question, there are a number of accepted foreign national and regional “non-thermal” standards that are science based and take the wellbeing of their citizens into account. Table 1.6 provides more details on them.

Table 1.6 RF/microwave Power Densities – Guidelines: Comparison between levels permitted in other countries & ICNIRP levels

Country/Region	RF/microwave exposure limit ($\mu\text{W}/\text{cm}^2$)	Approx.
Austria (Salzburg Health Dept) (Oberfeld 2003)	0.0001 (indoor) 0.001 (outdoor)	0.00001% 0.0001%
Lichtenstein (USG 2008)	0.1	0.01%
Belgium (Brussels, Wallonia, Flanders) (WHO 2009)	2.4	0.3%
Luxembourg (Pilette 2008)	2.4	0.3%
Ukraine (Ministry of Health of the Ukraine 1996)	2.4	0.3%
Switzerland (SAEFL 2000)	4.25 - Sensitive areas (e.g. schools & hospitals) 9.5 - General	0.5% 1%
Bulgaria (WHO 2002a)	10	1%
China (Chiang 2009)	10	1%
Hungary (Sage 2000)	10	1%
Italy (Vecchia 2003)	10	1%
Paris, France (McKeown 2007)	10	1%
Poland (Polish Minister of the Environment 2003)	10	1%
Russia (SanPiN 2003)	10	1%
ICNIRP (ICNIRP 1998)	1000 $\mu\text{W}/\text{cm}^2$	100%

As noted by Professor Yury Grigoriev, Chairman of the Russian National Committee on Non-Ionizing Radiation Protection, *“Presently there is a refusal by many western scientists to accept the possibility of the existence of detrimental non-thermal RF-EMF effects, which in consequence has resulted in an under estimation of the actual dangers that may exist to the health of the population through different degrees of RF-exposure. However there are a very large number of publications by scientists from both the east and the west documenting biological effects from low levels of RF-EMF.”* (Grigoriev 2010).

Around a quarter of the World’s population are protected by EMF exposure guidelines far more stringent than Canada’s. Please also refer to the commentary given below by the US EPA on the FCC’s guidelines which states that the generalisation by many that FCC guidelines protect humans from harm by any or all mechanisms is unjustified (US EPA 2002), and also the FCC’s own admission that “... there is no federally developed national standard for safe levels of exposure to radiofrequency (RF) [microwave] energy, ...” US Federal Communications Commission (FCC 2011).

As previously noted, in 2008 Paolo Vecchia, Chairman of ICNIRP, stated “the ICNIRP guidelines [which are similar to Safety Code 6 guidelines – present author’s comment] are neither mandatory prescriptions for safety, the “last word” on the issue nor are they defensive walls for Industry or others.” (Vecchia 2008).

There are numerous informed doctors and scientists who request safer standards: Board of American Academy of Environmental Medicine’s Resolution against Wireless Smart Meters, American Academy of Environmental Medicine 2012, Sage Report 2011, Report of The Standing Committee on Health, County of Santa Cruz 2011, Council of Europe: “Remove wireless from schools” 2011, Cellphones and Brain Tumors: 15 Reasons for Concern, Science, Spin and the Truth an examination of the potential Health Impacts of Radiofrequency Electromagnetic Radiation, 2010 (House of Commons: Report of the Standing Committee on Health), Behind Interphone 2009, Dutch Appeal 2009, European Parliament EMF Resolution 2009, London Resolution 2009, Porto Alegre Resolution 2009, International Appeal of Würzburg 2010, Paris Appeal 2009, Berlin Appeal 2008, Venice Resolution 2008, Bioinitiative Report 2012 & 2007, Brussels Appeal 2007, WiMax Appeal 2006, Pfarrkirchener Appeal 2005, Freienbacher Appeal 2005, Lichtenfelser Appeal 2005, Hofer Appeal 2005, Helsinki Appeal 2005, Allgaeuer Appeal

2006, Benevento Resolution 2006, Saarlander Appeal 2005, Parish Kirchner Appeal 2005, Coburger Appeal 2005, Stockacher Appeal 2005, Oberammergau Appeal 2005, Haibacher Appeal 2005, Bamberger Appeal 2004, Maintaler Appeal 2004, Declaration of Alcalá 2002, Catania Resolution 2002, Freiburger Appeal 2002 & 2012, Salzburg Resolution 2000 & Vienna Resolution 1998.

The fact that detrimental, sometimes life destroying, health effects are already being noted with smart meter roll outs elsewhere (EMFSN 2013) should be a wake up call that something is going wrong.

1.13 Itron AM17 vs. other meters

Document: BCSEA IR No. 1 - Question 60.2

Comment on Question 60.2: “Is there any significant difference between the RF exposure of the Itron AM17 meter and any of the other types of meters considered by FBC?” Response: “FortisBC did not request RF emission data from proponents responding to the RFP, only a statement of compliance with Health Canada Safety Code 6.”

If there is no significant difference between the RF/microwave exposure from the Itron AM17 meter and other types of smart meter, the health effects experienced by some members of the public may prove similar to those found in other roll outs. Also it should be taken into consideration that the meter is not the only source of microwave radiation that individuals would be exposed to from FortisBC. On page 45 of Appendix C-5, it is stated that “In addition to advanced meters at home, there is a small number of supporting infrastructure RF transmitters installed on the utility poles in the neighborhood above the level of the residences. Due to the distance of these transmitters from the residences, the typical exposure from these devices in the residence should not exceed the typical exposure from the advanced meter.” **Whilst no exact range of figures is given for this extra exposure, it would appear that cumulative 24/7 exposures of residents would be effectively doubled.**

1.14 Can customer turn off ZigBee radio?

Document: BCSEA IR No. 1 - Question 57.2

Comment on Question 57.2: “If so, is there some way that the customer, or FBC at the customer’s request, can turn off the ZigBee radio in a specific installed meter?” Response: “FortisBC intends to deploy the AMI meter configured with the Zigbee radio set to “quiet mode” where it will not send any signals unless a valid HAN device requests a beacon. The Utility can provision meters to accept requests from devices or to ignore requests and remain silent.”

Even when customers request that ZigBee radio is deactivated, there is still be the possibility that they will be exposed to microwave radiation from activated ZigBee radio devices from neighbours’ wireless meters. The peak power density from ZigBee radio is 31 $\mu\text{W}/\text{cm}^2$. According to Meyer (2012) ZigBee devices also present security issues.

1.15 RF signals – elimination process

Document: CEC IR No. 1 - Question 50.7.3

Comment on Question 50.7.3: “Does FortisBC believe that eliminating the RF signal from a Smart Meter would enable a person to eliminate RF signals from their personal environment?”

Please explain.” “Response: FortisBC does not believe it is possible for any customer to eliminate RF signals from their personal environment, even those in rural environments. Both natural (from earth and even human bodies) and man-made RF signals are constantly present all around us.”

Many radiofrequency and microwave frequency signals can be excluded from the environments that individuals occupy through shielding, the types of building materials used, and the choice of using non RF/microwave emitting technologies. Biological effects have been observed with both natural and manmade fields.

Even in situations where wired smart meters are used, radiofrequency radiation can be created from their Switched Mode Power Supply (SMPS). Details of this and of health effects noted at similar frequencies created in Nature (and frequencies created by BPL) are documented below:

1.16 Switched-Mode Power Supply (SMPS)

1.16.1 Background information

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

1.16.2 High-Frequency Voltage Transients (4-60 kHz)

It has been revealed that high-frequency transients, radiofrequency voltage spikes in the 4-60 kHz range, can be created by the Switched-Mode Power Supply (SMPS) units of smart meters (even when their wireless transmitters are disabled), unless suitable – and usually expensive – precautions are taken. This Very Low Frequency (VLF) interference, otherwise known as high frequency voltage transients (HFVT), or ‘dirty electricity’ – the term most readily used by EHS groups – can be readily carried indoors from those meters’ SMPS onto mains wiring and has been linked with detrimental health effects. The use/retention of traditional analog meters (not analog meters retrofitted with chips and antenna to operate wirelessly) helps avoid a number of problems.

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

1.16.3 Link between HFVT created by SMPS and health conditions

The high frequency voltage transients created by the SMPS units in smart meters, which can be found on indoor wiring, have been implicated as being a contributing factor to a number of the detrimental health effects observed with smart meter installations, even when wireless transmission is disabled.

It has been suggested by some, including Milham (2011), that the detrimental health effects noted in some instances even *before* the meters’ wireless function is enabled may be because of the addition of HFVT onto mains wiring [placebo effects too can come into play – present author’s comment, though

there have been documented occurrences of individuals getting ill without realising that a smart meter had been installed at the time that the symptoms had first appeared (EMFSN 2013).

Dr. Milham, a physician who has been advising individuals suffering ill-health after smart meter installations, states that in his opinion “disabling the two transmitters in each meter does not solve the health problems, since each meter has a switched mode power supply which puts out high frequency radio frequency signals 24/7.” He further states that he has had “a number of cases where symptoms continued after the meter’s transmitters were disabled, but disappeared when an analog meter was reinstalled.”

Whilst there will be skeptics who believe that the appearance and continuance of symptoms due to the presence of wireless meters, particularly when their wireless function is disabled, is a placebo effect alone – which in some cases it may be – there is scientific research, in addition to anecdotal findings, which provide some credence for the health effect claims.

1.16.4 Literature review on effects noted by with frequencies SMPS can create

1.16.4.1 Natural VLF-atmospherics/VLF-sferics (1-100 kHz)

These are naturally occurring electromagnetic pulses of short duration (around 500 μ s) in the 1-100 kHz range, with a frequency maximum normally around 10 kHz. They are generated by lightning and are of quite low-intensity ($<0.1\mu$ T). Sferics also appear to be created throughout dynamic weather processes, like the development and movement of cold and warm fronts (Schienle et al. 1996).

Research has revealed significant positive correlations between sferics (at intensities and frequencies similar to those created by SMPS) and human health effects, at levels greatly below those normally considered by authorities as giving cause for concern.

1.16.4.1.1 Background Information

Dr. Reinhold Reiter conducted some of the first investigations specifically investigating the biological effects of sferics on humans. His extensive work revealed significant positive correlations between sferics impulse rates and increased pain levels for brain injured patients, operation scars and wounds, plus incidences of asthma, angina pectoris and migraine. Increased reaction times, accident-rates, incidents of crime and suicides were also noted during natural enhanced sferics activity (Reiter 1974, 1960, 1954, 1953, 1951, 1950).

Sulman et al. (1976) later discovered a correlation between enhanced 10 kHz sferics activity and increased incidence of migraines, sleep disorders and tension. Laaber (1987) additionally found that the number of mistakes made by pupils on tasks requiring concentration increased when high levels of 10 kHz sferics occurred the night before testing ($r = 0.35$).

Research by Fischer & Grossmann (1990), analysing 2,800 emergency calls and 1,250 uses of ambulances (over the period 1984-1985), found that there were highly-significant correlations between increased 10 kHz sferics activity and the occurrence of particular events that would allow emergency staff levels and ambulance requirements to be predicted in advance. Their work also revealed the following probabilities for increased 10 kHz activity: **general troubles, insomnia, increased accident frequency or muscular spasms ($p < 0.001$), hypertension, suicide or thrombosis ($p < 0.05$). Biases towards positive correlations were found with migraine, colic, depression and heart attacks.**

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

1.16.4.1.2 Myocardial infarction (heart attack)

Though Ungeheuer (1952) discovered no increased incidents of myocardial infarction in humans with increased 28 kHz activity, a connection between sferics activity and heart attacks was found by Klein (1968) and Brezowsky & Rantscht-Froemsdorff (1966) when impulse rates were ≥ 0.02 V/m. A possible connection has also been made between geomagnetic activity and heart attacks in humans (Malin & Srivastava 1979, Weiss 1991).

A review by Undt (1962), referring to studies research undertaken by Wedler (1962) noted that an abnormally high mortality rate in West Berlin over the period 10-14 July 1959 was noticeably correlated with increased intensities of VLF- atmospherics – full details of this work were not available. Such findings also appear to correlate with those of Reiter (1954) for periods with VLF disturbances.

Klein (1968) investigated the possible influence of local sferics in Hamburg on 548 incidents of myocardial infarction in humans over an eight-year period (1955-1963). Significant correlations were found between noon minimum sferics levels ≥ 0.02 V/m and heart attacks that occurred during that time of the day. He additionally noted that 96% of 541 recorded heart-attacks occurred during the typical midday curve section when field-levels ≥ 0.02 V/m occurred, but that for field levels of 0.4 V/m only 43% of heart-attacks that occurred during such periods could be assigned to that part of the curve.

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

1.16.4.1.3 Sferics Simulation Studies

In order to reduce variables that could act as potential confounders in the assessment of the biological effects of the electromagnetic components of weather patterns that create sferics, a number of scientists have undertaken simulation studies under controlled experimental conditions. The field intensities appear of similar magnitude to that which may be created by SMPS units on electrical wiring. The sferics frequency range is also similar to that created by SMPS units.

1.16.4.1.4 Effects of simulated sferics on dizziness

A pilot study on humans by Ludwig & Mecke (1968) examined the effects of electric field amplitudes of 1 V/m and 10 mV/m, and magnetic field amplitudes of 26.5 mA/m, 2.65 mA/m on individuals. Square-wave impulses with frequencies of 10 kHz and 100 kHz were used with pulse repetition frequencies of 2.5, 5, 10 or 20 Hz. The simulation caused dizziness in some test-subjects who were indicated as having over-responsive parasympathetic nervous systems. (Dizziness was also one of the symptoms reported by respondents in the online survey initiated by The EMF Safety Network into the potential health effects of smart meters (Halteman 2011)).

1.16.4.1.5 Platelet adhesiveness, blood coagulation, thrombosis and haemorrhage risk

Rantscht-Froemsdorf & Rinck (1972) investigating field effects on blood coagulation discovered that variations in susceptibility to thrombosis (and haemorrhage) could occur under simulated natural sferics. In that work, test-subjects were exposed to either a 10 kHz impulse (*with amplitude 10 mV/m and a repetition frequency of between 3 and 10 Hz*), or a 10-100 kHz signal (*with amplitude of 100 mV/m and impulse rate between 30 and 100 Hz*) for a period of several weeks.

Jacobi et al. (1973) demonstrated that a rapid transformation in weather accompanied by sferics with field-strengths of 0.02-0.4 V/m, could significantly alter the degree of platelet adhesiveness that was measured ($p < 0.001$).

Jacobi et al. (1981) sought to replicate the effects of normal sferics patterns on platelet adhesiveness in a screened environment using simulated 10 kHz sferics (*with amplitude of 0.4 V/m repeated with a 10 Hz frequency*). Platelet adhesiveness was shown to significantly increase as a result of exposure, with the response being greater in some subjects than others. The degree adhesiveness that occurred was found to be linked with the test-subjects' individual physiological reaction-type, with adhesiveness being more pronounced in the platelets of that were noted as being psychologically labile. The reactions to sferics from such test-subjects were significantly greater ($p < 0.001$) than those obtained from those categorised as stable (Wever 1985/1983, Jacobi et al. 1981, Jacobi 1979, 1977, Jacobi & Krüskemper 1975).

Jacobi et al. (1981) noted, **"The increase in platelet adhesiveness induced by all kind of stressors is not a risk factor of thrombosis in itself. Only if the vessel walls are damaged, e.g. by atherosclerotic plaques, or if the blood flow is reduced, e.g. by heart failure, then the increased platelet adhesiveness will cause thrombosis."** Following exposures to the simulated sferics medication of anti-platelet drugs were found to be completely ineffective. Interestingly, the Deutsche Forschungsgemeinschaft (German Research Partnership) which provided the equipment used for those experiments, insisted that only field strengths ≤ 0.4 V/m should be tested, as they did not wish to endanger subjects predisposed to thrombosis (Wever 1985/1983).

Comment: As noted at the beginning of this section, the SMPS of smart/advanced meters have been shown to create amplitudes of 2 volts in the 4-60 kHz range (Brangan & Heddle 2011). As frequencies within that range and amplitude in sferics research have been shown to be biologically active, it would appear prudent to conduct similar independent research on the possible effects of the frequencies created by SMPS (*both by themselves and the frequencies created as electrical items are being used on the electrical wiring exposed to SMPS frequencies within buildings*) on blood coagulation and other parameters.

1.16.4.1.6 Effects of simulated sferics on brainwave patterns

A pilot study by Tirsch et al. (1994), cited by Schniele et al. (1998), showed that a 10-minute exposure to simulated 10 kHz sferics (with a magnetic field strength of 50 nT) resulted in a peak frequency shift within the EEG alpha band (8-13 Hz) in the brain's occipital lobes through increasing the power of faster oscillations within that range. Other studies have produced similar findings.

In research by Schienle et al. (1997) EEG registration was maintained after the conclusion of a 10-minute exposure of 20 test-subjects to simulated 10 kHz sferics (*with maximum amplitude of 50 nT and 500 microsecond durations, with a pulse-repetition rates between 7-20 Hz*) to investigate potential extended effects. **The sferics exposure was shown to provoke increases in alpha power for all electrode sites apart from the left parietal region.**

An increase beta power (14-30 Hz) was also exhibited, that was limited to only the right hemisphere of the brain. These increases in alpha and beta power shown during simulation continued 10 minutes after the exposure ended. Such effects were not registered with the control group of 20 test-subjects.

Schienle et al. (1997) noted that, **"A longer lasting influence of sferics exposure was displayed by subjects with a high degree in weather sensitivity, somatic complaints, and neuroticism, who continued to stay on an enhanced alpha power level until the end of registration (20 minutes after the end of exposure). With these results a general electrocortical sensitivity towards sferics as well as individual differences in sferics reactivity could be demonstrated."**

1.16.4.1.6.1 4-100 kHz (manmade high frequency voltage transients)

The past work of Havas (2006), Milham (2010) and Milham & Morgan (2008) and the observations of Milham (2011) are of interest with regard to the possible health effects of smart meters' SMPS (and also BPL) emissions, as the 'dirty electricity'/ HFVT (electromagnetic energy that deviates from a pure mains-frequency sine wave and contains both harmonic and transient components) they document in their research carries similar radiofrequency radiation transients.

Little has been written regarding this topic in peer-reviewed journals. De Vocht (2010) when conducting a literature search in PubMed found only seven articles on this subject. He noted that exposure to HFVT "was associated with increased cancer risks, while preferential removal of 4–100 kHz HFVT from 50–60 Hz ELF circuits was linked to a variety of improvements in health (plasma glucose levels in diabetic patients, symptoms of multiple sclerosis, asthma and other respiratory illnesses, and insomnia), well-being (tiredness, frustration, general health, irritation, sense of satisfaction, mood), and student behaviour."

De Vocht (2010) also noted that the studies which recorded the findings documented above often had "significant methodological flaws". This lack of detailed studies on manmade HFVT is one of the reasons that the effects of exposures to natural and simulated VLF-atmospherics/VLF-sferics (which cover a similar frequency range) are also documented in this present work.

Comment: The RF filters used to reduce exposure to HFVT in the research by Havas (2006) do so over the 4-100 kHz range. However, it appears they have no effect in reducing exposure to frequencies below that frequency range which can also be biologically active.

It would appear prudent to assess the effects of the fields created by SMPS on household wiring on different biological parameters, as tested in the research above both natural and manmade fields in the 1-100 kHz range.

It would also seem appropriate to assess how exposures may affect brainwave patterns whilst asleep. Tests could additionally be undertaken when the wireless functions in smart/advanced meters are activated and also when smart appliances are present, as may be the case in many 'real life situations' in the future. **Knowledge on the possible effects of such exposures on individuals' brainwave patterns during sleep, and sleep quality, would appear particularly valuable** as the sleep problems were noted in 49.1% of the respondents (n = 318) to The EMF Safety Network online survey (Halteman 2011).

1.16.4.1.6.2 Broadband over Power Lines (BPL) and health (9-500 kHz and at ≥ 1 MHz)

These are discussed in case FortisBC wishes in future to consider the use of alternatives technologies transmit data.

Broadband over Power Lines (BPL) - *which is also known as Power Line Communications (PLCs) in many countries and 'Linky' in France* - transform electric grids into smart grids through turning them into communications networks by placing RF-modulated carrier signals onto grid wiring. A variety of BPL systems use different frequency bands depending on the characteristics of the wiring they operate on. BPL typically operate at frequencies between 9-500 kHz or at frequencies of ≥ 1 MHz (Wikipedia 2011).

Some studies, as documented above, indicate biological effects at very low intensities at frequencies in the kHz range that some BPL can create. There have also been tests of ≥ 1 MHz frequencies that indicate that these frequencies too can be biologically active at low intensities. The possible effects of BPL on health have yet to be properly assessed.

1.16.4.1.6.3 ≥ 0.1 MHz high-frequency (manmade)

A pilot study instituted by Commander Russell M. Jaffe in 1978 (*who was Senior Staff Physician at the US National Institutes of Health at that time*) indicated that exposures to frequencies in the 0.1-100 MHz (100-100000 kHz) range appeared to weaken human muscle strength, and that proper radiofrequency shielding restored both tone and strength (Ott 1982). As BPL can create interference in this range, it may prove wise to undertake similar experimentation to determine if such systems are appropriate for use.

1.16.4.1.6.4 ≥ 100 MHz ultra-high-frequency (manmade)

Von Klitzing (1993) demonstrated that 15-minute exposure to 150 MHz signals of low amplitude ($1 \mu\text{W}/\text{cm}^2$) pulsed with frequencies corresponding to 8-10 Hz human brainwaves increased human alpha rhythms.

1.17 Anecdotal evidence on health effects from BPL

As indicated by the following, some individuals already appear to react adversely to BPL signals.

1.17.1 BPL Smart Meter Health Impacts Testimonials

Information source: Cellular Phone Task Force (2012):

“Transmitting by sending signals along the power line is sometimes promoted as a safer alternative to wireless. The reality is that these [BPL] type systems create “dirty electricity” on household wiring and the power lines outside people’s houses, which greatly affects some people.”

1.17.2 [BPL] communication health effect testimonials

“In the fall of 2005 we received a colorful brochure from Vattenfall [electric utility] that we would be receiving “the meter of modern times” for our vacation cabin. We immediately notified the utility that we wanted to opt out and keep the old meter, due to being electrosensitive.

The next time we visited the cabin, we noted that the neighbor had a new meter, while ours had not been touched. To my surprise, I still got EHS symptoms, i.e. I became dizzy, had pain in my head and stomach and felt restless.

***We didn’t know that [BPL] signals on the electrical line can travel into other households. Neither did we know that it doesn’t help to turn off the breakers, as the [BPL] signals travel on the neutral wire.** We found that to stop the signals from entering the house, we had to hire an electrician to install a special switch that disconnects all the wires.*

It wasn’t just me who couldn’t be in the cabin when the [BPL] was on. Neither could the mice, which used to enter the cabin when we were away, but not any more.”

“[The above] is part of an article in the 2009/3 issue of Ljusglimten, a Swedish magazine for people with electrical hypersensitivity. The Swedish electrical utility eventually took the problem

seriously and installed a filter on the line. This solved the problem, though the mice returned. There are many types of [BPL] systems, not all can be blocked by filters."

Twin Falls County, Idaho:

"I asked Idaho Power not to install a smart meter. I told them that they may access their meter, but they are not to install a communication device upon my home. One day when I was not at home, they climbed over my fence and installed their 'smart' meter.

As 'smart' meters were being installed around me, and I didn't have one at the time, I began to get headaches and dizziness from just their nearness. After the meter was installed, I was flat on my back for days with fatigue, constant headaches, palpitations, and feeling as if the earth and my body were vibrating. This went on for days, and I continue to have problems.

Then I began to have buzzing in the ears. This buzzing is very different from tinnitus, which I've had for years, and I believe it is deteriorating my hearing. I began to have problems with all wireless communication devices and even electronics. The meter has caused me to become electro hypersensitive. It has totally altered my life as to where I can go or how long I can be there until I feel sick.

I have two poodles. One of them had a change in behavior after the meter was installed. He became very distrustful of visitors, when before the meter he loved everyone who walked through the door. I think he has buzzing in his ears, too. When the buzzing changes throughout the day to higher intensities, he whimpers.

By the way, that meter which the power company told me didn't communicate wirelessly sure does a lot of wireless communication. I purchased a high frequency analyzer and the meter is constantly putting out WiFi and cellular signals along with the power line communication.

Idaho Power uses TWACS smart meters that in this case are also capable of communicating with the household gas and water meters by wireless."

From letter to utility in Pennsylvania:

"Perhaps you are not aware that [husband] and I have not been able to live in our home since mid-April and that I became seriously ill from the effects of the extreme electrical fields in our house. What are you going to do about this problem, Mr. [name]? Please let us know soon so that we will know how to plan our lives.

The utility company put the analog meter back, but the signals from the other meters in the area still travelled into the house on the electrical wires. The utility uses the Turtle TS1 system from Hunt Technologies (Landis + Gyr), which transmits non-stop, 24 hours a day. The couple eventually moved to an area without [BPL]."

"Jack (not his real name) has been sensitive to wireless transmitters for well over a decade. For that reason he stays away from the cities. He and his girlfriend spend their winters in Arizona, and the summers in eastern Washington State.

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

Jack's girlfriend stayed in the house while Jack drove back down to Arizona.

After asking around, they found out that the local utility had swapped out all of the electrical meters over the winter. The new smart meters communicate with the utility's computers by sending signals through the power line back to the substation. This is called [BPL] and is mostly used in rural areas. The specific system used is called TWACS.

Jack came back up to eastern Washington a month later, but he had to camp in the backyard. The pulses bother him even fifty feet (15 meters) from the house, with the power line 150 feet (50 meters) on the other side of the house.

The house is rented. The couple decided not to bother complaining to the landlord and the utility company. Even if they got the old meter back, it would not help. There is no way to stop the pulses coming from the outside. Instead, the couple moved away to an area without this menace."

Sweden:

"When they exchanged the electrical meters in our area, the utility promised to inform the residents when the new [BPL] system would start transmitting.

To be safe, I made sure to verify that the utility had my name on their list of people with EHS. They did, and they assured me that any problems would be taken care of if I had problems.

Then, suddenly, unexplainable and severe EHS symptoms showed up. I played detective trying to figure out what caused it, but was not successful.

The explanation came with the next electrical bill, which showed that the new [BPL] system was now in use. They had forgotten to notify us.

*After some run-around with the utility, I got to the person responsible for handling EHS cases. Then it all went smoothly. **Within two weeks, they had moved my electrical meter to a post away from the house, installed the E.ON filter and a ground rod. Now I am just hoping that the relief I got from that continues.***

[The above] story is translated from the Swedish magazine Ljusglinten (2009/3). The [BPL] smart meter was an Enerlux TLS.

Comment: In addition to the anecdotal effects of BPL frequencies on mice documented in one of the above testimonials, it has also been indicated in peer-reviewed research that frequencies in the range that BPL emit can affect wildlife.

1.17.3 Additional concerns over the use of BPL

BPL Effects on shortwave broadcasting: Low speed BPL (below 150 kHz) present no apparent problems - in terms of causing radiowave interference with broadcasting - High speed BPL can and do reduce the effective deployment range of broadcasting to different countries unless transmitter power output levels are substantially increased (Marshall 2010).

"There is strong evidence that the wide deployment of high-speed [BPL] will seriously impact radio communication. If we allow this to happen we sacrifice a proven long-distance universally accessible technology of considerable commercial and social importance for what can only be described as a short-term gain in convenience for local data networks." Richard Marshall [Managing Director and Principal Consultant of the RF and EMC-related electronic design, consultancy & training firm Richard Marshall Limited].

1.17.3.1 Effects on power usage for broadcasting

The increased use of BPL for smart meters may create unforeseen demands in the energy usage of shortwave broadcasters worldwide. Marshall (2010) predicts that in order to match these additional power requirements worldwide "Each year this would require the installation of a further electrical generation resource equivalent to some 30,000 wind turbines!"

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

BPL Effects on radio astronomy: In addition to space satellites, radio astronomy laboratories on Earth investigate solar emissions from the Sun and other planets. Their effective operation is vital in predicting possible disturbances that may seriously compromise the integrity of electrical grids and other infrastructures unless sufficient warning is given. The sensitivity of the measurements taken by these laboratories is in large part determined by their 'radio-noise' environment in the High Frequency range. Ohishi et al. (2003) calculated that to protect HF radio astronomy antenna from interference caused by a single BPL system, it is necessary to have a separation distance from it of 424 km. Far larger separations will be required if BPL are widely deployed.

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

1.18 Fibre optics – health concerns

Document: CSTS IR No. 2, Question 17.1

“Comment on 17.0: “Follow up to response to CSTS IR#1 - 12.8; 12.8 Would the use of a fibre optic network as an alternative to the RF mesh LAN solution eliminate health and environmental concerns with respect to the AMI Project?” Response: “FortisBC does not consider that there are health concerns founded on accepted science related to AMI systems, regardless of whether they use RF or non-RF technology.” And Question 17.1: “The question has not been answered. The question is not about the validity of the concerns from the perspective of FortisBC. The question is about the existence of the referenced customer health concerns and whether FortisBC would expect those concerns to exist with respect to fibre optic communication technology. Please answer the question.” Response: “The Company respectfully submits that the question was answered. FortisBC cannot know how “customer health concerns” (whether for a specific customer or in a general sense) might change if a different LAN technology was proposed and will not speculate in that regard. The validity of health concerns is however relevant to the question since any customer concern should be evaluated in terms of the validity of the concern.”

As health concerns have been indicated as being a major reason for consumer resistance to the smart meter programme, it appears odd that FortisBC has not addressed this issue. It appears that it would actually be quite easy to ask consumers about their possible preferences for LAN technology, particularly as the proposed investment is so large.

As noted by Powerwatch (2010), *“Wireless is not necessary - just cheaper and easier to implement.”*

Not all smart grids are wireless. Some utilities companies have already opted for fibre optic cabling for their primary communication needs. Others have opted for BPL, or use it as a backup channel or for simple installations they consider do not merit the installation costs of fibre optics. At present fibre optics have been adopted in part for smart metering purposes areas in Canada and the USA (SMPM 2011). Alternatives to wireless smart meters, and related technologies, may be required for a number of reasons. One of these is for the benefit of individuals who may be EHS, or simply do not wish to be exposed to raised levels of manmade electromagnetic fields. The use of wired smart meters (such as used by EPB in Chattanooga (Baker 2011), would avoid such problems. As a matter of best practice, filters should be used to reduce high frequency transients from smart meters that may otherwise create High-Frequency Voltage Transients on indoor wiring which have been indicated in some research as negatively impacting health (Milham 2010, Havas 2006).

1.18.1 Practicality of Fibre optics

The high up-front costs of smart grids present financial challenges (as do those of broadband projects). Whilst utility companies use only a small amount of the broadband capacity that they put in to support smart grid applications, a strong case can be given for investing in that capacity to increase revenue potential, particularly if they choose to do so in an environmentally-friendly manner. As proposed by Kennedy (2011), if utilities were to lease very high bandwidth ‘future friendly’ fibre optic capacity to providers of general broadband services; they, the general broadband providers, and their customers would all benefit. This would allow more broadband projects to become economically viable and lower prices for broadband customers – *a true ‘Win/Win’ situation.*

Additionally, in situations where fibre optics have already been put in by broadband providers, they could lease bandwidth to the utilities and avoid the need for wireless smart meter connections.

The ruggedness of fibre optic cables can provide tremendous benefits over their competitors. They are very secure, non-corroding, immune to water damage, electromagnetic and radiofrequency interference, difficult to damage (when in steel armoured cables or in underground conduit), and are

more reliable than their competitors during poor weather and catastrophic events. They also have longer service lives – fifty years plus – and lower maintenance costs (Kennedy 2011, Fehrenbacher 2009).

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

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

1.18.2 USA: Fibre optics case study

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

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

The creation of their fibre optics infrastructure has already led to Chattanooga attracting new business (the new North American manufacturing headquarters for Volkswagen and an Amazon distribution plant). As a result of its utilisation of fibre optics Chattanooga has been ranked as one of the World's top seven Intelligent Communities (ICF 2011). Chattanooga's ranking was in part achieved as a result of its fully-accessible fibre optic one gigabit residential Internet service being “200 times faster than the current [US] national average and ten times faster than the FCC's National Broadband Plan (a decade ahead of schedule),” (Baker 2011).

“Our 100% fiber-optic network will serve as a platform for accelerated innovation, job creation and deep creativity while serving as the backbone for the next generation of energy efficiency. All in all, with this infrastructure, we can't even imagine today what will be possible in the future – but we will be ready.” David Wade, EPB's Executive Vice President and Chief Operating Officer (Baker 2011). A fibre-optic network is also being built for Opelika, Alabama, USA. It is planned that the city's public power utility will use the network for smart-grid services and a private company be contracted to deliver triple-play services (Christopher 2010).

Germany: Fibre optics case study

In Germany, the city of Konstanz is also deploying a fibre network for its smart meter infrastructure. The ‘Fibre to the Home’ (FttH) fibre network being supplied by Cisco Systems will also allow the city to tap into new business for communication services using gigabit bandwidth – the planned integration between power and communications infrastructure is seen as a prerequisite for optimised use (Cisco 2012). **It is foreseen that its “broadband infrastructure also lays the foundation for a future smart grid that will improve the economic opportunities of renewable forms of energy significantly.”**

The advanced fibre optic network, which is now already in use in some areas of the city, allows a thousand times higher data rate than conventional copper cables can provide (Cisco 2012). This large-scale infrastructure project, launched in May 2011, will take a decade to complete and will help to provide a flexible more ‘future proof’ and ecologically sound system than wireless smart metering systems and BPL.

1.18.3 Fibre optic investment returns in France

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

1.18.4 Estimated returns on investment (non-binding)

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

As the basic outlay by ADTIM is €73 million (\$99,564,312), the gross return on its investment would be met in approximately 3 years. Going by the minimum estimate, the company should be making a clear profit margin in year 5 or 6 (Next-up 2010).

As the fibre-optic network's extensive installation is indicated as creating a substantial short-term profit for both public and private investors - even under difficult circumstances - and is able to do so without creating environmental risks; it is suggested that similar schemes could be undertaken in BC, and elsewhere, incorporating smart grid connections.

"Considering the developments in technology and in economic matters ... and in view of the fears expressed by some ... concerning the effects of intense radio waves, the committee ... has decided to modify its strategy for providing this service for those areas not yet covered. As a result no new wi-fi or wi-max antennas will be used ...," Didier Guillaume, President of Conseil Général de la Drôme and Senator of the Upper House of the Parliament of France. ***"I am keenly aware of the need to keep in mind the potential health risks linked to radiation, I give my full backing to this decision, which bears out the wish of the General Council to limit the sources of intense radio wave emission,"*** (Guillaume 2009).

1.18.5 Fibre optics as a practical alternative to wireless and BPL

Fibre optics networks present a more secure, cost-effective, alternative to wireless smart meters. They are also more biologically friendly and 'future proofed' than wireless options and BPL. "...when you add a demand for reliability and resiliency (as well as a technology that doesn't conduct electricity) to the trends already highlighted, fiber offers a exemplary conduit for the intelligence, two-way communications, and control and monitoring capabilities smart grid applications demand." (Hardy 2010).

Fibre optics appears a smarter more 'environmentally friendly' alternative to adopt for general rollouts to gain public acceptance and attract investment.

1.18.5.1 Home Area Networks (HAN)

Public health concerns, the recent classification of RF/microwave radiation as a Class 2B carcinogen (WHO/IARC 2011), the BioInitiative Report 2012 recommending drastically lower RF/microwave exposure levels, and the recommendation by the Parliamentary Assembly of the Council of Europe (PACE 2011) that electromagnetic emissions should be "as low as reasonably achievable"

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

1.18.5.2 HAN design and specification

The smart meter HAN interface can be activated to both receive or transmit signals to smart appliances by either the utility company or the smart appliances themselves transmitting data. This can only take place, however, after the utility permits HAN communication by issuing a security password that only it controls. There are HAN that can be used for wired networks. Wired HAN networks are used in several European countries including Germany and is likely to cause fewer problems for those who are electrosensitive (EHS).

Signals from wireless HAN can be blocked or degraded by the presence of some types of building materials. In particular signals can often be blocked by foil-backed plasterboard (used in many buildings) and some types of foil-backed high thermal insulation. Wire mesh used in some old buildings for plaster and lath work also blocks signals. Concrete and some dense building materials too can compromise signals. Signals can also be deliberately blocked by the use of particular materials and finishes by electrosensitives who attempt to screen themselves and their homes from RF/microwaves which they say can often make them feel unwell.

The result of such factors is that reliable signals cannot be received in some areas, whilst increased signals can be encountered in others thereby raising occupancy exposure to RF/microwave radiation). Ideally wired options should be available to reduce risk to those who are considered particularly vulnerable to RF/microwave radiation, those who for personal reasons do not wish to be exposed to such regimes, and those who wish to optimally use smart appliances without signal degradation.

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

The use of fibre-optic cabling, in contrast to other alternatives, allows built-in systems to be 'future proofed' against increasing needs for bandwidths whilst helping to create 'electromagnetically clean' environments and good transmission. It would appear prudent to consider its use for consumers' HAN and smart meters to make them more desirable to end-users.

Future proofing investments: for smart meters to meet the international Electric Infrastructure Security Council (EIS) requirements and be a financial success, they need to be "future proofed" and made more desirable to the end user. One way to help achieve this may be through providing a mainly fibre optic system. This reduces health and security issues and makes smart grid more attractive for investors.

The use of fibre optics also helps prevent the AMI creating interference with customers' wireless devices.

1.19 Signal disruption

Document: Shadrack IR No. 1, Questions 21

Comment on Question 21: "In its answer to 31.2 BCUC IR#1, FortisBC states that it: "anticipates very minor impact". Would FortisBC agree that where a smart meter disrupts one of their customer's ability to communicate using Wi-Fi, a ham radio, cordless phone, baby crib monitor, etc, that that disruption has a major impact on that customer's ability to use products that they had previously bought, installed and used?" Response: "... FortisBC does not agree that any disruption constitutes a major impact. ..."

In California in the USA, the emissions from PG&E's wireless electric smart meters (which operate in the 902-928 MHz range have already been implicated as interfering with: baby monitors, remote car starters, cordless phones, DirecTV systems, garage door openers, motion detectors, patio speakers, wireless headphones, wireless microphones and security systems – even in the middle of the night. Such problems were first noted in 2009, and can occur when the smart meters transmit information wirelessly back to the utility (OTLB 2011, Rockstroh 2010).

Problems have also been reported with the use of this frequency range by smart meters in Canada. In Ontario, the utility company Chatham-Kent Hydro has installed wireless smart meters that operate over the same frequency range used by PG&E and proposed by FortisBC. Its choice to use these unlicensed frequencies appears to have been taken as a cost saving measure in an attempt to benefit its customers who had to fund the rollout.

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

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

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

Though Industry Canada does not get involved with cases of interference, this is still a matter of law enforceable in Civil Courts and a matter of concern to those in the smart meter industry. Businesses or individuals who have their investment in wireless equipment rendered useless as a result of permanent interference have recourse to legal action, with the likelihood that, due to the large number of parties affected "a group of cases could be certified for Class Action," (C-K ARC 2010).

A change to the general adoption of fibre optic systems by FortisBC would provide a simple solution to reduce risk of bandwidth interference and a number of possible legal actions.

2 Human Rights

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2.1 Human Rights Tribunal: Electro-hypersensitive (CSTS IR1, Q4.1) & Citizens for Safe Technology (CEC IR1, Q49.3, Q49.3.1, Q49.3.2)

Document: CSTS IR No. 1- Question 4.1 and CEC IR No. 1 - Questions 49.3, 49.3.1, 49.3.2

<p><i>CSTS IR No. 1</i></p> <p><i>4.0 Reference: Application - Executive Summary - page 1 - line 18</i></p> <p><i>FortisBC estimates that the AMI Project will be at a capitol cost of \$47.7 million.</i></p> <p><i>4.1 Is FortisBC aware that the British Columbia Human Rights Tribunal has accepted a representative complaint against BC Hydro's smart meter program on behalf of a class consisting of those persons allegedly diagnosed as being electro-hypersensitive who have been advised to avoid wireless technology?</i></p>	<p><i>Response:</i></p> <p><i>FortisBC is aware that on August 28, 2012, the B.C. Human Rights Tribunal (BCHRT) issued a decision addressing whether to accept a complaint filed by CSTS against BC Hydro alleging discrimination on the basis of physical disability in relation to BC Hydro's SMI implementation.</i></p> <p><i>In its decision, the BCHRT agreed that CSTS had alleged a potential breach of the Human Rights Code, but took exception to the reference to "unspecified medical conditions" in alleging various disabilities. Further, the BCHRT found that while CSTS is an appropriate representative, the class, as defined for the purposes of the complaint, is overbroad. Specifically, the BCHRT notes that the defining characteristics must be specific enough to clearly delineate membership, and that a vague and medically-unsubstantiated reference by a physician to avoid wireless technology is insufficient to constitute a disability for the purposes of the complaint.</i></p> <p><i>The decision provided CSTS the option of filing an amended complaint within 30 days of the date of the decision to restrict the class to those persons allegedly diagnosed with electro-hypersensitivity who have been advised to avoid wireless technology. FortisBC is aware that an amended complaint has been filed by CSTS in this regard. Finally, in its decision, the BCHRT noted the possibility (in the event an amended complaint was received) of holding a hearing on the discrete issue of whether or not electro-hypersensitivity is a disability for the purposes of the Human Rights Code.</i></p>
<p><i>CEC IR No. 1</i></p> <p><i>49.0 Reference: Exhibit B-6, BCUC 1.43.1</i></p> <p><i>49.3 Does FortisBC predict that a BC Human Rights tribunal ruling relating to the BC Hydro SMI program in favour of the Citizens for Safe Technology could result in a delay or otherwise necessitate a change in FortisBC's AMI implementation? Please provide a rationale.</i></p>	<p><i>Response:</i></p> <p><i>FortisBC believes that a ruling requiring a change in the BC Hydro SMI implementation is unlikely.</i></p> <p><i>Please also refer to the response to CSTS IR No. 1 Q4.1.</i></p>
<p><i>49.3.1 If so, has FortisBC developed possible means of addressing such changes?</i></p>	<p><i>Response:</i></p> <p><i>No. Considering that in its decision dated August 28, 2012, the BC Human Rights</i></p>

Tribunal directed that any amended complaint brought forward by CSTS is to be restricted to a class comprised of persons allegedly diagnosed with electro-hypersensitivity (a medical condition not generally recognized by the medical and scientific community), FortisBC reasonably expects any possible changes stemming from a future Tribunal decision on an amended complaint unlikely to have a material impact on the Project.

49.3.2 If the BC Human Rights Tribunal hearing has not provided a ruling prior to the August 2013 deadline to proceed with the Itron contract, will FortisBC proceed with the Itron contract?

Response:

Yes, however the Company's decision to proceed with the Project will ultimately be based on the decision provided by the BCUC.

Comment on Question 4.1: "Is FortisBC aware that the British Columbia Human Rights Tribunal has accepted a representative complaint against BC Hydro's smart meter program on behalf of a class consisting of those persons allegedly diagnosed as being electro-hypersensitive who have been advised to avoid wireless technology?" "Response: FortisBC is aware that ... the B.C. Human Rights Tribunal (BCHRT) issued a decision addressing whether to accept a complaint filed by CSTS against BC Hydro alleging discrimination on the basis of physical disability in relation to BC Hydro's SMI implementation. ... In its decision, the BCHRT agreed that CSTS had alleged a potential breach of the Human Rights Code, but took exception to the reference to "unspecified medical conditions" in alleging various disabilities. ... the BCHRT found that ... the class, as defined for the purposes of the complaint, is overbroad. ... the defining characteristics must be specific enough to clearly delineate membership, ...

A number of studies have indicated a variety health problems that appear to be aggravated by exposure to raised field regimes well below the maximum levels of exposure stipulated in Health Canada's Safety Code 6 (Health Canada 2009, 2009a). As an example, Oberfeld et al. (2004) found statistically significant associations between measured electric fields in the microwave range and 13 out of 16 health-related symptoms. These were as follows: difficulty in concentration; feeling of discomfort; sleeping disorder; irritability; depressive tendency; loss of appetite; loss of memory; headaches; dizziness; visual disorder; cardiovascular problems; and nausea. Such symptoms are often noted by individuals claiming to be EHS, and also those with no knowledge of the condition who are exposed to raised field regimes.

There are also other studies that have found a dose-response effect in association with increased exposure to radiowaves and microwaves. As examples, refer to Eger & Jahn (2010), Navarro et al. (2003), Hutter et al. (2002), Santini et al. (2002) and Johnson-Liakouris (1998). Time restrictions in writing this report preclude further studies showing associations being identified and documented.

All of the above symptoms can have serious repercussions on the health, well-being and productivity of individuals. Many are documented in detail in the Chapter 'Health Matters', along with details of exposure levels that have been linked with such effects, and the possible economic consequences of such conditions.

As an example, one of the symptoms commonly documented as a result of raised (low level) exposure is depression, which is Canada's leading cause of disability. As noted by BC's Physicians (2009), "... the burden of depression is greater than the burden caused by common diseases such as heart attack, stroke, and diabetes."

It is indicated that FortisBC, by intending to increase individuals' exposures to RF/microwaves, may discriminate against those with existing, or potential physical disabilities.

The reasoning behind this hypothesis is as follows: increased exposure to RF/microwaves may increase likelihood of depression. Increased likelihood of depression increases the likelihood of succumbing to a number of medical illnesses, and possibly worsens those conditions (Table 2.1).

"The Government of Canada seeks to reduce barriers and increase opportunities to ensure the full participation of people with disabilities in Canadian society. **Canada has a strong legal and legislative framework that guarantees the equal rights of people with disabilities,**" Human Resources and Skills Development Canada (2011). It appears that FortisBC's proposal may breach the equal rights of people with disabilities.

Table 2.1 Heightened risk of medical illness for people with depression

Medical condition	Risk level
Alzheimer's disease	1.71 to 2.67 times the rate for general population
Cancer	1.35 to 1.88 times the rate for general population
Diabetes (type 2)	Depression is an independent risk factor
Epilepsy	4 to 6 times the rate for general population
Obesity	Childhood or adolescent depression is a predictor of obesity
Stroke	2.6 times the rate for general population

Source: Mental Illness & Addiction in Canada, Mood Disorders Society of Canada, 2007. Second Edition. Cited by BC's Physicians (2009).

"The economic impact of depression is ... estimated at \$2.6 billion per year for Canada ... For an average British Columbia company with 500 employees, yearly costs of untreated depression are nearly \$1.4 million in lost work days and reduced productivity ..." (BC's Physicians 2009).

Oberfeld et al. (2004) noted depressive tendency was associated with exposures to 900/1800 MHz radiation levels of 0.25-1.29 V/m (0.0165-0.4400 $\mu\text{W}/\text{cm}^2$) compared to levels of 0.05-0.22 V/m (0.0006-0.0128 $\mu\text{W}/\text{cm}^2$) ($p = 0.0016$). These levels are substantially below Health Canada's Safety Code 6 (Health Canada 2009, 2009a). According to FortisBC's Response to Question 18.1, the microwave exposure from their proposed smart meters, at a mean duty cycle of 0.06%, is 0.056 $\mu\text{W}/\text{cm}^2$.

Also it should be taken into consideration that smart meters are not the only source of microwave radiation individuals would be exposed to from FortisBC. On page 45 of Appendix C-5, it is stated that "In addition to advanced meters at home, there is a small number of supporting infrastructure RF transmitters installed on the utility poles in the neighborhood above the level of the residences. ... the typical exposure from these devices in the residence should not exceed the typical exposure from the advanced meter." Whilst no exact range of figures is given for this extra exposure, it would appear that cumulative 24/7 exposures of residents could be effectively doubled (even before exposures from future wireless smart appliances are factored in).

Refer also to the review of Oberfeld et al. (2004)'s study in the Chapter on 'Health Matters' in this present commentary for details of associations between microwave exposure levels and other symptoms commonly reported by those categorised as EHS.

Common signs and symptoms of electromagnetic hypersensitivity include: anxiety; blurred vision; chest discomfort; depression; dizziness; fatigue; headaches; heart palpitations; liver disease; memory impairments; paresthesias (sensation of tingling, burning, pricking, or numbness); phobias; thought processing difficulties; thyroid dysfunction; general malaise; muscle pain; nausea; night sweats; restless legs; sleep disorder; tinnitus; and weakness (Genuis & Lipp 2012, Havas 2006, Johansson 2006).

The Chapter 'Health Matters' additionally documents other health conditions that may be negatively impacted through raised exposures to comparatively low levels of radiowave and microwave exposure.

The American Academy of Environmental Medicine (2012) additionally document medical conditions which they consider may be exacerbated through raised exposures to electromagnetic fields.

The possible liabilities of not addressing health problems exacerbated by exposures also have to be taken into account. In 2011, the Labour Court in Madrid, Spain declared that hypersensitivity, caused in part by exposure to RF/microwaves, can cause permanent disability. The ruling is unique in this regard and sets a precedent for future conditions related to EHS. The verdict issued on May 23rd of that year awarded the college professor, who has been permanently incapacitated, a permanent disability pension at 100% of his base salary rate. The costs of ignoring the issue of EHS may be high both for the individual and those who endorse widespread increased exposures to a recognised Class 2B carcinogen.

The possible health burden, and financial burden, created as a result of the increased use of the present generation of wireless technologies may be significant. Safer alternatives in keeping with the ethos of BC's health promotion initiatives are available.

As a large number of potential human rights issues that may arise as a result of the proposed smart metering scheme do not appear to have been fully addressed. They will be discussed in greater detail elsewhere in this present Chapter.

2.2 Electro–hypersensitivity (Q16, Q17, Q23 & Q24)

Document: WKCC IR No. 2 - Questions 16, 17, 23 & 24

<p>16. Does FortisBC agree that there is a certain percentage of our population which is/might be electro–sensitive? If so, please state the percentage as far as it is generally known to be and provide information sources. If FortisBC does not agree, please state why not?</p>
<p>Response:</p> <p>FortisBC understands that a certain percentage of the population in some countries have reported being “electro-sensitive”. FortisBC is not aware of any scientific or medical surveys that have assessed the prevalence of such persons in Canada. Based on research studies, the World Health Organization has determined that there is no scientific basis to link such reported symptoms to EMF (ELF or RF) exposure. Consequently, no diagnostic criteria have been developed for ‘electro-sensitivity.’ As stated in the World Health Organization backgrounder dated December 2005 and found at: http://www.who.int/peh-emf/publications/facts/fs296/en/ :</p> <p>“EHS [Electromagnetic hypersensitivity] is characterized by a variety of non-specific symptoms that differ from individual to individual. The symptoms are certainly real and can vary widely in their severity. Whatever its cause, EHS can be a disabling problem for the affected individual. EHS has no clear diagnostic criteria and there is no scientific basis to link EHS symptoms to EMF exposure. Further, EHS is not a medical diagnosis, nor is it clear that it represents a single medical problem.”</p>
<p>17. Is FortisBC aware that in Sweden electro–hyper–sensitivity (EHS) is an officially recognized functional impairment; that in the U.S., EHS afflicted people are protected under the U.S. Disability Act, and that in Canada EHS afflicted people are recognized by the Canadian Human Rights Commission? If FortisBC are aware, how will FortisBC and/or PHO make sure that those recognized EHS people in British Columbia will be given an option not to be involuntarily and chronically cumulatively exposed to persistent wireless smart meter radio microwave radiation?</p>
<p>Response:</p> <p>FortisBC is aware of the claims asserted in the question but has not assessed their accuracy or legal status. However, the Company notes the following report issued by the Ireland Department of Communications, Energy, and Natural Resources, available at:</p> <p>http://www.dcenr.gov.ie/NR/rdonlyres/9E29937F-1A27-4A16-A8C3-F403A623300C/0/ElectromagneticReport.pdf</p> <p>The report states:</p> <p>“The focus in Sweden is on the symptoms presented by the afflicted person and the right to sick leave, sickness benefits, disability pension etc is based on the degree of ill health and functional handicap of the person regardless of a known or unknown cause for the condition.”</p> <p>“The Swedish Board of Health and Welfare is the Swedish authority to grant financial support through the national budget to disability organisations. A disability organisation is according to the authorities understood to be an organisation which members (at least a majority of) meet substantial difficulties in everyday life due to some kind of disability. The National Board of</p>

Health and Welfare thus make their decisions based on the consequences for the afflicted individuals and not based on any known underlying cause of the disability/problems. The Swedish Association for the Electrosensitive was granted financial support as a disability organisation. Most disability organisations that have received this type of financial support join the Swedish Disability Federation, as has The Swedish Association for the Electrosensitive. This fact has sometimes been misinterpreted as if electromagnetic hypersensitivity is a recognised medical diagnosis in Sweden."

FortisBC believes that its AMI Project will be compliant with the applicable legal framework.

23. Please inquire by the PHO, whether he is willing to assure an ES/EHS afflicted person and his/her medical doctor in writing that the wireless smart meters, that PHO is instrumental in approving to be affixed to homes, are biologically harmless for ES/EHS and any other persons beyond a reasonable doubt? As FortisBC and PHO must be aware, "Beyond a reasonable doubt" is an accepted scientific measure in bio-safety. Does FortisBC /PHO agree that no less a determination should apply in this instance?

24. Please inquire by PHO, whether he would order FortisBC and/or B.C. Hydro that, upon a customer's request with a medical doctor's advice and prescription, that the customer be allowed to retain the present analog meter or, in the case of a smart meter, to be connected via a hard-wired (non-radio wave frequency/non-microwave frequency emitting) smart meter or leave the existing previous non-wireless analog or digital meter? This would probably involve only 1-3 % (+/-) of BC households? If PHO would not make this recommendation, please inquire with him why not?

Response:

FortisBC has not asked the PHO to express an opinion about wireless smart meters and persons reporting ES/EHS symptoms or to formulate health policies to address their concerns, however, please refer to the response to BC Hydro IR No. 2 Q2.1 for a statement from the Chief Medical Health Officer of British Columbia, dated June 2011, regarding health concerns about cellular phone transmission antennae and base stations. As well, please also refer to the response to BC Hydro IR No. 2 Q2.2 which provides test results from the BC Centre for Disease Control titled "Measurement of Radiofrequency (RF) Emissions from BC Hydro's Itron Smart Meters". The ultimate determination of the safety of the proposed AMI system (related to reasonable doubt mentioned) is the responsibility of the BCUC.

Comment on Question 16: "Does FortisBC agree that there is a certain percentage of our population which is/might be electro-sensitive? If so, please state the percentage as far as it is generally known to be and provide information sources. If FortisBC does not agree, please state why not?" "Response: FortisBC understands that a certain percentage of the population in some countries have reported being "electro-sensitive". ..."

FortisBC avoided answering the above on whether it believed that a certain percentage of the population is/might be electro-sensitive. It did however quote the World Health Organization which states that "The symptoms are certainly real and can vary widely in their severity."

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

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

It is estimated by Schreier et al. (2006) that approximately 5% of the Swiss population may be EHS. If a similar fraction is affected in British Columbia, this would amount to approximately 231,129 individuals.

EHS has become officially fully recognised as a functional impairment in Sweden since 2007. It is not regarded as a disease (Johansson 2010). **Survey studies indicate that around 230,000 – 290,000 Swedish adults (out of a population of 9,000,000) – approximately 2.5% to 3.2% of the population - report a variety of symptoms when in contact with manmade sources of EMFs** (Miljöhälsorapport 2001). If BC had a similar proportion of EHS to Sweden this would amount to approximately 115,564 to 147,922 individuals.

Comment on Question 16: ... “Response: “... the World Health Organization has determined that there is no scientific basis to link such reported symptoms to EMF (ELF or RF) exposure. Consequently, no diagnostic criteria have been developed for ‘electro-sensitivity.’ ...”

Literature contained in this present document provides details of some of the scientific basis as to why health symptoms can be related to exposure to electromagnetic fields.

Comment on Question 16: ... “Response: “...EHS [Electromagnetic hypersensitivity] is characterized by a variety of non-specific symptoms that differ from individual to individual. The symptoms are certainly real and can vary widely in their severity. ...” “[It is not] clear that it represents a single medical problem.”

Agreed. It represents numerous medical problems. Refer also to the comments on Article 3 of The Universal Declaration of Human Rights in this present document, which document medical conditions and disabilities which would more than likely benefit from reduced exposures to electromagnetic and RF/microwave exposure (The American Academy of Environmental Medicine 2012). It is suggested by the present author that the cost of the above to nations is immense and avoidable. The creation of more stringent ‘electromagnetic hygiene’ regimes can benefit everyone, encourage the development and adoption of greener technologies and create real ‘Win/Win’ situations.

Comment on Question 17: “Is FortisBC aware that in Sweden electro-hyper-sensitivity (EHS) is an officially recognized functional impairment; that in the U.S., EHS afflicted people are protected under the U.S. Disability Act, and that in Canada EHS afflicted people are recognized by the Canadian Human Rights Commission? ...” “Response: FortisBC is aware of the claims asserted in the question but has not assessed their accuracy or legal status. ...”

Given the seriousness of the effects of EHS (FortisBC quote the World Health Organization with regard to EHS in their Response to Question 16 as stating “The symptoms are certainly real and can vary widely in their severity”) this issue needs to be properly addressed. Many of the health related complaints about smart meter roll outs document symptoms similar to those experienced by individuals with EHS. An explanation as to why FortisBC has not assessed their accuracy or legal status would appear warranted. Such an assessment may help it in making informed decisions on the design of their proposed infrastructure, and help it better understand the needs of their customers and fellow citizens of BC.

Comment on Question 24: "Please inquire by PHO, whether he would order FortisBC and/or B.C. Hydro that, upon a customer's request with a medical doctor's advice and prescription, that the customer be allowed to retain the present analog meter or, in the case of a smart meter, to be connected via a hard-wired (non-radio wave frequency/non-microwave frequency emitting) smart meter or leave the existing previous non-wireless analog or digital meter? This would probably involve only 1-3 % (+/-) of BC households? If PHO would not make this recommendation, please inquire with him why not?" Response: "FortisBC has not asked the PHO to express an opinion about wireless smart meters and persons reporting ES/EHS symptoms or to formulate health policies to address their concerns ..."

As FortisBC appears unwilling to ask the Provincial Health Officer "whether he would order FortisBC and/or B.C. Hydro that ... the customer be allowed to retain the present analog meter or, in the case of a smart meter, to be connected via a hard-wired (non-radio wave frequency/non-microwave frequency emitting) smart meter or leave the existing previous non-wireless analog or digital meter?" perhaps someone else should ask him. It appears important to know the answer.

It would be to the benefit of all parties if a comprehensive presentation of available scientific evidence on health effects noted at the frequencies FortisBC intends to use, and "anecdotal" evidence of adverse health effects such as that available from the EMF Safety Network (EMFSN 2013), were also presented to the Public Health Officer at the same time to help aid him in making his informed decision.

In 2011, it was reported in the USA that PG&E and the Central Maine Power Company had both been legally forced to offer opt-out programs to customers who do not wish smart meters (SKT&A 2011, SmartGridNews.com 2011).

As some individuals may wish to opt out because of health concerns, it is important to realise that standard smart meters with their wireless function fully disabled may also cause health problems due to the high-frequency voltage transients that can be created by their switched mode power supplies. Refer to the Chapter on 'Health Matters' for further details.

2.3 Radio/microwave exposure limits/guidelines: Canada & US (Q19)

Document: WKCC IR No. 2, Question 19

19. Please state (with references) radio/microwave exposure limits/guidelines for:
 - Canada
 - USA
 - any other country and their exposure limits that FortisBC are aware of and provide links. If these countries have different exposure limits which are lower than Canada's, please explain why Canada should not also adopt much stricter guidelines.

Response:

The limits on occupational and public exposure to radiofrequency fields in Canada are contained in Tables 5 and 6 in Health Canada's Safety Code 6 and similar limits in the USA are published by the Federal Communications Commission, Parts 1 and 2 of the FCC's Rules and Regulations [47 C.F.R. 1.1307(b), 1.1310, 2.1091, 2.1093 (<http://transition.fcc.gov/Bureaus/EngineeringTechnology/Documents/fedreg/61/41006.pdf>)].

A world database of standards for ELF and RF electromagnetic field exposures has been assembled by the World Health Organization (<http://www.who.int/docstore/peh-emf/EMFStandards/who-0102/Worldmap5.htm>). FortisBC has no control over the radiofrequency guidelines developed by Health Canada but notes that the exposures from FortisBC smart meters calculated in Table 1 of Exponent's report are below what appears to be the lowest standard in that database from Russia.

Comment on Question 19: “Please state (with references) radio/microwave exposure limits/guidelines for: – Canada – USA – any other country and their exposure limits that FortisBC are aware of and provide links. If these countries have different exposure limits which are lower than Canada’s, please explain why Canada should not also adopt much stricter guidelines.” Response: “The limits on occupational and public exposure to radiofrequency fields in Canada are contained in Tables 5 and 6 in Health Canada’s Safety Code 6 ... FortisBC has no control over the radiofrequency guidelines developed by Health Canada but notes that the exposures from FortisBC smart meters calculated in Table 1 of Exponent’s report are below what appears to be the lowest standard in that database from Russia.”

A list of exposure limits, including some which are more rigorous than Russia’s, are shown in Table 2.2 below:

Table 2.2 RF/microwave Power Densities – Guidelines: Comparison between levels permitted in other countries & ICNIRP levels

Country/Region	RF/microwave exposure limit ($\mu\text{W}/\text{cm}^2$)	Approx.
Austria (Salzburg Health Dept) (Oberfeld 2003)	0.0001 (indoor) 0.001 (outdoor)	0.00001% 0.0001%
Lichtenstein (USG 2008)	0.1	0.01%
Belgium (Brussels, Wallonia, Flanders) (WHO 2009)	2.4	0.3%
Luxembourg (Pilette 2008)	2.4	0.3%
Ukraine (Ministry of Health of the Ukraine 1996)	2.4	0.3%
Switzerland (SAEFL 2000)	4.25 - Sensitive areas (e.g. schools & hospitals) 9.5 - General	0.5% 1%
Bulgaria (WHO 2002a)	10	1%
China (Chiang 2009)	10	1%
Hungary (Sage 2000)	10	1%
Italy (Vecchia 2003)	10	1%
Paris, France (McKeown 2007)	10	1%
Poland (Polish Minister of the Environment 2003)	10	1%
Russia (SanPiN 2003)	10	1%
ICNIRP (ICNIRP 1998)	1000 $\mu\text{W}/\text{cm}^2$	100%

Exposure standards often change as more becomes known about risk. It is generally because of increased knowledge of risk that standards become more rigorous.

2.4 Exposure limits/guidelines: Biological effects (Q8) & Non-thermal effects – Canada SC6 (Q9)

Document: WKCC IR No. 2 - Questions 8 and 9

<p>8. Does FortisBC agree that biological effects are associated with radiowave/microwave energy radiation below the US and Canada regulatory limit as stated in the studies in Biological Effects Of Microwave Below U.S. & Canada’s Regulatory Limit in the link http://citizensforsafetechnology.org/Biological-effects-of-microwaves-below-US-and-Canadas-regulatory-limit,8,1195 If you do not agree, please state why not.</p>
<p>Response:</p> <p>A variety of biological responses of bacteria, plants, mice, chickens, rats, pine needles, trees, rabbits, cows, frogs, guinea pigs to radiofrequency fields are listed, and associations of human neuropsychological responses with sources of radiofrequency fields in communities. It is not clear that the effects reported have been confirmed or that all effects if confirmed are adverse.</p>

9. *Is FortisBC aware and do you agree that the Royal Panel's report "Review of the Potential Health Risks of Radiofrequency Fields from Wireless Telecommunication Devices" <http://www.rsc.ca/documents/RFreport-en.pdf> admits that Safety Code 6 (SC6) does not apply to non-thermal biological effect protection? If not, please state where and how SC6 does, indeed, take into account non-thermal effect protection.*

Response:

FortisBC is aware of the cited report. The question regarding the relationship of Safety Code 6 to non-thermal biological effects is answered in the Royal Panel's 1999 report:

What are the implications for Safety Code 6 of the panel's scientific review of the currently available data on biological effects and the potential adverse health effects of exposure to radiofrequency fields? In particular, should the phenomenon of non-thermal effects be considered in Safety Code 6?

Based on its review of the currently available scientific data, the panel concluded that Safety Code 6 generally protects both workers and the general public from adverse health effects associated with thermal exposures of the whole body to radiofrequency fields. Although the whole body exposure limits given in Safety Code 6 appear protective against thermal effects, the panel noted that protracted worker exposures at the local limits established for the head, neck and trunk and for the limbs could lead to thermal effects. The panel therefore recommends that these local exposure limits for workers be reviewed, both in terms of the level and duration of exposure.

Biological effects can occur at non-thermal exposure levels. However, since there is insufficient evidence to conclude that such biological effects are associated with adverse health effects, the potential significance of biological effects observed at non-thermal exposure levels requires clarification before non-thermal effects are considered for inclusion in Safety Code 6. (p. 4)

Comment on Question 8. "Does FortisBC agree that biological effects are associated with radiowave/microwave energy radiation below the US and Canada regulatory limit ... If you do not agree, please state why not." Response: "A variety of biological responses of bacteria, plants, mice, chickens, rats, pine needles, trees, rabbits, cows, frogs, guinea pigs to radiofrequency fields are listed, and associations of human neuropsychological responses with sources of radiofrequency fields in communities. It is not clear that the effects reported have been confirmed or that all effects if confirmed are adverse."

Many of the effects reported have been confirmed in peer-reviewed research. In situations where effects are confirmed not all effects are adverse. Refer to the Chapters 'Health Matters' and 'Environmental Concerns' for further details.

Seeking to mimic electromagnetic field regimes found in Nature and the principles of their operation can often result in the creation of beneficial effects.

Comment on Question 9. "Is FortisBC aware and do you agree that the Royal Panel's report ... admits that Safety Code 6 (SC6) does not apply to non-thermal biological effect protection? If not, please state where and how SC6 does, indeed, take into account non-thermal effect protection." Response: "FortisBC is aware of the cited report. The question regarding the relationship of Safety Code 6 to non-thermal biological effects is answered in the Royal Panel's 1999 report: ... Biological effects can occur at non-thermal exposure levels."

There is much evidence available documenting detrimental biological effects at non-thermal levels. Refer to the Chapters on 'Health Matters' and 'Environment Concerns' in this present document for further details.

2.5 Alternative standards i.e. non-thermal (Q20.2) & RF exposure risks – non-thermal standard (CSTS IR2, Q22.1)

Document: CSTS IR No. 1, Questions 20.2 and CSTS IR No. 2, Question 22.1

<p><i>CSTS IR No. 1</i></p> <p><i>20.0 Reference - Application - Appendix C-5 - page 7</i></p> <p><i>Exponent says the final step in the analysis is to compare the specific exposure to the relevant standard.</i></p> <p><i>20.2 What consideration has FortisBC given to the assessment of exposure risks according to alternative standards such as the non-thermal standard?</i></p>
<p><i>Response:</i></p> <p><i>FortisBC is not aware of any science-based, generally accepted "non-thermal standard".</i></p>
<p><i>CSTS IR No. 2</i></p> <p><i>22.0 Follow up to response to CSTS IR#1 - 20.2</i></p> <p><i>22.1 The question has not been answered. The standard referred to is referenced by the allusion in the Exponent Report at page 17 to "some studies" that have reported effects occurring with RF exposures below the level that raises the body temperature. The standard referred to is further exemplified in the 2007 Bioinitiative report. It considers adverse health affects as occurring at non-thermal levels of exposure. What consideration has FortisBC given to the assessment of exposure risks according to that standard, regardless of whether FortisBC regards that standard as being science-based or generally accepted?</i></p>
<p><i>Response:</i></p> <p><i>Respectfully, FortisBC answered the question. Please also refer to the response to WKCC IR No. 2 Q32. FortisBC has not considered following an unofficial 'standard' that has not been accepted by Health Canada or provincial health agencies.</i></p>

Comment on CSTS IR No. 1, Question 20.2: "What consideration has FortisBC given to the assessment of exposure risks according to alternative standards such as the non-thermal standard?" Response: "FortisBC is not aware of any science-based, generally accepted "non-thermal standard", and CSTS IR No. 2, Question 22.1: "Follow up to response to CSTS IR#1 - 20.2, Question 22.1: "The question has not been answered. ..." Response: "... FortisBC has not considered following an unofficial 'standard' that has not been accepted by Health Canada or provincial health agencies."

There are many officially accepted non-thermal standards abroad that are based on peer-reviewed scientific research. Refer to the Comment on Question 27, which lists the countries where such regulations apply.

2.6 Exposure limits/guidelines: WHO/IARC – Class 2B carcinogen – Canada SC6 (Q14)

Document: WKCC IR No. 2, Question 14

14. Please state whether the May, 2011, World Health Organization/International Agency for Research on Cancer's Class 2B possible carcinogen classification of radio frequency radiation is considered in SC6, or is a review of SC6 to be expected in near future because of this recent classification? If not, please inquire whether Provincial Health Officer, Dr. Perry Kendall [PHO], plans to apply for an SC6 review with regard to the Class 2B classification of radio frequency radiation by Health Canada as soon as possible and inform about.

Response:

Health Canada is well aware of the IARC report as discussed in information Safety of Cell Phones and Cell Phone Towers (<http://www.hc-sc.gc.ca/hl-vs/iyh-vsv/prod/cell-eng.php>)

It has been known throughout that Health Canada Safety Code 6 (the Code) is subject to review. The establishment of a further panel or target reporting date does not change that underlying premise. The Preface to the existing Code notes that the safety limits "are based on an ongoing review of published scientific studies" and that the Code is "periodically revised" (Exhibit B-1, Appendix B-6 p. 5 of 30). The Royal Society itself has previously been involved in this exercise.

There is no basis to assume that any revisions to the Code would be either recommended or, if recommended, significant. It is apparent from the context that an expert panel has been struck because of public comment on the issue rather than because of an underlying, objective concern. Notably the concern expressed by prominent Quebec scientists in their recent "Open Letter to the Public" ("Wireless Technologies: For an Informed and Responsible Debate Guided by Sound Science") has been not with the technology (indeed, to the contrary), but with the nature and content of the public discussion.

Given that advanced meters operate on average at a level 10,000 times less than the current Code limit and that the proposed advanced meters meet the strictest exposure limits in the world (which are approximately 100 times lower than Canada), it is highly unlikely that any change would have any impact on the AMI Project.

The Commission is accustomed to proceeding in circumstances where further research is being done into an issue. For example, in its Vancouver Island Transmission Reinforcement Project decision, the Commission directed British Columbia Transmission Corporation to file updates on EMF risk assessments and any changes in guidelines developed by the World Health Organization, International Commission on Non-Ionizing Radiation Protection, Health Canada and others where relevant (Decision dated July 7, 2006 at p. 72).

FortisBC's application is made in a context where many customers in Canada and the United States already have wireless advanced meters. Radio frequency (RF)-mesh based solutions have captured approximately 90 percent of the Canadian smart meter communications market (refer to response to BCUC IR No. 1 Q113.1.4). More generally, by the time of FortisBC's Request for Proposals (RFP), the North American AMI market had generally shifted to RF technologies (refer to response to Shadrack IR No. 2 Q2.12).

In the highly unlikely event that the Code limit is lowered enough to make the proposed AMI meters non-compliant, there would be time to halt the deployment of the meters as this is not scheduled until 2014.

FortisBC does not have any information as to the plans of the Provincial Health Officer.

Comment on Question 14: “Please state whether the May, 2011, World Health Organization/International Agency for Research on Cancer’s Class 2B possible carcinogen classification of radio frequency radiation is considered in SC6, ...” Response “...FortisBC’s application is made in a context where many customers in Canada and the United States already have wireless advanced meters. ...”

FortisBC’s application is also made in a context where many customers are experiencing health issues as a result of the roll out of wireless smart meters. A number of human rights issues are being raised as to their appropriateness.

Comment on Question 14: “Please state whether the May, 2011, World Health Organization/International Agency for Research on Cancer’s Class 2B possible carcinogen classification of radio frequency radiation is considered in SC6, ...” Response: “... the safety limits “are based on an ongoing review of published scientific studies” ... In the highly unlikely event that the Code limit is lowered enough to make the proposed AMI meters non-compliant, there would be time to halt the deployment of the meters as this is not scheduled until 2014. ...”

The smart meters are intended to have an operational life of around 20 years. In the present author’s opinion, it appears highly likely that Safety Code 6 will be substantially revised during that period. It could therefore be the case that at any time after their installation the proposed smart meters could be found to be non-compliant with revised Canadian guidelines.

2.7 Recognition of the resolutions/appeals/reports calling for stricter regulations

Document: WKCC IR No. 2, Question 18

18. *Qualified medical doctors and scientists around the globe are calling for stricter regulations and/or a moratorium on wireless technology. Please state FortisBC position, as to which ones, and why, FortisBC would not recognise/consider/support any of the resolutions/appeals/reports below:*

*Vienna Resolution 1998
Salzburg Resolution 2000
Declaration of Alcalá 2002
Catania Resolution 2002
Freiburger Appeal 2002 & 2012
Bamberger Appeal 2004
Maintaler Appeal 2004
Coburger Appeal 2005
Stockacher Appeal 2005
Oberammergau Appeal 2005
Haibacher Appeal 2005
Pfarrkirchener Appeal 2005
Freienbacher Appeal 2005
Lichtenfelser Appeal 2005
Hofer Appeal 2005
Helsinki Appeal 2005
Parish Kirchner Appeal 2005
Saarlander Appeal 2005
Benevento Resolution 2006
Allgaeuer Appeal 2006
WiMax Appeal 2006*

Brussels Appeal 2007
Bioinitiative Report, 2007
Schlüchterner appeal
Venice Resolution 2008
Berlin Appeal 2008
Paris Appeal 2009
London Resolution 2009
Porto Alegre Resolution 2009
European Parliament EMF Resolution 2009
Dutch Appeal 2009
Behind Interphone, August 7, 2009
Int'l Appeal of Würzburg 2010

Cellphones and Brain Tumors: 15 Reasons for Concern, Science, Spin and the Truth An examination of the potential Health Impacts of Radiofrequency Electromagnetic Radiation, 2010 (House of Commons: Report of the Standing Committee on Health)
Council of Europe: "Remove wireless from schools" 2011
Sage Report 2011
Report of The Standing Committee on Health, County of Santa Cruz 2011
Board of American Academy of Environmental Medicine's Resolution against wireless smart meters, American Academy of Environmental Medicine, January 19, 2012

Response:

FortisBC is generally aware of such "resolutions/appeals/reports", and understands that they do not provide the kind of scientific evidence that are relied upon by health agencies in making decisions about health and safety. FortisBC relies upon the scientists and physicians at Health Canada and other qualified health agencies to assess the relevance and validity of the scientific evidence concerning the safety of radiofrequency exposures.

Comment on Document: WKCC IR No. 2, Question 18: "Qualified medical doctors and scientists around the globe are calling for stricter regulations and/or a moratorium on wireless technology. ..." Response: "...FortisBC relies upon the scientists and physicians at Health Canada and other qualified health agencies to assess the relevance and validity of the scientific evidence concerning the safety of radiofrequency exposures.

Experienced scientists and physicians in health agencies abroad, who have assessed "the relevance and validity of the scientific evidence concerning the safety of radiofrequency exposures," have been instrumental in developing guidelines that are far stricter than Health Canada's Safety Code 6 – refer to the Comment on Question 27 for a listing of exposure standards abroad. Safer alternatives than that presently proposed by FortisBC are available and have been indicated as being cost effective – a 'Win/Win' situation for all parties.

2.8 Precautionary principle (Q20.1 & Q20.2)

Document: WKCC IR No. 2 - Questions 20.1, 20.2

20.1. Please confirm :

"...The precautionary principle or precautionary approach states if an action or policy has a suspected risk of causing harm to the public or to the environment, in the absence of scientific consensus that the action or policy is harmful, the burden of proof that it is not harmful falls on those taking the action. This principle allows policy makers to make discretionary decisions in situations where there is the possibility of harm from taking a particular course or making a certain decision when extensive scientific knowledge on the matter is lacking. The principle implies that there is a social responsibility to protect the public from exposure to harm, when scientific

investigation has found a plausible risk. These protections can be relaxed only if further scientific findings emerge that provide sound evidence that no harm will result. In some legal systems, as in the law of the European Union, the application of the precautionary principle has been made a statutory requirement..."

[source: http://en.wikipedia.org/wiki/Precautionary_principle]

Response:

Numerous other definitions of the precautionary principle are available. For example, the Canadian Environmental Protection Act (1999) states that "... the government of Canada is committed to implementing the precautionary principle that, where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation". See also Health Canada Decision-Making Framework for Identifying, Assessing, and Managing Health Risks (http://www.hc-sc.gc.ca/ahc-asc/pubs/hpfb-dgpsa/risk-risques_tc-tm-eng.php)

20.2. Please state whether in Canada and/or British Columbia the Precautionary Principle with regard to the smart meter project has been considered. If so, please state how; if not, why not.

Response:

FortisBC assumes that "the smart meter project" referenced in the question is the FortisBC Advanced Metering Infrastructure project. That project has not yet been the subject of a Commission determination, or indeed legal argument as to whether such matters as the "precautionary principle" can or should be considered in relation to it.

Comments on Questions 20.1 and 20.2:

There are many benefits achievable from adopting a "Precautionary Principle" approach as a matter of best practice as early as possible in a project irrespective of whether there is a requirement from others that such initiatives are undertaken. Its adoption can reduce both risk and liability.

Principle 15 of the Rio Declaration on Environment and Development (UNEP 1992) states that, "In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."

Other Principles from the Rio Declaration that appear to apply with regard to FortisBC's application are shown below:

Principle 1: "Human beings are at the centre of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature."

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

Principle 4: "In order to achieve sustainable development, environmental protection shall constitute an integral part of the development process and cannot be considered in isolation from it."

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

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

Principle 7: “States shall cooperate in a spirit of global partnership to conserve, protect and restore the health and integrity of the Earth’s ecosystem. ...”

Transparent, properly funded, unbiased research is urgently required on the possible effects of smart meters and related technologies on the health and integrity of the Earth’s ecosystem.

Principle 9: “States should cooperate to strengthen endogenous capacity-building for sustainable development by improving scientific understanding through exchanges of scientific and technological knowledge, and by enhancing the development, adaptation, diffusion and transfer of technologies, including new and innovative technologies.”

If a true spirit of cooperation and global partnership can be achieved, that takes onboard the advice of relevant specialists often excluded from such developments, this goal can be achieved. ‘Open innovation’ approaches based on collaboration and co-creation may prove particularly worthwhile in creating environmentally cost effective solutions that may benefit all.

Principle 13: “States shall develop national law regarding liability and compensation for the victims of pollution and other environmental damage. States shall also cooperate in an expeditious and more determined manner to develop further international law regarding liability and compensation for adverse effects of environmental damage caused by activities within their jurisdiction or control to areas beyond their jurisdiction.”

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

Principle 16: “National authorities should endeavour to promote the internalization of environmental costs and the use of economic instruments, taking into account the approach that the polluter should, in principle, bear the cost of pollution, with due regard to the public interest and without distorting international trade and investment.”

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

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

Principle 17: “Environmental impact assessment [EIA], as a national instrument, shall be undertaken for proposed activities that are likely to have a significant adverse impact on the environment and are subject to a decision of a competent national authority.”

It appears that some smart meter and smart grid EMF regimes may in their present forms risk causing serious or irreversible damage to the environment. It is proposed that a comprehensive EIA on the smart meters and related technology that FortisBC propose using should be carried out at the earliest possible opportunity to help address these issues.

Ensuring that metering and other types of electronic technology are ‘environmentally sound’ can create direct beneficial financial impact whilst also helping to future proof such systems. It is proposed by the present author that such ‘best practice’ measures might be directly recouped in BC through savings on overall healthcare expenditure and increased workforce productivity.

The responsibility for environmental impact lies with the provider – providing impetus for proper development and the creation of World-class clean-technology products and services. Responsibly undertaking risk assessment and investment may greatly benefit FortisBC and British Columbia.

As noted by Hoffman & Rowe (2010), when authorities are aware (or should be aware) of real risk to life they are under obligation to take appropriate mitigative action to protect those at risk. The same would appear to be true of utility companies.

The adoption of the "Precautionary Principle" would seem to provide many benefits for all parties.

2.9 Position on Class 2B carcinogen (Q27) & Proof of safety (Q31)

Document: WKCC IR No. 2, Questions 27 and 31

<p>27. On what basis is FortisBC or B.C. Hydro allowed to put something that is emitting a Class 2B possible carcinogen on/in homes and buildings? This is the first time it has been known that governments are forcing their citizens to use something that is dangerous. Is it FortisBC's and PHO's position that this is acceptable?</p>
<p>Response:</p> <p>FortisBC does not believe that the radio frequency transmission associated with the wireless advanced meters that it has proposed are dangerous.</p> <p>FortisBC does not yet have approval to proceed with its AMI Project. It is seeking approval of a CPCN for the AMI Project pursuant to the Utilities Commission Act. It does believe that its AMI Project should be accepted.</p> <p>FortisBC does not speak for the Provincial Health Officer or BC Hydro. However, the Company notes the following statements on BC Hydro's website ¹:</p> <p>¹ http://www.bchydro.com/energy_in_bc/projects/smart_metering_infrastructure_program/faqs.html</p> <p>If the World Health Organization (WHO) says cell phones are "possibly carcinogenic", are smart meters still safe?</p> <p>The WHO has not drawn any definitive conclusions about cell phones, but has called for further investigation.</p> <p>The WHO stated: "In the area of biological effects and medical applications of non-ionizing radiation, approximately 25,000 articles have been published over the past 30 years. Despite the feeling of some people that more research needs to be done, scientific knowledge in this area is now more extensive than for most chemicals. Based on a recent in-depth review of the scientific literature, the WHO concluded that current evidence does not confirm the existence of any health consequences from exposure to low level electromagnetic fields. However, some gaps in knowledge about biological effects exist and need further research."</p> <p>While smart meters and cell phones both communicate wirelessly, they have different parameters. Smart meters are located outside of the home and transmit less than one minute a day at one hundredth the power of a cell phone. The exposure to radio frequency from a smart meter – over its entire 20-year lifespan – is the equivalent to a 30-minute cell phone conversation.</p> <p>For more information on the WHO's recent announcement, please refer to Provincial Health Officer Perry Kendall's statement.</p> <p>More generally, BC Hydro says the following on its website:</p> <p>Are smart meters safe?</p>

Smart meters are safe, as confirmed by health and science authorities including B.C.'s Provincial Health Officer, Health Canada and the World Health Organization.

Smart meters communicate for a total average of less than one minute a day. In fact, exposure to radio frequency during a 20-year life span of a smart meter is equivalent to the exposure during a single 30-minute cell phone call.

BC Hydro's smart meters are well below Health Canada's exposure limits and the precautionary limits set by Switzerland, the country with the most rigorous standards in the world.

For more information, please see Radio Frequency and BC Hydro's Smart Meters and the factsheet on radio frequency in Related Resources.

31. Please take note and confirm, if not, explain why not:

There is an established and useful definition of safety. It is the WHO IARC's own invention.

If a toxicant or toxic exposure is studied by IARC for potential carcinogenicity, and classified as a 4 - Not A Carcinogen - this is the closest definition to 'studied and safe' that we have Studied. Safe. Decided.

If the IARC listing is anything between 2A or 2B listing, it is by definition, to some degree, 'not-safe' (i.e., a listed probable or possible carcinogen), and

If it is a 1A listing, it is a known carcinogen.

Does FortisBC agree that this obviously an answer to 'proof of safety' argument. And, provides a legitimate answer for those who dismiss the scientific evidence because "you can't prove the null or negative". Of course one can - IARC does it.

Response:

Science determines the likelihood and severity of potential risks; it is the responsibility of government to rule on safety, i.e., the acceptability of a risk. The IARC classifications are used to describe the strength of the evidence, not safety. Nowhere in the 2011 IARC report on radiofrequency fields do the words "safe" or "safety" appear.

Comment on Question 27. "On what basis is FortisBC or B.C. Hydro allowed to put something that is emitting a Class 2B possible carcinogen on/in homes and buildings? This is the first time it has been known that governments are forcing their citizens to use something that is dangerous. Is it FortisBC's and PHO's position that this is acceptable?"
"Response: "... BC Hydro says the following on its website: Are smart meters safe? Smart meters are safe, as confirmed by health and science authorities including B.C.'s Provincial Health Officer, Health Canada and the World Health Organization."

If smart meters were truly safe, many of the detrimental health and detrimental effects being reported after their rollouts would not be occurring. There are already instances of people reporting adverse health effects without realizing that smart meters had been installed, and then being able to track back the date to the start of their symptoms to the installation date (EMFSN 2013). There is also evidence indicating that bees and plants are being harmed. There is considerable peer reviewed scientific literature documenting biological effects at non-thermal levels that provide a scientific basis for the effects observed in the frequency ranges FortisBC intends to use. Details of many of these are included in this present document. Scientific opinion often changes as more evidence becomes available.

The proposal for a wireless system being used by FortisBC for metering purposes (indirectly?) encourages the use of wireless technologies as documented below:

"The widespread deployment of ZigBee-based HANs by utilities throughout North America is expected to result in a variety of new products and applications [which will emit microwave radiation – present author's comment] that will help customers manage their electricity usage. Products are in development that will enable customers, should they wish to do so, to optionally connect appliances such as washers, dryers, furnaces and air conditioners and with technology emerging today in home automation, control these devices from their home network. ... control of these devices will reside solely in the hands of the customer, and not with the utility," FortisBC Inc (2012). Unfortunately the microwave emitters in many of these devices cannot be turned off thereby further increasing involuntary exposures.

The fact that RF/microwave radiation is now recognised as a Class 2B carcinogen (WHO/IARC 2011) should be seriously considered rather than dismissed out of turn. Consideration should also be given to the fact that, regardless of the current opinion of Health Canada and BC Hydro, many people in the "real World" are getting ill as a result of smart meter rollouts. The proliferation of other RF/microwave devices is likely to further contribute to the problem.

More biologically friendly alternatives are required.

Comment on Question 27. "On what basis is FortisBC or B.C. Hydro allowed to put something that is emitting a Class 2B possible carcinogen on/in homes and buildings? This is the first time it has been known that governments are forcing their citizens to use something that is dangerous. Is it FortisBC's and PHO's position that this is acceptable?"
"Response: "... Smart meters communicate for a total average of less than one minute a day. In fact, exposure to radio frequency during a 20-year life span of a smart meter is equivalent to the exposure during a single 30-minute cell phone call."

Pulsed signals in the frequency ranges proposed by FortisBC have been shown to be biologically active, and in many cases biologically harmful, at lesser intensities than the 24/7 pulsed signals emitted by the technology FortisBC proposes to use. Refer to the Chapters on 'Health Matters' and 'Environmental Concerns' for additional details.

Evidence provided by FortisBC appears to contradict the above statement related to communication time. According to the answer given by FortisBC to Question 55.6, the theoretical maximum duty cycle of 5% for a meter would result in a daily transmission of 72 minutes. A field deployment demonstrated a maximum duty cycle of 0.58% - a daily transmission of 8 minutes.

In answer to Question 58.2, FortisBC responded that a duty cycle of 1% for the ZigBee radio resulted in a transmission time of 14 minutes per day. Exposures from neighbouring smart meters and other parts of FortisBC's proposed AMI also have to be taken into account (See Figure 2.1). Table 2.3 has been compiled from information on EMF emissions given in the FortisBC application (FortisBC Inc., 2012) and the Responses given to previous queries. Further information is required in order to properly assess exposure levels (with exposure time and micro-environment taken into account).

Comment on Question 27. "On what basis is FortisBC or B.C. Hydro allowed to put something that is emitting a Class 2B possible carcinogen on/in homes and buildings? This is the first time it has been known that governments are forcing their citizens to use something that is dangerous. Is it FortisBC's and PHO's position that this is acceptable?"
"Response: "... BC Hydro's smart meters are well below Health Canada's exposure limits and the precautionary limits set by Switzerland, the country with the most rigorous standards in the world. ..."

A list of exposure limits, including some which are more rigorous than Switzerland's, are shown in Figure 2.2 and Table 2.2. Generally, exposure standards change as more becomes known about risk. It is because of increased knowledge of risk that standards become more rigorous.

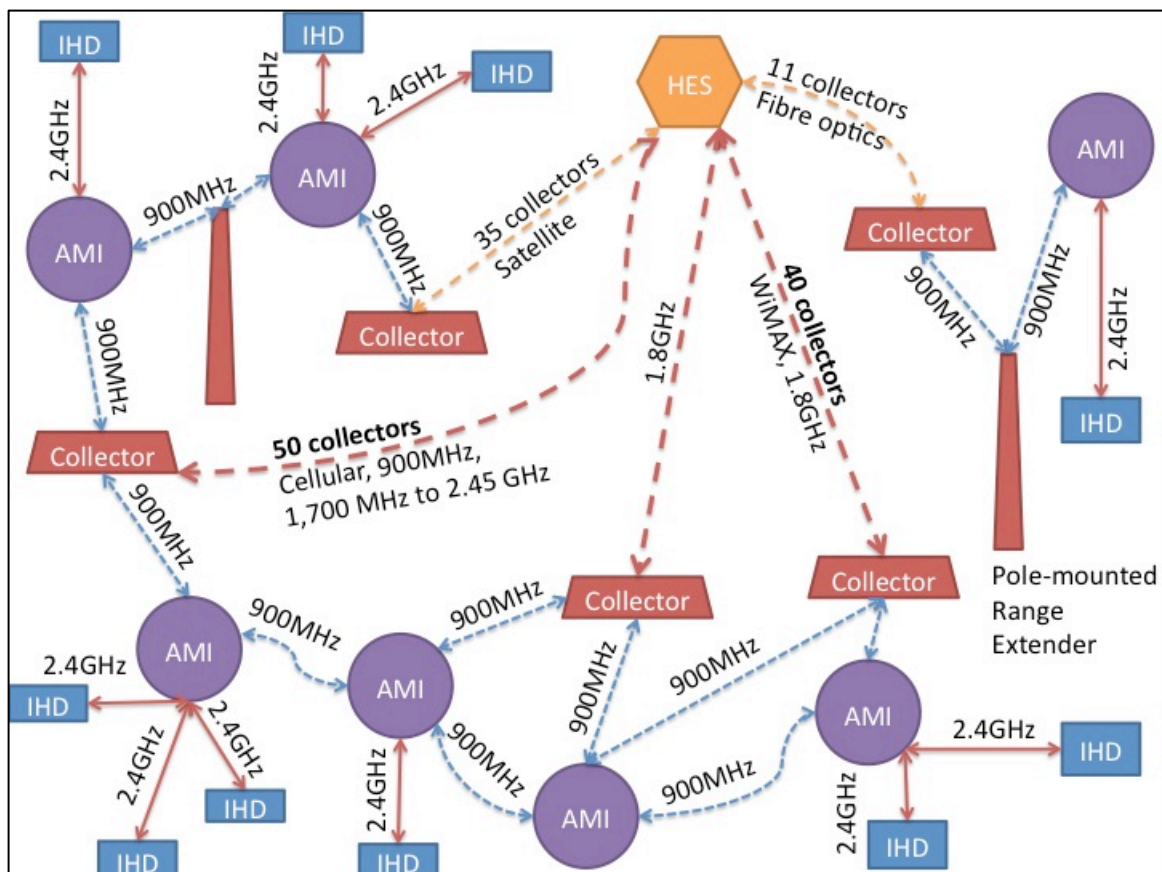


Figure 2.1 AMI system overview (Adapted from information from FortisBC Inc., 2012, Project Description, pp.41-49)

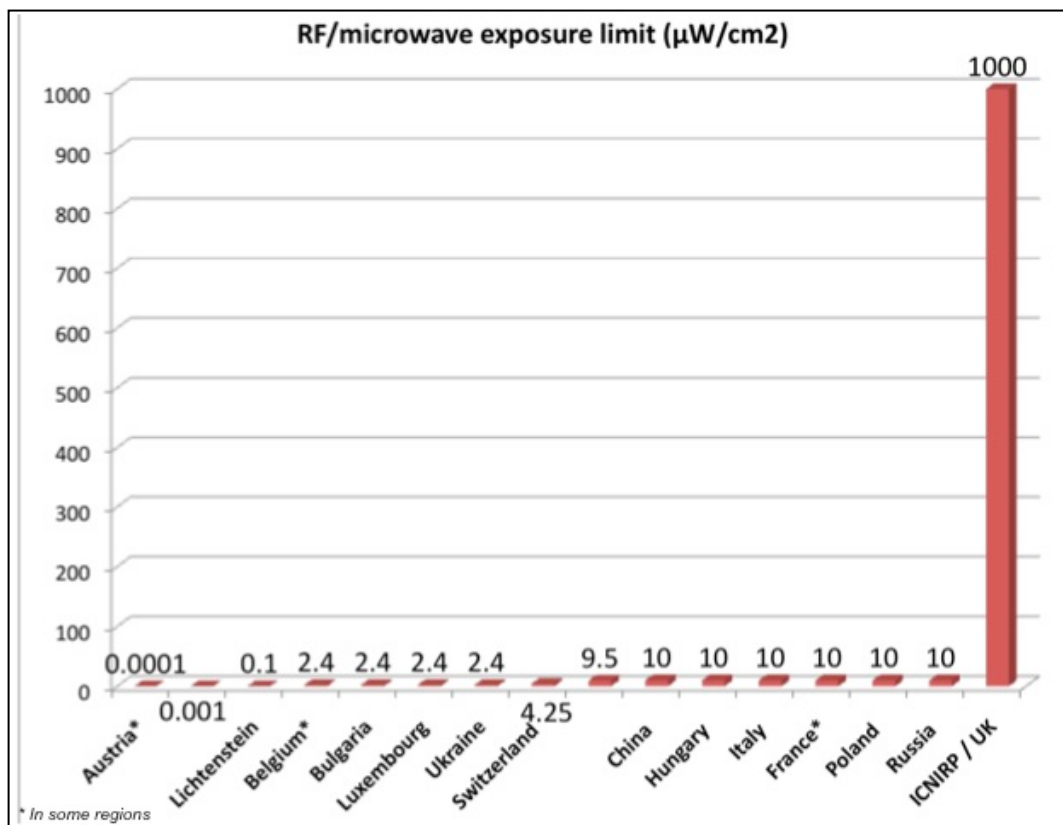


Figure 2.2 Comparison of national and international exposure standards/ guidelines

Table 2.3 AMI system transmission details (*further details required*).

Device	Interface	Media & Frequency	Power	Power density	Trans. distance	Install. distance	24-hr Duty cycle	Transmission Time	Exposure
Collector	11 Collectors to HES	Fibre optics							
	35 Collectors to HES	Satellite							
	40 Collectors to HES	WiMAX, 1.8GHz			10-15km				
	50 Collectors to HES	Cellular 900 MHz, 1,700 MHz to 2.45 GHz							
Range Extender	Extenders to HES?								
	Extenders to Collectors?								
	Extenders to AMI meters	900 MHz			1km	To be designed			
AMI meter	1 AMI meter to at least 1 Collector	902-928 MHz			1km	To be designed			
	AMI meter to AMI meter	902-928 MHz	689 mW	Peak (excl. duty cycle) @20cm: 227 $\mu\text{W}/\text{cm}^2$	Up to 100m	Varies	Typical use: 0.02% - 0.58% (0.3-8.4 mins) Mean: 0.06% (0.9mins) Max: 5% (72mins) Non-data signal lengths: 18 - 125mSec.	Average no. of transmission ~1,268/day Billing data: 2-3 times/day Non-billing data: >1min./day @ steady state Command and Control Signals, Alarms/alerts: durations 29-33 mSec; 90% of trans., 1,141 trans./day Scheduled and on-demand meter reads: durations 53-103 mSec; 10% of trans., 127 trans./day	Per unit of AMI meter Max. typical daily cycle 0.58% @50cm: 0.54 $\mu\text{W}/\text{cm}^2$ Max. supported duty cycle 5% @50cm: 4.7 $\mu\text{W}/\text{cm}^2$ Mean duty cycle 0.06% @50cm: 0.056 $\mu\text{W}/\text{cm}^2$.
	AMI meter to at least 1 IHD	Zigbee 2.4-2.4835 GHz	Emitted power: 21.93 dBm (155.96 mW) Radio power: 18.13 dBm (65.01 mW) Antenna Gain: 3.8 dBi (2.399 mW)	Peak (excl. duty cycle) @20cm: 31 $\mu\text{W}/\text{cm}^2$ During active transmission 50 cm & 1% duty cycle 0.00013 mW/cm2.	Up to 100m	Varies		1% duty cycle = 14 min./day	
IHD	IHD to other wireless HDs	450 MHz to 3 GHz				Varies			

2.10 Smart meters' legal issues

Document: WKCC IR No. 2, Question 30

30. Smart meters' legal issues: Please take note and confirm, if not, explain why not:

In consideration of the statements in sections 29.1. -29.4 and of the constitutional, common/civil law rights of affected persons and parties, the energy carrying photons of the wireless smart meter radiation into the environment do encroach on private property, thereby damaging property.

This encroachment constitutes a taking of property by way of trespass, nuisance and assault and affects all property owners living adjacent to electric power lines. The intent of the word "damage" in the Constitution was to grant relief to property owners who have been substantially damaged by the creation of public improvements abutting their lands, but whose land has not been physically taken by government. Our Constitution states that private property shall not be taken or damaged for public or private use without just compensation.

Even if the transmission carried out by wireless smart meters was for the purpose of providing remote/ convenient meter reading and trouble detection, physical forces (photon energetic radiation) from wireless gadgets, including smart meters, are by law, restricted to the right-of-way and cannot invade/assault private property in the form of nuisance and trespass without a property owner's permission. In order to obtain permission from a property owner who may or may not be aware of and/or may or may not agree to endure such assault/trespass/nuisance, the power company would have to obtain the property owner's signature on an Informed Consent Agreement prior to such a trespass. Without such Informed Consent, the property owner's right to live in peace and enjoy his/her home are violated. This property owner then becomes a victim of assault, trespass and nuisance due to the noise, the EMR consisting photons entering upon and through the land, and the home. Furthermore, these energetic radiating forces invade the human tissue of the property owner, his/her family, and anyone setting foot on such property, thereby causing bodily harm.

EMR are tangible intrusions that can be measured. In fact, power companies themselves know the levels of the fields at any distance, and power companies also know well that all EMR from any transmitters (smart meters, telecommunication transmitters, wireless laptops, routers, baby monitors, cordless phones etc.) that each and every transmission is adding up thus increasing the pollution in the environment. The action these high frequency (including ELF modulated) energy radiation constitutes an "intentional invasion" of the rights of all property owners living in close proximities of any transmitters (incl. smart meters) and unreasonably interferes with humans rights to use and enjoy their properties, thereby "damaging personal property." The personal rights of these affected people are violated, some additional legal terms that do apply with the EMR issue are: civil assault, civil battery, negligence, assault, bodily harm, intimidation, mischief, common nuisance, criminal negligence, causing bodily harm by criminal negligence.

Comparatively, under criminal law, if someone intentionally/knowingly hits a person, that is an assault and does bodily harm to that person. Either one of the mentioned electric forces can be a force, a component of simple assault, and are most likely a weapon, an element of some more serious assault charges, such as causing bodily harm. The impact of encroachment of smart meter radiation on the environment past a utilities' right-of- way, is synonymous with a physical attack. In other words, encroachment upon private property by smart meter radiation constitutes assault, which causes bodily injury. Smart meter's radiation induce currents in conductive materials, including human bodies, animals and plants that is, in effect, "a physical attack".

Smart meter radiation exposure have not yet scientifically conclusive been declared safe. This extreme exposure constitutes a violation of the personal property rights and common law rights of the affected persons by way of personal injury, trespass, civil assault, civil battery and a

taking of their property rights whether such exposure is permitted out of ignorance or inflicted arbitrarily, wantonly and willfully and without due process of law.

Electric utility companies, including FortisBC, do not have the right to assault affected property owners and residents with their electric forces' emissions. The elements of civil assault to FortisBC and the effected persons are/will be as follows:

FortisBC acts with the intent of making contact with the person (with their smart meter radiation emissions).

These affected people are placed in apprehension of imminent contact with their persons by conduct of FortisBC.

Such contact is or appears to be harmful of offensive.

Negligence and/or nuisance would apply as well to electric forces' emissions.

The movement of electro-magnetic forces (photons) from the lawful utility corridor to lands outside of that corridor constitutes trespass or nuisance - both are torts. Having the right to transmit power within a given corridor does not carry with it permission or the right to transmit something dangerous or capable of harm beyond the perimeter of that corridor.

The September/October issue 2001 of "Microwave News" indicates that the World Health Organization (WHO) is recommending "prudent avoidance." In the case of persons living in close proximity to smart meters, it is "impossible" to "avoid" exposures to these not harmless radiation. Obviously, persons living in such situations, in fact, have to endure "an unavoidable trespass".

Response:

FortisBC does not agree with the statements made in WKCC IR No. 2 Q30. FortisBC believes that the AMI Project will be compliant with the applicable legal framework.

The statements made by WKCC in IR No. 2 Q30 are fundamentally in error, in both fact and law. The "question" consists of a series of offensive and incorrect assertions and implications, including the suggestion that the Company is assaulting its customers (intentionally or otherwise) in some manner. The Company takes fundamental issue with the suggestions advanced in this "question" and believes it to be inappropriate.

Without limiting the generality of the foregoing, FortisBC notes that:

the RF transmission associated with the advanced meters that FortisBC has proposed:

does not involve encroachment on property in any sense recognized by law;

does not damage property;

does not involve trespass, nuisance, assault, negligence or any other tort, criminal offence or violation of human rights;

does not involve the taking of property;

the Constitution contains no wording or philosophy approximating the content alleged in WKCC IR No. 2 Q30;

no signatures are required from property owners in order to permit wireless advanced meters to be lawfully installed and operate;

Given the number of misstatements in WKCC IR No. 2 Q30, the list above is not intended to be exhaustive.

Comment on Question 30: “Smart meters’ legal issues: ...” “Response: ... the RF transmission associated with the advanced meters that FortisBC has proposed: ... does not damage property;”

In Article 17 (2) of The Universal Declaration of Human Rights (UN 1948) it is declared that “No one shall be arbitrarily deprived of his property.”

The term ‘property’ can be used legally to describe anything over which the rights of possession, use, and enjoyment are exercised. It can be legally defined as including real estate, land, growing plants and animals. Where components of Advanced Metering Infrastructures (AMI) are indicated as causing losses to any of these, claims could be made that that this basic human right is being breached.

Both scientific research and anecdotal evidence indicate that, in addition to potentially harming humans, RF/microwaves exposures at levels considerably below those given in Safety Code 6 (Health Canada 2009, 2009a) appear capable of causing physical damage to flora and fauna. (Refer to the Chapter on ‘Environmental Concerns’ for further details).

In a number of incidences damage is indicated at occurring at or below levels that RF/microwave emitting smart metering systems operate. Additionally, it is possible that the increased exposure levels caused by the addition of such infrastructure may raise background RF/microwave exposures to a degree where detrimental biological effects may be observed.

Comment on Question 30: “Smart meters’ legal issues: ...” “Response: ... the RF transmission associated with the advanced meters that FortisBC has proposed: ... does not involve ... nuisance, ...”

The right for people to be able to enjoy their property in the manner to which they have become accustomed can become severely compromised by RF/microwave emissions from smart meters making them feel unwell. Some may claim that the installation of wireless smart meters and wireless smart technology is an actionable nuisance, the radiation from which interferes with their right to peacefully enjoy their possessions (including parts of their homes and their gardens). It is already documented that wireless smart meters prevent some individuals using parts of their homes in order to avoid/reduce adverse health effects (EMFSN 2013, Gregory 2011, Havas 2011).

Comment on Question 30: “Smart meters’ legal issues: ...” “Response: ... the RF transmission associated with the advanced meters that FortisBC has proposed: ... does not involve ... negligence ...” or any other tort, criminal offence or violation of human rights;...”

Negligence might be claimed:

- If the Precautionary Principle and best practice measures are ignored.
- If scientific evidence documenting harmful biological effects from RF/microwave emissions is ignored
- If the anecdotal evidence of detrimental health effects from other smart meter roll outs is ignored
- If the fact that RF/microwave radiation is recognised as a Class 2B carcinogen (WHO/IARC 2011) is ignored.
- If serious cyber security issues are ignored and/or poorly addressed.

- If issues with the increased vulnerability of smart meters to natural and manmade electromagnetic pulse (EMP) events, compared with the analog meters FortisBC wish to replace, are ignored.

- If the apparent design flaw in the new meters that makes them vulnerable to malfunction in the extreme cold weather events that can occur in BC is ignored.

- If safer alternatives to the presently proposed system, which address the above issues, are not adopted.

FortisBC has an opportunity to create a World-class infrastructure where everyone can benefit. To do so it has to address many inconvenient truths and challenges.

Comment on Question 30: "Smart meters' legal issues: ..." "Response: ... the RF transmission associated with the advanced meters that FortisBC has proposed: ... does not involve ... violation of human rights; ..."

Advanced Metering Infrastructures (AMI) / Smart Metering Systems and Human Rights

There is increasing talk worldwide of individuals coming together to pursue human rights claims related to smart meters and related RF/microwave emitting devices. The Dutch Government has had to retreat on its former position of making smart meters compulsory (metering.com, 2009).

International Bill of Human Rights

General background: The United Nations International Bill of Human Rights is comprised of: The Universal Declaration of Human Rights; The International Covenant on Economic, Social and Cultural Rights; and The International Covenant on Civil and Political Rights (with its two optional protocols).

As noted by United Nations Association in Canada/Association canadienne pour les Nations Unies (UNAC 2012a), whilst The Universal Declaration of Human Rights "is not part of binding international law. ... it is still a potent instrument used to apply *moral* and diplomatic pressure on states that violate the Declaration's principles. ..." and "... constitutes an obligation for the members of the international community" to protect and preserve the rights of its citizenry."

It appears that the proposed introduction of Advanced Metering Infrastructures (AMI) / Smart Metering Systems, in British Columbia, in their present formats, may contravene a number of basic human rights.

The Universal Declaration of Human Rights

General background: This landmark declaration, initially adopted by the UN General Assembly in 1948, was the first international declaration of the human rights and fundamental freedoms for which all of humankind is inherently entitled (UNAC 2012). Professor John Peters Humphrey (1905-1995), a Canadian, who was the first Director of the United Nations Division of Human Rights, was a principal drafter of this Declaration and also prepared its first preliminary draft and guided it through to its adoption by the UN General Assembly.

"The Declaration is based on the "inherent dignity" of all people and affirms the equal rights of all men and women, in addition to their right to freedom. The Declaration gives human rights precedence over the power of the state. While states are permitted to regulate rights, they are prohibited from violating them," United Nations Association in Canada/Association canadienne pour les Nations Unies (UNAC 2012a).

The General Assembly of the United Nations has proclaimed The Universal Declaration of Human Rights to be “a common standard of achievement for all peoples and all nations...” to promote “social progress and better standards of life in larger freedom,” (UNAC 2012).

Whilst The Universal Declaration of Human Rights is “not part of binding international law. ... is still a potent instrument used to apply moral and diplomatic pressure on states that violate the Declaration’s principles. ...” and “...” constitutes an obligation for the members of the international community” to protect and preserve the rights of its citizenry,” The Canadian Charter of Rights and Freedoms is a legal instrument (UNAC 2012a).

It appears vital, for all parties, that the moral and ethical issues raised below as related to this Declaration and FortisBC’s smart metering are appropriately addressed:

Article 2.

“Everyone is entitled to all the rights and freedoms set forth in this Declaration, ... “

As everyone is entitled to all of the Declaration’s rights and freedoms, it appears important to ensure that the metering infrastructures of British Columbia are modernised and managed with this in mind.

Article 3.

“Everyone has the right to life, liberty and security of person.”

Right to Life: This basic human right is also declared in The International Covenant on Civil and Political Rights (OHCHR 2007), The International Covenant on Economic, Social and Cultural Rights, (OHCHR 2007a), The UN Convention on the Rights of the Child (United Nations 1989), The UN Declaration of the Rights of the Child (UN 2012), and The Canadian Charter of Rights and Freedoms, which states that everyone has the legal right to life (Department of Justice Canada 2012).

Expectant and New Mothers: It is recognised in The International Covenant on Economic, Social and Cultural Rights (OHCHR 2007a) that “*Special protection should be accorded to mothers during a reasonable period before and after childbirth.*”

Protection for Children: The need for special protection being accorded to children is recognized in human rights legislation. As examples, it is mentioned both in The UN Convention on the Rights of the Child (United Nations 1989) and The Declaration of the Rights of the Child (UN 2012), that “*the child, by reason of his physical and mental immaturity, needs special safeguards and care, including appropriate legal protection, before as well as after birth,*” (emphasis added by present author). A Canada Fit for Children (Canadian CRC 2004) also seeks children to be protected from harm.

As evidence indicates that some RF/microwave regimes (at levels lower than Health Canada’s Safety Code 6 (Health Canada 2009, 2009a) presently allows) may raise risk of infertility, miscarriage, and cause damage to both animal and human offspring (e.g. Avendaño et al. 2012, Falzone et al. 2011, Agarwal et al. 2009, De Iuliis et al. 2009, Mailankot et al. 2009, Davoudi et al. 2002, Santini et al. 2002, Cherry 2000, Magras & Zenos 1997, Kondra et al. 1970); **claims might be brought that increasing involuntary exposures to this Class 2B carcinogen (WHO/IARC 2011) may be against children’s right to life. Refer to the Chapters on ‘Health Matters’ and ‘Environmental Concerns’ of this present document for further details of the studies.**

General Population: Claims might also be brought that other individuals may be arbitrarily deprived of their lives - *or have their life quality significantly reduced* - through health conditions exacerbated or brought on as a result of the involuntary RF/microwave exposures they receive.

As indicated in European case law conducted through the European Convention of Human Rights (LM&R v Switzerland 1996), which discussed matters related to the Right to Life; Article 3 of The Universal Declaration of Human Rights appears relevant in situations where health may be put at risk, and not restricted to actual death or risk of death.

There are a number of the health conditions for which increased exposures to RF/microwave radiation are indicated as risk factors. These include: **Cancer; Alzheimer's disease and other dementias; Autism; Attention Deficit Hyperactivity Disorder (ADHD); Depression; Diabetes; Electromagnetic Hypersensitivity (EHS); Headache disorders; Infertility; Obesity and overweight; Physical inactivity; and Sleep problems.** Further details are given in the Chapter on "Health Matters."

American Academy of Environmental Medicine Recommendations Regarding Electromagnetic and Radiofrequency Exposure: The American Academy of Environmental Medicine (2012) notes that from double-blinded, placebo controlled research on humans [Rea et al. 1991], it appears that medical conditions and disabilities which would more than likely benefit from reduced exposures to electromagnetic and RF/microwave exposure "*include, but are not limited to*":

Heart disease and vascular effects including arrhythmia, tachycardia, flushing, edema; Gastrointestinal conditions including nausea, belching; Ocular (burning); Musculoskeletal effects including pain, muscle tightness, spasm, fibrillation; Neurological conditions such as paresthesias, somnolence, cephalgia, dizziness, unconsciousness, depression; Pulmonary conditions including chest tightness, dyspnea, decreased pulmonary function; Oral (pressure in ears, tooth pain); Dermal (itching, burning, pain); Autonomic nervous system dysfunction (dysautonomia).

"Based on numerous studies showing harmful biological effects from EMF and RF exposure, medical conditions and disabilities that would more than likely benefit from avoiding exposure include, but are not limited to":

Cancer and Genetic defects [Ban et al. 2011, Xu et al. 2010, Phillips et al. 2009, Ruediger 2009, Zhao et al. 2007, Lee et al. 2005, Domsia et al. 2004, Lai & Singh 2004, Mashevich et al. 2003].

Fetal abnormalities and pregnancy [Ingole & Ghosh 2006, Magras & Zenos 1997].

Liver disease and genitourinary disease [Ingole & Ghosh 2006, Lubec et al. 1989].

Neurodegenerative diseases (Alzheimer's Disease; Amyotrophic Lateral Sclerosis; and Parkinson's Disease) [Xu et al. 2010, Nittby et al. 2009, Awad et al. 2008, Zhao et al. 2007, Leszczynski & Joenvaara 2002].

Neurological conditions (Depression; Anxiety; Attention deficit disorder; Autonomic nervous system dysfunction; Dizziness; Fatigue; Headaches; Tremors; Decreased memory; Sleep disruption; Visual disruption) [Abdel-Rassoul et al. 2007, Hutter et al. 2006, Santini et al. 2002, Kolodynski & Kolodynska 1996].

The American Academy of Environmental Medicine (2012) additionally states the following:

"Because Smart Meters produce Radiofrequency emissions, it is recommended that patients with the above conditions and disabilities be accommodated to protect their health. The AAEM recommends: that no Smart Meters be on these patients' homes, that Smart Meters be removed within a reasonable distance of patients' homes depending on the patients' perception and/or symptoms, and that no collection meters be placed near patients' homes depending on patients' perception and/or symptoms."

The present author suggests that the creation/retention of low field RF/microwave exposure levels is likely to benefit all individuals, not just patients with the above conditions.

The levels of RF/microwave exposure indicated as causing and/or exacerbating health problems appear to be well below those presently permitted by Health Canada's Safety Code 6 (Health Canada 2009, 2009a). As noted by Hoffman & Rowe (2010), when authorities are aware (or should be aware) of real risk to life they are under obligation to take appropriate mitigative action to protect those at risk.

Numerous health complaints have already arisen worldwide with regard to wireless utility smart meters (EMFSN 2013). The results of an online survey initiated by The EMF Safety Network in 2011 (Halteman 2011) are shown below. 78% of respondents were from California, with 93% of them over 40 years old, 43% of them over 60 years old and 73% of them women. 49% of the respondents were said to be 'electrosensitive'. It is not known how many of them were categorised as electrosensitive before the installations. From the results that are shown, it appears that at least some citizens' health may be put at risk, and their quality of life suffer, as a result of inappropriate exposure to RF/microwave emissions from such units (Table 2.4).

Table 2.4 Health & Smart Meter safety survey (Halteman 2011)

Condition	Detrimental effects*
Sleep problems	49.1%
Stress, anxiety, irritability	43.1%
Headaches	40.9%
Ringing in the ears	38.1%
Concentration, memory or learning problems	34.6%
Fatigue, muscle or physical weakness	34.3%
Disorientation, dizziness, or balance problems	25.8%
Eye problems, including eye pain, pressure in the eyes, blurred vision	33.0%
Cardiac symptoms, heart palpitations, heart arrhythmias, chest pain	25.8%
Leg cramps, or neuropathy	19.2%
Arthritis, body pain, sharp, stabbing pains	18.2%
Nausea, flu-like symptoms	17.3%
Sinus problems, nose bleeds	14.5%
Respiratory problems, cough, asthma	13.8%
Skin rashes, facial flushing	12.6%
Urinary problems	8.8%
Endocrine disorders, thyroid problems, diabetes	8.8%
High blood pressure	7.2%
None of the above	8.8%
Other	30.5%

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

The health problems that have been noted after smart meter roll outs (EMFSN 2013) indicate that, regardless of how some wish to view matters, **these problems are very real and are affecting increasing numbers of individuals.**

Please read all the testimonies available at the following link (EMFSN 2013):
http://emfsafetynetwork.org/?page_id=2292

Taking into account the health effects reported worldwide from smart meter exposure (EMFSN 2013), and the medical conditions and disabilities indicated as being potentially exacerbated by raised field regimes (American Academy of Environmental Medicine 2012), it appears that some smart metering systems – *such as that presently proposed by FortisBC* – may be a cause of real risk to life, health and life quality, and breach Article 3.

Right to Liberty:

Insights provided into individuals' living patterns and relationships, gained through smart meters and related devices, may impinge on their freedom of liberty to do as they please within their own homes and therefore be in breach of their human rights (Anderson & Fuloria 2010, metering.com 2009).

In 2009, the Dutch government was forced to retreat on its former position of making smart meters compulsory in all homes (metering.com, 2009). Their proposed mandatory rollout was opposed by privacy watchdog groups and consumer organisations, including Consumentenbond (the Netherlands' main consumer organisation), which commissioned a report into the matter by the University of Tilburg (Cuipers & Koops 2008). That report concluded that the fine granularity of data from smart meters could give away sensitive information that might fall into the hands of third parties (including police and insurance companies) on consumers' energy usage habits, including when individuals' leave and return to their homes (which could be particularly useful to burglars).

It also stated that the insights these intelligent monitoring devices would provide into living patterns and relationships could affect individuals' freedom to do as they please. The hourly record of energy consumption proposed by FortisBC would also create fine granularity data on the customers' consumption patterns and causes privacy concerns for many individuals.

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

The liberty of vulnerable individuals to go where they wish is also at risk with the roll out of smart meters. Under Article 3, the rights of vulnerable individuals may be violated if emissions from smart meters and other forms of electronic technology associated with the AMI proposal prevent them from being able to go where they wish (even in their own homes and gardens) unhindered by man-made electromagnetic field regimes perceived as detrimental to their well-being.

"EHS has been described by patients as a 'loner's disease'. Due to the prevalence of ubiquitous EMR in the contemporary urban environment, EHS causes patients to experience extreme social isolation. The serious symptoms confine them to their home. Venturing out to shopping malls, libraries, theaters, hospitals, and doctors' offices is often precarious because of the prevalence of wireless routers, cell phones, antennas, and other sources of EMR. Furthermore many ... are often no longer able to spend time in the homes of family members due to EMR issues. As a result, huge stresses are placed on marriages and families ..." (Genuis & Lipp 2012).

The physical liberties of individuals may be violated if EMF emissions from smart meters (and related RF/microwave emitting technologies) prevent them from being able to go where they wish, even within their own homes, without feeling unwell and/or having their health compromised.

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

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

Right to Security:

'Security of person' can be legally defined as "The legal and uninterrupted enjoyment by a man of his life, his body, his health and his reputation." Claims may be brought by some that enjoyment of life, body, health and reputation may be seriously compromised by smart meters.

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

Additionally, with regard to privacy issues, it could be claimed that lifestyle information determined by third parties from analysis of energy usage divulged by smart meters (if data is not suitably protected and/or anonymised) may potentially damage individuals' reputations and security of person.

It is declared in Article 3 that “Everyone has the right to life, liberty and security of person.” FortisBC’s proposed metering system may breach this right, as it appears likely to increase citizens’ ‘Vulnerability to Extreme Weather Events, Manmade EMP & Cyber Attack’.

Article 5.

“No one shall be subjected to torture or to cruel, inhuman or degrading treatment or punishment.”

The term ‘Degrading treatment’ can be defined as “... such as to arouse ... feelings of fear, anguish and inferiority, capable of humiliating and debasing... and possibly breaking... physical or moral resistance,” (Conseil de l’Europe / Council of Europe 1978).

The above appears very similar to descriptions provided by some electrohypersensitive (EHS) individuals describing how their condition makes them feel when exposed to RF/microwave emissions (EMFSN 2013). This suggests that exposing vulnerable individuals to such regimes may be against Article 5 of The Universal Declaration of Human Rights.

“EHS frequently experience ridicule and eventual rejection or dismissal by their usual systems of support. This common outcome has a profound impact on many aspects of life including employment, accommodation, healthcare, finances as well as having a profound bearing on social, emotional and psychological dimensions of life,” Genuis & Lipp (2012).

Article 5 embodies a fundamental human right. “... the right to freedom from bodily harm is second only to the right to life, and is equally based on the right which all people have a level of basic respect and dignity as human beings,” (Hoffman & Rowe 2010).

It appears that this Article may be breached by the forced introduction and exposure to increased levels of RF/microwave radiation – a *recognized Class 2B carcinogen (WHO/IARC 2011)* - proposed by FortisBC. This present document provides numerous examples from peer-reviewed scientific research on how increased exposures may cause bodily harm. For a brief review of some of these by The American Academy of Environmental Medicine (2012), refer to the commentary on Article 3 of The Universal Declaration of Human Rights (UN 1948) given above.

It appears from NTSM (2002) that Article 5 may also covers living conditions, and that when/if violations are proved, the inconvenience and cost of rectifying matters is placed on the State. This has yet to be tested in Canadian Law.

Article 7.

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

Claims might be brought that if FortisBC, other service providers, and authorities (including Health Canada), ignore the special needs of individuals who are, or believe they are, vulnerable to exposure to the particular levels and types of EMF radiation emitted by many smart meters and related devices, they may be guilty of discrimination and wilful blindness.

“The doctrine of wilful blindness imputes knowledge to an accused whose suspicion is aroused to the point where he or she sees the need for further inquiries, but deliberately chooses not to make those inquiries. This was similarly stated in the U.S. case of *State v. McCallum* : “[T]he rule is that if a party has his suspicion aroused but then deliberately omits to make further [i]nquiries, because he wishes to remain in ignorance, he is deemed to have knowledge.... The rule that wilful blindness is equivalent to knowledge is essential....” Michener (2010).

"In Jorgensen (Supreme Court of Canada, 1995), Mr. Justice Sopinka explained: "A finding of wilful blindness involves an affirmative answer to the question: Did the accused shut his eyes because he knew or strongly suspected that looking would fix him with knowledge?" Michener (2010).

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

Article 8.

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

As everyone has the above right, there appears a very real possibility that those who violate such rights may be required to pay for their actions.

Article 12.

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

Privacy: A growing number of parties worldwide are of the belief that the arbitrary installation of smart meters, as presently proposed by a number of service providers, would be in breach of this basic human right (FIPR 2010, OTLB 2010, Cuipers & Koops 2008).

The policy for mandatory smart meter installations in all homes has already been successfully contested in the Netherlands (Anderson & Fuloria 2010), causing the previously proposed compulsory introduction of smart metering there to be replaced by a voluntary 'opt in' scheme in 2009. The Dutch Minister of Economic Affairs, Maria van der Hoeven, had intended that refusing installation of a smart meter would be punishable by either a €17,000 (\$23,053) fine or six months prison term. She now backs the installation of such units being voluntary (metering.com 2009).

The Dutch Government's proposed mandatory rollout of smart meters was opposed by both privacy watchdog groups and consumer organisations, including Consumentenbond (the Netherlands' main consumer organisation), which commissioned a report into the matter by the University of Tilburg (Cuipers & Koops 2008). That report concluded that smart meters could give away sensitive information that might fall into the hands of third parties (including police and insurance companies) on consumers' energy usage habits, including when individuals' leave and return to their homes (which could be particularly useful to burglars). It also stated that the insights these intelligent monitoring devices would provide into living patterns and relationships could affect individuals' freedom to do as they please within their own homes and therefore be in breach of human rights.

The quality of home life and enjoyment of inhabiting a dwelling may be "spoiled by various forms of interference, such as noise, light, smells, fumes or other forms of pollution [*including some suggest electromagnetic pollution – comment by present author*], and anyone who has experienced this might well refer to it as an invasion of their privacy," (Hoffman & Rowe 2010).

In Guerra and others v. Italy (Conseil de l'Europe/Council of Europe 1998), it was ruled that environmental pollution can cause a violation of human rights. In that instance, the European Court found the state guilty of failing to take 'positive steps' to provide vital information and that the quality of life of individuals, and that of their home and private lives had suffered as a result of their human rights being breached on this issue.

In the case of *López Ostra v Spain* (Conseil de l'Europe/Council of Europe 1994), the European Court declared that "environmental pollution may affect individuals' well-being and prevent them from enjoying their homes in such a way as to affect their private and family life adversely, without ... seriously endangering their health." Refer also to the results from the Health & Smart Meter safety survey (Halteman 2011) shown above in this present document and the online statements of affected individuals found at the following link: http://emfsafetynetwork.org/?page_id=2292 (EMFSN 2013). To gain further insights into the problems that can arise.

The right for people to be able to enjoy their property in the manner to which they have become accustomed can become severely compromised by RF/microwave emissions from smart meters making them feel unwell. Some may claim that the installation of wireless smart meters and wireless smart technology is an actionable nuisance, the radiation from which interferes with their right to peacefully enjoy their possessions (including their homes and their gardens).

It is already documented that wireless smart meters prevent some individuals using parts of their homes, or have even caused individuals to move out of their homes, in order to avoid/reduce adverse health effects (EMFSN 2013, Gregory 2011, Havas 2011). This is also stated in Shadrack IR No. 1, Question 42. "Over the last six months I have received a number of phone calls from persons concerned about the health effects of wireless smart meters, including some who have moved to rural BC precisely to avoid coming into contact with EMR."

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

Article 13.

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

This freedom is already being compromised in Canada as a result of electromagnetic pollution restricting the freedom of movement of EHS individuals.

Article 16.

1. "Men and women of full age, without any limitation ... have the right to marry and to found a family. ..."

Scientific research has demonstrated that increased exposures to RF/microwave can reduce human fertility and increase risk of miscarriage, thereby hindering individuals' rights to found families (Cherry 2000). Claims of breaches of this human right may be brought if similar risks are proven with regard to radiofrequency and microwave emissions from smart meters and related technologies. (Opting for technologies, such as fibre optics, may reduce such risks and the likelihood of claims, whilst also providing further benefits – present author's comment).

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

As this is the case, it appears odd that FortisBC wishes to increase such risk by increasing background radiation levels still further.

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

Dramatically reduced birth rates in the British Columbia - as might result from increased 24/7 RF/microwave exposures due to the roll out of wireless smart meters and related technologies (and the presently often encouraged use of wireless devices) - would cause a declining young labour force, crucially undermining BC's economic viability and increasing the burden of supporting the ill and elderly per capita.

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

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

Article 17.

... 2. “No one shall be arbitrarily deprived of his property.”

The term ‘property’ can be used legally to describe anything over which the rights of possession, use, and enjoyment are exercised. It can also be legally defined as including real estate, land, growing plants and animals. Where components of Advanced Metering Infrastructures (AMI) are indicated as causing losses to any of these, claims could be made that that this basic human right is being breached.

Both scientific research and anecdotal evidence indicate that, in addition to potentially harming humans, RF/microwaves exposures at levels considerably below those given in Health Canada's Safety Code 6 (Health Canada 2009) appear capable of causing damage to plants and animals. In some incidences damage is indicated at occurring at or below levels that RF/microwave emitting smart metering systems operate. Refer also to the Chapter ‘Environmental Concerns’ in present document.

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

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

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

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

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

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

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

Some smart meter regimes may cause individuals to be deprived of other possessions, including animals and vegetation (through creating inappropriate field regimes that may instigate their die-off or that of insects they rely on) – Refer also to section above on Article 2 covering environmental concerns.

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

The effects on individuals’ livelihoods of proposed metering schemes should be seriously taken into consideration so that optimum solutions can be obtained “in accordance with the general interest ...” This appears to be a very good instance where the Precautionary Principle should be applied.

Article 21.

... 2. “Everyone has the right of equal access to public service in his country. ...”

Inappropriate RF/microwave regimes from certain types of smart meters and related technology may prohibit some vulnerable individuals (with health conditions that are exacerbated by inappropriate exposures to radiofrequency and microwave radiation) from directly accessing public services if such emitters are present.

Article 23.

1. “Everyone has the right to work, to free choice of employment, to just and favourable conditions of work ...”

It has been suggested that the EMF emissions from some smart meters and related smart technologies in the workplace may compromise the right to work of vulnerable individuals who may react adversely to such exposures. It might therefore be claimed that such conditions are neither just nor favourable to such individuals and may compromise their free choice of employment.

Electromagnetic hypersensitivity is recognised as a “loner’s disease”. The prevalence of increasing levels of electromagnetic radiation in the environment adds greatly to their problems of finding places where they can work without feeling unwell. The proliferation of present day wireless technology adds greatly to their problems. “The pronounced physical and psychological symptoms often prompt EHS [individuals]... to take medical leaves from their employment and many eventually leave work all together,” Genuis & Lipp (2012).

Article 25.

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

Anecdotal evidence already indicates that the standard of living of many individuals, as related to health, wellbeing and earning ability, is presently being compromised in a number of smart meter rollouts (EMFSN 2013, KCRA 2011).

Standards of living, as related to useable space within individuals' homes, may also become compromised, as vulnerable individuals are no longer able to occupy some areas of their homes, gardens, and other areas of their property, for prolonged periods due to emissions from some types of smart meters and related technology (EMFSN 2013, KCRA 2011).

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

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

Article 27.

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

Individuals may be prohibited from fully participating in the cultural life of the community if their health is compromised as a result of unwarranted exposures to RF/microwave radiation from smart meters and related smart technologies that damage their health.

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

As noted by Prime Minister Stephen Harper in 2007, when discussing 'Building the Canadian Advantage' (Government of Canada 2012), the Canadian Government encourages and expects Canadian companies to meet high standards of Corporate Social Responsibility (CSR). This declaration that he made appears in keeping with the Canadian Government's human rights obligations. CSR is defined as "as the way companies integrate social, environmental, and economic concerns into their values and operations in a transparent and accountable manner. It is integral to long-term business growth and success, ..." (Government of Canada 2012a).

Taking the needs of the vulnerable into account, such as those who are electro-hypersensitive, ... would appear to be part of the CSR responsibilities that FortisBC is required to meet.

Tackling such matters responsibly to encourage health promotion

Constitution Act, 1982 (80), 1982, c. 11 (U.K.),

Schedule B,

Part I: Canadian Charter of Rights and Freedoms (Department of Justice Canada 2012).

Canadian Charter of Rights and Freedoms

Whereas Canada is founded upon principles that recognize the supremacy of God and the rule of law:

Guarantee of Rights and Freedoms

1. "The Canadian Charter of Rights and Freedoms guarantees the rights and freedoms set out in it subject only to such reasonable limits prescribed by law as can be demonstrably justified in a free and democratic society."

Legal Rights

7. "Everyone has the right to life, liberty and security of the person and the right not to be deprived thereof except in accordance with the principles of fundamental justice."

Right to Life

This basic human right is also declared in The Universal Declaration of Human Rights (UN 1948), The International Covenant on Civil and Political Rights (OHCHR 2007), The International Covenant on Economic, Social and Cultural Rights, (OHCHR 2007a), The UN Convention on the Rights of the Child (United Nations 1989) and The UN Declaration of the Rights of the Child (UN 2012).

As evidence indicates that some RF/microwave regimes, at levels considerably below those Health Canada's Safety Code 6 (Health Canada 2009, 2009a) presently allows, may raise risk of infertility, miscarriage, and cause damage to human offspring; claims might be brought that increasing involuntary exposures to this Class 2B carcinogen (WHO/IARC 2011) may be against individuals' right to life. Refer to the Chapters on 'Health Matters' and 'Environmental Concerns' for further details of studies.

General Population: Claims might also be brought that other individuals may be arbitrarily deprived of their lives - *or have their life quality significantly reduced* - through health conditions exacerbated or brought on as a result of the involuntary RF/microwave exposures they receive.

Expectant and New Mothers: It is recognised in The International Covenant on Economic, Social and Cultural Rights (OHCHR 2007a) that "Special protection should be accorded to mothers during a reasonable period before and after childbirth." Refer to Chapter 3 for details of RF/microwave health risks for expectant mothers.

Protection for Children: The need for special protection being accorded to children is recognized in human rights legislation. As examples, it is mentioned both in The UN Convention on the Rights of the Child (United Nations 1989) and The Declaration of the Rights of the Child (UN 2012), that "the child, by reason of his physical and mental immaturity, needs special safeguards and care, including appropriate legal protection, before as well as after birth." (emphasis added by present author).

Professor Yuri Grigoriev, Chairman of the Russian National Committee on Non-Ionizing Radiation Protection and Member of the World Health Organization's International Advisory Committee on EMF and Health, Russia, states that as exposures have increased it is now necessary to develop new standards related to children's exposures to RF/microwave radiation. "The potential health risk for children is very high and creates a completely new problem we urgently need to address. As noted by the WHO: "Children are different from adults. Children have a unique vulnerability. As they grow and develop, there are 'windows of susceptibility': periods when their organs and systems may be particularly sensitive to the effect of certain environmental threats" (WHO 2003)."

It is recognised by the International Commission on Non-Ionizing Radiation Protection that "... children, the elderly, and some chronically ill people might have a lower tolerance for one or more forms of [non-ionising radiation] exposure than the rest of the population." (ICNIRP 2002).

Right to Life – Health at Risk: As indicated in European case law, conducted through the European Convention of Human Rights (LM&R v Switzerland 1996), Right to Life appears relevant in situations where health may be put at risk, and not restricted to actual death or risk of death.

There are a number of the health conditions for which increased exposures to RF/microwave radiation are indicated as risk factors. These include: **Cancer; Alzheimer’s disease and other dementias; Autism; Depression; Diabetes; Electromagnetic Hypersensitivity (EHS); Headache disorders; Infertility; Obesity and overweight; Physical inactivity; and Sleep problems.** Further details are given in the Chapter on ‘Health Matters.’

The American Academy of Environmental Medicine (2012) notes that from double-blinded, placebo controlled research on humans [Rea et al. 1991], it appears that medical conditions and disabilities which would more than likely benefit from reduced exposures to electromagnetic and RF/microwave exposure “include, but are not limited to”:

Heart disease and vascular effects including arrhythmia, tachycardia, flushing, edema; Gastrointestinal conditions including nausea, belching; Ocular (burning); Musculoskeletal effects including pain, muscle tightness, spasm, fibrillation; Neurological conditions such as paresthesias, somnolence, cephalgia, dizziness, unconsciousness, depression; Pulmonary conditions including chest tightness, dyspnea, decreased pulmonary function; Oral (pressure in ears, tooth pain); Dermal (itching, burning, pain); Autonomic nervous system dysfunction (dysautonomia).

It further notes that: “Based on numerous studies showing harmful biological effects from EMF and RF exposure, medical conditions and disabilities that would more than likely benefit from avoiding exposure include, but are not limited to”: **Cancer and Genetic defects** [Ban et al. 2011, Xu et al. 2010, Phillips et al. 2009, Ruediger 2009, Zhao et al. 2007, Lee et al. 2005, Demsia et al. 2004, Lai & Singh 2004, Mashevich et al. 2003]; **Fetal abnormalities and pregnancy** [Ingole & Ghosh 2006, Magras & Zenos 1997]; **Liver disease and genitourinary disease** [Ingole & Ghosh 2006, Lubec et al. 1989]; **Neurodegenerative diseases (Alzheimer’s Disease; Amyotrophic Lateral Sclerosis; and Parkinson’s Disease)** [Xu et al. 2010, Nittby et al. 2009, Awad et al. 2008, Zhao et al. 2007, Leszczynski & Joenvaara 2002]; **Neurological conditions (Depression; Anxiety; Attention deficit disorder; Autonomic nervous system dysfunction; Dizziness; Fatigue; Headaches; Tremors; Decreased memory; Sleep disruption; Visual disruption)** [Abdel-Rassoul et al. 2007, Hutter et al. 2006, Santini et al. 2002, Kolodynski & Kolodynska 1996].

The American Academy of Environmental Medicine (2012) additionally states: “Because Smart Meters produce Radiofrequency emissions, it is recommended that patients with the above conditions and disabilities be accommodated to protect their health. The AAEM recommends: that no Smart Meters be on these patients’ homes, that Smart Meters be removed within a reasonable distance of patients’ homes depending on the patients’ perception and/or symptoms, and that no collection meters be placed near patients’ homes depending on patients’ perception and/or symptoms.”

The present author suggests that the creation/retention of low field RF/microwave exposure levels (and the development and use of low field technologies) is likely to benefit all individuals, not just patients with the above conditions. The levels of RF/microwave exposure indicated as causing and/or exacerbating health problems appear to be well below those presently permitted by Health Canada’s Safety Code 6 (Health Canada 2009, 2009a).

As noted by Hoffman & Rowe (2010), when authorities are aware (or should be aware) of real risk to life they are under obligation to take appropriate mitigative action to protect those at risk.

Numerous health complaints have already arisen after the installation of smart meters (EMFSN 2013). The results of an online survey initiated by The EMF Safety Network in 2011 (Halteman 2011) are shown below. 78% of respondents were from California, with 93% over 40 years old, 43% over 60 years old and 73% of them women. 49% of the respondents were said to be ‘electrosensitive’. It is not known how many were categorised as EHS before the installations. From the results shown (Table 2.4), it appears that citizens’ health may be put at risk, and their quality of life suffer, as a result of inappropriate exposure to RF/microwave emissions from such units.

The health problems that have been noted after smart meter roll outs (EMFSN 2013) indicate that, regardless of how some wish to view matters, **these problems are very real and are affecting increasing numbers of individuals.**

Please read all the testimonies available at the following link (EMFSN 2013):
http://emfsafetynetwork.org/?page_id=2292

Right to Liberty:

Insights provided into individuals' living patterns and relationships, gained through smart meters and related devices, may infringe on their freedom of liberty within their own homes and therefore be in breach of their human rights (Anderson & Fuloria 2010, metering.com 2009).

In 2009, the Dutch government was forced to retreat on its former position of making smart meters compulsory in all homes (metering.com, 2009). Their proposed mandatory rollout was opposed by privacy watchdog groups and consumer organisations, including Consumentenbond (the Netherlands' main consumer organisation), which commissioned a report into the matter by the University of Tilburg (Cuipers & Koops 2008). That report concluded that the fine granularity of data from smart meters could give away sensitive information that might fall into the hands of third parties (including police and insurance companies) on consumers' energy usage habits, including when individuals' leave and return to their homes (*which could be particularly useful to burglars*).

It also stated that the insights these intelligent monitoring devices would provide into living patterns and relationships could affect individuals' freedom to do as they please. The hourly record of energy consumption proposed by FortisBC would also create fine granularity data of customers' consumption patterns and causes privacy concerns for many individuals.

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

The liberty of vulnerable individuals to go where they wish is also at risk with the roll out of smart meters. The rights of vulnerable individuals, such as EHS, may be violated if emissions from smart meters, and other forms of electronic technology associated with the FortisBC AMI proposal, prevent them from being able to go where they wish (even in their own homes and gardens) unhindered by man-made electromagnetic field regimes perceived as detrimental to their well-being.

As noted by FortisBC, quoting the World Health Organization with regard to EHS in their Response to Question 16, "*The symptoms are certainly real and can vary widely in their severity.*"

"EHS has been described by patients as a 'loner's disease'. Due to the prevalence of ubiquitous EMR in the contemporary urban environment, EHS causes patients to experience extreme social isolation. The serious symptoms confine them to their home. Venturing out to shopping malls, libraries, theaters, hospitals, and doctors' offices is often precarious because of the prevalence of wireless routers, cell phones, antennas, and other sources of EMR. Furthermore many ... are often no longer able to spend time in the homes of family members due to EMR issues. As a result, huge stresses are placed on marriages and families ..." (Genuis & Lipp 2012).

The physical liberties of individuals may be violated if EMF emissions from smart meters (and related RF/microwave emitting technologies) prevent them from being able to go where they wish, even within their own homes, without feeling unwell and/or having their health compromised.

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

Right to Security:

Security of person can be legally defined as “*The legal and uninterrupted enjoyment by a man of his life, his body, his health and his reputation.*” Claims may be brought by some that enjoyment of life, body, health and reputation may be seriously compromised by FortisBC’s installation of smart meters.

Claims may be brought from EHS individuals that their reputations have been damaged as a result of how they are forced to behave as a result of exposures, or potential exposures to RF/microwave radiation from FortisBC installations. Claims might also be brought that they find that how they are forced to behave as a result of that radiation is degrading and damaging to their security of person.

Additionally, with regard to privacy issues, it could be claimed that lifestyle information determined by third parties from analysis of energy usage divulged by smart meters (if data is not suitably protected and/or anonymised) may potentially damage individuals’ reputations and their security of person.

Perhaps the greatest potential breaches of individuals “right to life, liberty and security of the person and the right not to be deprived thereof except in accordance with the principles of fundamental justice” may be as a result of FortisBC’s apparent failure to adequately address their proposed Advanced Metering Infrastructure’s ‘Vulnerability to Extreme Weather Events, Manmade EMP & Cyber Attack’.

These issues are discussed in detail in the Chapter on “Security Concerns”.

8. “Everyone has the right to be secure against unreasonable search or seizure.”

The fine granularity of data that FortisBC proposes to collect from smart meters appears excessive and could provide sensitive information that might fall into the hands of third parties (including police and insurance companies) on consumers’ energy usage habits, including when individuals’ leave and return to their homes (which could be particularly useful to burglars).

It is proposed that the collection of such data constitutes an unreasonable search into consumers’ energy usage habits and lifestyles.

9. Everyone has the right not to be arbitrarily ... imprisoned.

Increasing the levels of RF/microwave radiation in the environment, as FortisBC proposes to do, would make life considerably more difficult for individuals who are EHS, or who have other health conditions that are indicated as being exacerbated by increased exposure.

As noted by Genuis & Lipp (2012), “EHS has been described by patients as a ‘loner’s disease’. Due to the prevalence of ubiquitous EMR in the contemporary urban environment, EHS causes patients to experience extreme social isolation. **The serious symptoms confine them to their home.**”

In addition to seeking to increase the environmental exposures of RF/microwaves such individuals have difficulty in coping with, FortisBC presently seeks to even irradiate what may be their sole refuge from such radiation and not allow them to opt out of such regimes.

Additionally, it has been reported elsewhere that the installation of smart meters has prevented individuals occupying parts of their own homes (EMFSN 2011).

These actions appear to constitute serious breaches of the above fundamental human right.

12. "Everyone has the right not to be subjected to any cruel and unusual treatment or punishment."

FortisBC's proposed treatment of individuals indicated as being electromagnetically hypersensitive, as outlined in 9 above, may be considered by some to be a form of "cruel and unusual treatment or punishment."

This insensitive treatment of individuals who are EHS, is further compounded by FortisBC stating in Exhibit B-1 Section 8.5 that they will disconnect the power supply of those who refuse to have smart meters – *again this appears to be an example of cruel or unusual treatment.*

Refer also to the comments by this present author on this issue in the section on '**Violence, bullying and other forms of intimidation**' in the discussion on **A Canada Fit for Children** (2002) in this present Chapter.

Equality Rights

15. (1) Every individual is equal before and under the law and has the right to the equal protection and equal benefit of the law without discrimination ...

Claims may be made that the creation of electromagnetic field regimes inappropriate to those suffering from EHS, or individuals with other health ailments which have been indicated as being exacerbated, or potentially exacerbated by smart meter exposures (refer to the Chapter 'Health Matters'), may be a form of discrimination against the vulnerable, particularly when practical alternatives that do not create such regimes are available.

Claims might also be brought that if FortisBC, other service providers, and authorities (including Health Canada), ignore the special needs of individuals who are, or believe they are, vulnerable to exposure to radiation emitted by many smart meters and related devices, they may be guilty of discrimination and wilful blindness.

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

These are known challenges that have to be addressed otherwise accusations of wilful blindness may be made.

. "The doctrine of wilful blindness imputes knowledge to an accused whose suspicion is aroused to the point where he or she sees the need for further inquiries, but deliberately chooses not to make those inquiries. This was similarly stated in the U.S. case of *State v. McCallum* : "[T]he rule is that if a party has his suspicion aroused but then deliberately omits to make further [i]nquiries, because he wishes to remain in ignorance, he is deemed to have knowledge.... The rule that wilful blindness is equivalent to knowledge is essential...." Michener (2010).

"In *Jorgensen* (Supreme Court of Canada, 1995), Mr. Justice Sopinka explained: "A finding of wilful blindness involves an affirmative answer to the question: Did the accused shut his eyes because he knew or strongly suspected that looking would fix him with knowledge?" Michener (2010).

Claims might additionally be brought that those who deliberately ignore and dismiss relevant evidence of potential risks, whether through wilful blindness or recklessness, may be guilty of inciting others to unwittingly discriminate against such individuals.

Enforcement

24. (1) "Anyone whose rights or freedoms, as guaranteed by this Charter, have been infringed or denied may apply to a court of competent jurisdiction to obtain such remedy as the court considers appropriate and just in the circumstances."

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

General background: This Convention was adopted and opened for signature, ratification and accession by the United Nations General Assembly resolution 44/25 of November 20th 1989. Its entry into force came on September 2nd 1990 in accordance with Article 49 (OHCHR 1990) and it was ratified by Canada in 1991 (PHAC 2012). As was the case with the Universal Declaration of Human Rights, Canada had an active role in the drafting and promoting of this Convention.

The Convention requires States to act in the best interests of children. It is the first legally binding international convention affirming human rights for all children. Canada is legally bound to its requirements by international law. As noted by the International Commission on Non-Ionizing Radiation Protection "... children, ... might have a lower tolerance for one or more forms of [non-ionising radiation] exposure than the rest of the population" (ICNIRP 2002).

"ICNIRP... public safety limits are inadequate and obsolete with respect to prolonged, low-intensity exposures" Fragopoulou et al. (2010)

"the ICNIRP guidelines are neither mandatory prescriptions for safety, the "last word" on the issue nor are they defensive walls for Industry or others." Paolo Vecchia, Chairman for ICNIRP (Vecchia 2008).

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

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

As noted by the Public Health Agency of Canada, which is responsible for coordinating the federal implementation of this Convention within Canada, "**The Convention outlines the responsibilities governments have to ensure a child's right to survival, healthy development, protection and participation in all matters that affect them.**" Its legislative implementation at federal level in Canada is undertaken by The Department of Justice (PHAC 2012).

It is recorded in the Convention, quoting from the Declaration of the Rights of the Child (UN 1922), that "the child, by reason of his physical and mental immaturity, needs special safeguards and care, including appropriate legal protection, before as well as after birth."

Selected sections from the UN Convention (*with commentary by present author*)

Part I

Article 1

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

Article 2

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

Claims may be made that the creation of electromagnetic field regimes inappropriate to children suffering from EHS, or children with other health ailments indicated as being exacerbated (or potentially exacerbated) by such exposures, may be a form of discrimination.

Claims might also be brought that if FortisBC, other service providers, and authorities (including Health Canada), ignore the special needs of individuals who are, or believe they are, vulnerable to exposure to the radiation emitted by many types of smart meters and related devices, they may be guilty of discrimination and wilful blindness.

Claims might additionally be brought that those who deliberately ignore and dismiss relevant scientific evidence of potential risks, whether through wilful blindness or recklessness, may be guilty of inciting others to unwittingly discriminate against such children.

Article 3

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

As research indicates that even relatively low levels of increased exposure to RF/microwave radiation could be detrimental to children, mandatorily increasing exposures as FortisBC intends to do, would be in breach of this basic human right.

See Chapter on 'Health Matters' for examples.

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

Research has indicated that such protection measures should include protecting them against mandatory exposure to a Class 2B carcinogen, such as that proposed by FortisBC. In addition to the health effects associated with increased exposures, concentration and memory function has also been affected and learning problems.

From data provided in Table 2 of Exhibit B-1, Appendix C-5, the exposure at 0.5 metres from 2.4 GHz ZigBee radio on 1% duty cycle is 0.13 $\mu\text{W}/\text{cm}^2$. In "real life" situations actual environmental exposures would normally be higher, with other wireless devices increasing exposure levels further.

With regard to children (aged 8-17), short-term exposure to RF/microwave radiation at levels of 0.003-0.02 $\mu\text{W}/\text{cm}^2$ was indicated as causing headaches, irritation and concentration difficulties in school (Heinrich et al. 2010). Thomas et al. (2010) (also investigating the effects of short-term RF/microwave exposures on children aged 8-17) found that exposure to levels of 0.003-0.05 $\mu\text{W}/\text{cm}^2$ were associated with behavioral and conduct problems in school.

Research by Kolodynski & Kolodynska (1996) revealed that an exposure level of 0.16 $\mu\text{W}/\text{cm}^2$, just slightly above the power density value of the 2.4 GHz ZigBee radio at a distance of 0.5 metres, was shown to affect childrens' memory, attention levels and motor function.

It is recognised by the International Commission on Non-Ionizing Radiation Protection that "... children, ... might have a lower tolerance for one or more forms of [non-ionising radiation] exposure than the rest of the population." (ICNIRP 2002).

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

It is proposed that exposing children to increased levels of RF/microwave radiation, a recognised Class 2B carcinogen (WHO/IARC 2011), may be unwise, particularly as safer alternatives are available for the construction of a safer and more biologically friendly AMI. Resolution 1815 of the Council of Europe calls for all reasonable measures to be taken to reduce exposure to electromagnetic fields, particularly RF/microwaves (PACE 2011), it would appear prudent if similar measures were undertaken in Canada and elsewhere.

The permitted exposure levels in the Canada are substantially higher than those permitted in many other countries, including China, Bulgaria, Italy, Poland, Switzerland and Russia. If the Precautionary Principle was correctly adhered to, it is likely that the Canadian limits would be substantially lower.

Additionally, FortisBC's apparent failure to adequately address their proposed Advanced Metering Infrastructure's 'Vulnerability to Extreme Weather Events, Manmade EMP & Cyber Attack' may negatively impact on children's safety. Refer to the Chapter on Security Concerns for a detailed discussion on these apparent vulnerabilities.

Article 6

1. "States Parties recognize that every child has the inherent right to life."

As evidence suggests that some RF/microwave regimes considerably lower than those permitted by Health Canada's Safety Code 6 (Health Canada 2009, 2009a) may cause miscarriage and damage to human offspring; claims might be brought that increasing involuntary exposures to this Class 2B carcinogen (WHO/IARC 2011) may be against children's inherent right to life. Refer to the Chapter on 'Health Matters' for further details of studies.

2. "States Parties shall ensure to the maximum extent possible the survival and development of the child."

It is recognised in this Convention and The Declaration of the Rights of the Child (UN 1922), that "the child, by reason of his physical and mental immaturity, needs special safeguards and care, including appropriate legal protection, *before as well as after birth*," (emphasis added by present author).

An important safeguard to help ensure to the maximum extent possible the survival and development of the child would appear to be limiting the exposure of the child and its parents to avoidable health risks. Increased exposure to RF/microwave radiation, a Class 2B carcinogen, constitutes a health risk. FortisBC's present intention to mandatorily increase individuals' exposure appears to breach this guideline.

Article 12

1. "States Parties shall assure to the child who is capable of forming his or her own views the right to express those views freely in all matters affecting the child, the views of the child being given due weight in accordance with the age and maturity of the child."

The views of children with regard to the impacts that smart metering may have on their health and the environment should be respected.

2. "For this purpose, the child shall in particular be provided the opportunity to be heard in any judicial and administrative proceedings affecting the child, either directly, or through a representative or an appropriate body, in a manner consistent with the procedural rules of national law."

As above.

Article 16

1. "No child shall be subjected to arbitrary or unlawful interference with his or her privacy, family, home or correspondence, nor to unlawful attacks on his or her honour and reputation."

The prohibition of children's right of full enjoyment of proper privacy in their own homes as a result of data monitoring is potentially cruel, inhuman, demeaning and degrading and an apparent breach of Article 16. Lifestyle information determined by third parties from analysis of energy usage divulged by smart meters (if data is not suitably protected and/or anonymised) may potentially damage children's security of person (particularly if energy usage patterns indicate that they may be the only ones at home).

Claims may additionally be brought from EHS children (or their parents or guardians) that their reputations have been damaged as a result of how they feel they are forced to behave as a result of exposures, or potential exposures to RF/microwave radiation from FortisBC installations. Claims might also be brought that they find that how EHS children are forced to behave as a result of that radiation is degrading and damaging to their security of person.

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

2. "The child has the right to the protection of the law against such interference or attacks."

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

Article 19

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

It may be argued by some, children and pregnant mothers included, that FortisBC's proposed mandatory 24/7 exposure of children to RF/microwaves regimes (particularly when safer cost-effective alternatives are available) violates Article 19.1.

Article 23

1. "States Parties recognize that a mentally or physically disabled child should enjoy a full and decent life, in conditions which ensure dignity, promote self-reliance and facilitate the child's active participation in the community."

As raised exposures to RF/microwave radiation, at levels below those FortisBC wish to create, have been implicated in causing behavioural, concentration and memory problems in children (Heinrich et al. 2010, Thomas et al. 2010), it would appear possible they may similarly hinder the mentally or physically disabled child, particularly if they are EHS.

Article 24

1. "States Parties recognize the right of the child to the enjoyment of the highest attainable standard of health ..."

Refer to the Chapter on 'Health Matters' for details on how increased raised exposures to RF/microwave radiation may negatively impact on children's health.

2. "States Parties shall pursue full implementation of this right ... taking into consideration the dangers and risks of environmental pollution; ..."

Refer to the Chapter on 'Health Matters' for details on how increased raised exposures to RF/microwave radiation may negatively impact on children's health and also the Chapter 'Environmental Concerns' for details of environmental effects.

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

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

FortisBC is presently adhering to the 'traditional' modern practice of using wireless technologies, which may be "prejudicial to the health of children" (and others), instead of adopting proven and more biologically friendly solutions.

Article 37

"States Parties shall ensure that: (a) 'No child shall be subjected to torture or other cruel, inhuman or degrading treatment or punishment.'"

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

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

FortisBC's present intention as documented in its response to Question 34.1 (as stated in the Application (Exhibit B-1) at page 142) to cut off the power supply/suspend customers' services of those refusing the installation of 'advanced' meters – *if it does not judge there to be extenuating circumstances* – may be seen by some as a form of bullying, intimidation and/or victimisation that may have negative impact on customers' children (and the utility's reputation). Children, and adults, may consider this a "cruel, inhuman or degrading treatment or punishment."

Article 42

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

As noted by Prime Minister Stephen Harper in 2007 (Government of Canada 2012), the Canadian Government encourages and expects Canadian companies to meet high standards of Corporate Social Responsibility (CSR). His declaration appears in keeping with the Canadian Government's human rights obligations. CSR is defined as "as the way companies integrate social, environmental, and economic concerns into their values and operations in a transparent and accountable manner. It is integral to long-term business growth and success, ..." (Government of Canada 2012a).

UN Declaration of the Rights of the Child

General background: This Declaration was adopted by the UN General Assembly in 1959 (UN 2012). It was the first major international consensus on the fundamental principles of children's human rights.

Selected sections from the UN Convention with commentary are shown below:

Preamble:

"... the peoples of the United Nations have, in the Charter, reaffirmed their faith in fundamental human rights and in the dignity and worth of the human person, and have determined to promote social progress and better standards of life in larger freedom, ..."

"... everyone is entitled to all the rights and freedoms set forth therein, without distinction of any kind, ..."

"... **the child**, by reason of his physical and mental immaturity, **needs special safeguards and care, including appropriate legal protection, before as well as after birth.**"

"... mankind owes to the child the best it has to give, ..."

RF/microwave radiation is now recognised as a Class 2B carcinogen (WHO/IARC 2011). Exposure to raised levels of RF/microwave radiation well below those currently advocated as safe by Health Canada's Safety Code 6 may detrimentally impact on childhood health and well-being. It is proposed by the present author that special safeguards with regard to electromagnetic field exposure may be required to protect the child both before and after birth.

As noted by Becker (1990), "*fetal or newborn brain cells are particularly sensitive to electromagnetic field exposure.*" Research indicates that exposing pregnant women and young children to raised levels of RF/microwave radiation may increase likelihood of autism (Klinghardt 2008). Divan et al. (2008) found higher chance of children having emotional and social problems at school age if their mothers exposed them to raised levels of RF/microwave radiation during pregnancy. Animal research by Tamir et al. (2012) indicates that fetal exposure to 800-1900 MHz radiation can affect both neurodevelopment and behaviour.

De Iuliis et al. (2009) demonstrated that purified human spermatozoa exposed to raised levels of RF/microwave radiation exhibited significantly reduced sperm motility and vitality, with significantly elevated DNA fragmentation and mitochondrial generation of reactive oxygen species being found to occur after exposure ($p < 0.001$). **DNA fragmentation is linked to reduced fertilisation & embryo quality, miscarriage & increased illness in offspring - including childhood cancer** (Avendaño et al. 2010, Aitken & De Iuliis 2007).

Raised exposures (*similar to those that can be created by some smart meters – comment by present author*) have been linked with increased incidences of childhood leukemia (Hocking et al. 1996).

Raised field exposures have also been linked to depression (Eger & Jahn 2010, Oberfeld et al. 2004, Santini et al. 2002), childhood and adolescent depression are predictors for obesity. Chiang et al. (1989) found that children exposed to microwaves had lower scores in memory function tests than controls in low field environments and also exhibited change in immune function dependant on exposure regime with higher field exposures casing suppression.

Children can also be EHS. The physical and psychological impact of this condition also has to be factored in. As noted by Genuis & Lipp (2012) *“Symptoms often lead to ongoing psychological stress and in- tense fear of being ‘hit’ by EMR wherever they go. Many patients become incapacitated by such fear - knowing that an invisible wireless signal may incite major symptoms in their body at any time and any place. This unremitting fear and preoccupation with health issues can have a major impact on well-being, ...”*

As declared in the Declaration *“... **mankind owes to the child the best it has to give,** ...”* This would seem to infer that factors such as those noted above should be taken into consideration when determining the best type of metering infrastructure to develop. Correctly approached, FortisBC has the opportunity to correctly address many of these issues and create a metering system that truly contributes to the benefit of children and other members of society.

“THIS DECLARATION OF THE RIGHTS OF THE CHILD to the end that he may have a happy childhood and enjoy for his own good and for the good of society the rights and freedoms herein set forth, and calls upon parents, upon men and women as individuals, and upon voluntary organizations, local authorities and national Governments to recognize these rights and strive for their observance by legislative and other measures progressively taken in accordance with the following principles:”

1 *“The child shall enjoy all the rights set forth in this Declaration. Every child, without any exception whatsoever, shall be entitled to these rights, without distinction or discrimination on account of race, colour, sex, language, religion, political or other opinion, national or social origin, property, birth or other status, whether of himself or of his family.”*

2 *“The child shall enjoy special protection, and shall be given opportunities and facilities, by law and by other means, to enable him to develop physically, mentally, morally, spiritually and socially in a healthy and normal manner and in conditions of freedom and dignity. In the enactment of laws for this purpose, the best interests of the child shall be the paramount consideration.”*

7 *“The child ... shall be given an education which will ... enable him, on a basis of equal opportunity, to develop his abilities, his individual judgement, and his sense of moral and social responsibility, and to become a useful member of society.*

Children and adults are indicated as having better memory function in low field environments (Chiang et al. 1989). Significant associations have been found between field exposure & concentration problems at levels $<0.1 \mu\text{W}/\text{cm}^2$ (Hutter et al. 2006). Such findings indicate that children in lower field environments will learn better and may have better opportunities to develop abilities than those exposed to similar levels of radiation from smart meters.

“The best interests of the child shall be the guiding principle of those responsible for his education and guidance; that responsibility lies in the first place with his parents.”

If because of health, or other concerns, a child's parents consider that the retention of analog metering at their dwelling is in the best interests of the child, it (from the perspective of the present author) may be appropriate to respect this viewpoint instead of threatening to disconnect the power supply.

The child shall have full opportunity for play and recreation, ... ; society and the public authorities shall endeavour to promote the enjoyment of this right."

As noted by Parsons (2011), cited by Genuis & Lipp (2012), individuals with EHS "frequently experience ridicule and eventual rejection or dismissal by their usual systems of support. This common outcome has a profound impact on many aspects of life ... as well as having a profound bearing on social, emotional and psychological dimensions of life." Such desperate situations may be even harder for children to bear.

8 "The child shall in all circumstances be among the first to receive protection and relief."

The possible widespread adoption of more 'biologically friendly' alternatives to the wireless transmission of data should be seriously considered by FortisBC. A number of roll outs have indicated that the use of fibre optics can be financially viable.

9 "The child shall be protected against all forms of neglect, cruelty and exploitation. ..."

Deliberately increasing the exposure of an EHS child to electromagnetic radiation may be considered cruel by some and in breach of the fundamental principles of children's human rights.

10 "The child shall be protected from practices which may foster ... any ... form of discrimination. ..."

A Canada Fit for Children

Canadian Children's Rights Council (Canadian CRC 2004).

"The Public Health Agency of Canada is responsible for coordinating federal implementation of the Convention in Canada. The Department of Justice is responsible for its legislative implementation at the federal level," PHAC (2012).

II. DECLARATION

6. "A country that believes in the future values its children. Canada is a forward-looking nation with a strong sense of responsibility. We believe that children should have the opportunity to be fully prepared to live a responsible life in a free society, in a spirit of understanding, peace, dignity, tolerance, equality and solidarity."

11. "We affirm our obligation to promote and protect the human rights of all children. ..."

It appears that a number of human rights for children may be breached by FortisBC's present AMI proposal. Some of these are detailed below and elsewhere in this present Chapter.

12. "Each of us can make a difference in the life of a child. So let us all commit to working together to build a Canada and a world fit for children – a world in which children are loved and respected, and where every boy and girl is able to enjoy childhood and grow up healthy, in dignity and peace."

Seeking to expose children to a recognised Class 2B carcinogen (WHO/IARC 2011) 24/7 as FortisBC presently intend to do, when safer alternatives are available, appears contrary to this aim. Refer also to other comments given in this section.

(1) Children's well-being in Canada: A shared responsibility

17. "The well-being of children is a shared responsibility in Canadian society. ..."

Corporate Social Responsibility (CSR) also appears to apply with regard to children's well-being in Canada. As noted by Prime Minister Stephen Harper in 2007, the Canadian Government encourages and expects Canadian companies to meet high standards of Corporate Social Responsibility (CSR) (Government of Canada 2012). This declaration that he made appears in keeping with the Canadian Government's human rights obligations. CSR is defined as "as the way companies integrate social, environmental, and economic concerns into their values and operations in a transparent and accountable manner. It is integral to long-term business growth and success, ..." (Government of Canada 2012a).

If this is taken into account, it appears that the social, environmental and economic concerns raised by FortisBC's present metering proposal indicate that it may be unfit for purpose.

21. "The Government of Canada has identified population health, the maintenance and improvement of the health of the entire population and the reduction of inequities in health status among groups within the population, as the best approach for program and policy development, ..." "[An] entire range of individual factors and conditions – and their interactions – ... have been shown to be correlated with health status. ..."

It is indicated that RF/microwave exposure levels are also correlated with health status. As an example, when Oberfeld et al. (2004) undertook a health survey in the vicinity of two GSM 900/1800 MHz cell phone base stations, all models demonstrated statistically significant associations between measured electric fields in the microwave range [0.05-0.22 V/m (0.0006-0.0128 $\mu\text{W}/\text{cm}^2$) compared to high exposure 0.25-1.29 V/m (0.0165- 0.4400 $\mu\text{W}/\text{cm}^2$)] and 13 out of 16 health-related symptoms.

The adjusted (age, gender, distance) logistic regression model Oberfeld et al. (2004) used showed statistically significant positive exposure-response associations between electric field strengths and the following variables: Cardiovascular problems; Loss of appetite; Difficulty in concentration; Depressive tendency; Feeling of discomfort; Dizziness; Fatigue; Headaches; Irritability; Nausea, Loss of memory; Sleeping disorder; and Visual disorder.

The exposure levels at which effects were noted are less than those that would be created by FortisBC's proposed AMI project. [In FortisBC's Response to Question 18.1, the microwave exposure from their proposed smart meters, at a mean duty cycle of 0.06%, is noted as being 0.056 $\mu\text{W}/\text{cm}^2$].

24. "We all recognize the importance of good parenting for child ..."

One of the roles of good parenting is to protect children from perceived harm. FortisBC's intention to mandatorily expose children to increased levels of a recognised Class 2B carcinogen (WHO/IARC 2011) may be perceived by some as unnecessary risk to the health and wellbeing of children.

(4) Supporting the health of children in Canada

35. "The responsibility of governments to protect our health is a key component of Canada's social contract. Public health, defined as the organised efforts of society to protect, promote and restore the health of the entire population, has three main functions: disease and injury prevention and control; protection from health threats; and health promotion. Canada's public health efforts include ... threats to health such as environmental toxins; ... [and] pollutants; ... Canada's current efforts have focused on individual threats to health like diabetes and the promotion of protective factors such as healthy living. Children are a key population for public health efforts."

As detailed elsewhere in this present document, increased exposures to RF/microwave radiation are now indicated in many scientific studies to be a factor that can affect health and well-being. Public health efforts, and best practice initiatives by industry, which recognise this can be used to protect, promote and restore the health of the entire population. Refer also to the Chapter on 'Health Matters.'

37. "The Federal/Provincial/Territorial Ministers of Health agreed in September 2002 to work together on an Integrated Pan-Canadian Healthy Living Strategy. ... The Healthy Living Strategy is aimed at reducing non-communicable diseases by addressing their common risk factors and the underlying conditions in society that contribute to them. ..."

Exposure to RF/microwave radiation, a Class 2B carcinogen (WHO/IARC 2011), is a known risk factor. Refer to the Chapter on 'Health Matters' for further details, and also the work of Oberfeld et al. (2004) documented above.

FortisBC's present AMI strategy would increase population exposure to a risk factor already indicated as causing ill-health.

(7) Building on what we know

47. "Canada's efforts to support children and families are based on a strong body of evidence of what works best. ..."

A growing body of evidence worldwide indicates that increased exposures to many types of radiofrequency and microwave radiation may be detrimental to children and their families. Refer to the Chapter 'Health Matters.'

IV. PLAN OF ACTION

53. "No one government, organisation or individual alone can effectively address the broad range of issues affecting children today. A Canada Fit for Children was developed in close collaboration with a wide array of partners and reflects a consensus on a range of priority areas for children. Throughout the consultation process certain shared principles, priorities and strategies for action emerged. As a result, the action plan offers a collective vision for moving forward to create a Canada and a world fit for children. It is a call to action, identifying strategies that everyone in Canada can contribute to in different ways and at different times, and inviting all sectors of Canadian society – governments, organizations and individuals including children – to take it forward as a common task."

In keeping with this bold initiative, it appears appropriate to suggest that a similar strategy could be considered with regard to the design of the smart grid in British Columbia? A bringing together of a wide array of partners in Canada with complimentary skill-sets, to work in close collaboration with each other, in an air of mutual respect, to openly address and help resolve the broad range of issues that have arisen.

A. Creating a Canada and a World Fit for Children

54. "We want a world fit for children, because a world fit for us is a world fit for anyone', ... Everyone is implicated in shaping the world for children whether or not we are conscious of what we are doing. So for our sake as well as theirs, everyone must work together to improve our world. ..."

A far better AMI than FortisBC currently proposes can be created to address the concerns that have been raised to date about such systems.

55. "We commit to implementing the Plan of Action according to the following principles based on Canadian values: Recognition that parents (and legal guardians where designated) have the primary responsibility for the care and nurture of children."

This primary responsibility of parents to care and nurture their children, by doing what they think is best for them, may in some cases extend to them wishing to opt out of smart metering to protect their children.

FortisBC's present intention (as stated in the Application (Exhibit B-1) at page 142) to disconnect energy provision to those who wish to protect their children from what they see as a threat from smart meters appears unjust, in breach of this commitment, and contrary to Canadian values.

Recognition of governments' role and responsibilities

57. The protection of children is fundamental to the Plan of Action. All governments in Canada are determined to protect children from harm, securing their healthy development and well-being and respecting both their dignity and their resilience. ... "As a society, we share a collective responsibility for the safety and security of all children, and must work together to model and promote a culture of respect."

The reported health problems that are occurring with smart meter roll outs elsewhere, in conjunction with the increased vulnerabilities of the grid that have become apparent through the adoption of smart metering, indicate the urgent need to address the shortfalls of the FortisBC proposal.

As the protection of children is fundamental to the Plan of Action and all governments in Canada are determined to protect children from harm, securing their healthy development and well-being and respecting both their dignity and their resilience, it is important that the FortisBC metering infrastructure is safe.

Ensuring social inclusion

59. "All children must be provided with opportunities that enable their full participation in society. Experiences of discrimination can have a serious negative impact on the health and well-being of children. No child should be excluded ... Social inclusion is one of the primary and most effective vehicles for addressing the rights of children. It is important to create inclusive, flexible and responsive systems that strive to reduce disparity, promote diversity and enhance awareness of social inclusion for all children."

The creation of RF/microwave regimes that FortisBC presently propose will lead to the social exclusion of children who are EHS.

As noted by Genuis & Lipp (2012) "EHS has been described ... as a 'loner's disease'. Due to the prevalence of ubiquitous EMR in the contemporary urban environment, EHS causes [individuals] to experience extreme social isolation. The serious symptoms confine them to their home. Venturing out to shopping malls, libraries, theatres, hospitals, and doctors' offices is often precarious because of the prevalence of wireless routers, cell phones, antennas, and other sources of EMR. ... many ... are often no longer able to spend time in the homes of family members due to EMR issues. As a result, huge stresses are placed on marriages and families ... The inability to participate in previously enjoyed leisure activities and meaningful occupations is worsened by the lack of empathy and fractured relationships with family, colleagues and health care providers."

The creation of low field metering and technology initiatives can help redress this imbalance.

Sharing research, information and best practice

52. "Research plays an essential role, not only in finding new solutions, but also in determining the nature of the challenge and measuring progress towards goals. Much work has been done in Canada and in other nations to study, analyze and review the situation and needs of children. We in Canada recognize the importance of expanding our knowledge to ensure that our decisions are evidence based."

As noted by the World Health Organization (WHO 1986), "Systematic assessment of the health impact of a rapidly changing environment - particularly in areas of technology, work, energy production and urbanization - is essential."

It appears there may be a need for additional stakeholders to help expand knowledge on how FortisBC may help the citizens, and future generations of BC, get the AMI they deserve.

An expanded group could include academics, technical staff and experts on: human rights issues, electromagnetic pulse (EMP) and electromagnetic compatibility (EMC) issues, cyber-security, health (as related to the biological effects of possible emissions from smart meters & related technology) and environmental matters.

A more collaborative approach (as outlined above), with regard to what FortisBC is wishing to achieve, could prove of great benefit to all in determining what is realistic, practical and achievable. In particular, it appears vital for BC to ensure that additional 'appropriate' health, cyber and environmental impact assessments are undertaken on the technologies FortisBC proposes for its metering system and related equipment, so that appropriate choices are made, and the technology chosen is made as safe and as resilient as possible to protect both present and future generations.

Refer also to the section 'Health Promotion – Making things better' in the Chapter 'Health Matters.'

B. Goals, Strategies and Actions for Canada

1. Supporting Families and Strengthening Communities

Priorities for action

(a) Child- and family-friendly policies

67. "... As part of our shared responsibility to raise healthy children and promote and support families, we will continue to work together to build a child-friendly and family-enabling society by developing policies and initiatives that are culturally rooted and accountable."

As accountability is an issue, and new apparent risks have been raised, it may be prudent for FortisBC to consider redeveloping its proposal to take such matters into account.

(b) Early learning and child care

68. "Every child deserves a healthy start in life. Early childhood to age six is a critical period for child growth and development. Research has shown that quality early learning and child care has a positive impact ..."

Research by Oberfeld et al. (2004) investigating the apparent effects of different field exposures on health-related symptoms found statistically significant associations between increased microwave exposure and symptoms in 13 out of 16 health-related symptoms. The field levels assessed were 0.05-0.22 V/m (0.0006-0.0128 $\mu\text{W}/\text{cm}^2$) and 0.25-1.29 V/m (0.0165- 0.4400 $\mu\text{W}/\text{cm}^2$). The trend observed for difficulties in concentration was ($p = 0.0001$) and that for loss of memory was ($p = 0.0031$). In FortisBC's Response to Question 18.1, the microwave exposure from their proposed smart meters, at a mean duty cycle of 0.06%, is noted as being 0.056 $\mu\text{W}/\text{cm}^2$.

In the online survey on smart meters by the EMF Safety Network (Halteman 2011), 34.6% of the 318 respondents stated that either they or members of their family had suffered from concentration, memory or learning problems after the installation of smart meters. Research by Chiang et al. (1989) found that children, exposed to microwave power densities $\geq 10 \mu\text{W}/\text{cm}^2$ had lower scores in memory function tests than controls in low field environments ($p < 0.01$).

In addition to creating possible health problems for vulnerable children, it appears that the levels of microwave radiation FortisBC wish to expose children to may also hamper early learning abilities.

(e) Social inclusion and diversity: Building community

77. "Respect for diversity and active civic participation are core Canadian values. Yet some children, young people and adults, such as ... those with disabilities ... may experience barriers to full participation in society. ... These barriers can prevent parents, families and legal guardians from providing a balanced, integrated life for their children. Barriers may also prevent children and young people from sharing their opinions and fully participating in the creation of a Canada that responds equitably to all."

It is recognised that suffering from EHS can cause social exclusion and prevent individuals from fully participating in their communities. It has been described by sufferers as a "loner's disease." Genuis & Lipp (2012), note that due to the increasing presence of manmade radiation in the urban environment, those with EHS can experience extreme social isolation. Such conditions appear particularly hard for EHS children.

FortisBC's intention to increase background levels of radiation with their metering infrastructure will create a further barrier to EHS children being able to fully participate and integrate with others. Safer technology, such as fibre optics, which has already been indicated as being cost effective, could be used instead.

78. "We recognize that all children in Canada have the right to participate and contribute, in accordance with their abilities, as valued and respected members of communities and society as a whole. As a multitude of experiences contribute to Canada's diverse fabric, it is important that legislation, policy services and activities are sensitive to the barriers that can affect children, young people and their families."

As above.

(g) Inclusion and support of children with disabilities

2. Promoting Healthy Lives

87. "We in Canada are committed to promoting and maintaining the physical and mental health of all children in Canada. ... We will aim to reduce inequities in health status among different groups of children, and will take action on the factors and conditions that have been shown to influence the health of our populations. ..."

FortisBC wishes to expose citizens to increased levels of RF/microwave radiation, a Class 2B carcinogen (WHO/IARC 2011), 24/7.

Anecdotal evidence from other smart meter rollouts (EMFSN 2013), indicates that the radiation from smart meters can ruin physical and mental health. Scientific research also indicates that exposures levels below those created by the smart meter units FortisBC wishes to use can cause health problems. It appears highly likely that if FortisBC was allowed by BCUC to carry out its present metering proposal it would result in increasing inequities in health status among different groups of children.

Priorities for action

(a) Healthy active living

88. "Healthy eating and physical activity plays a fundamental role in promoting healthy growth and development and reducing the risk of chronic disease. By creating supportive environments and encouraging informed choices, children in Canada can establish patterns for healthy living that they will carry into adulthood. Physical activity, sports and recreation programs provide considerable physical benefits for children and can also serve as tools to teach important values and life skills including self-confidence, teamwork, communication, inclusion, discipline, respect and fair play."

Healthy eating: Research indicates that increased levels of background microwave radiation can reduce the levels of anthocyanin created by plants (Haggerty 2010). The presence of anthocyanin in food and supplements provides a number of potential health benefits as they are potent antioxidants, which (in association with other flavonoids) may help reduce likelihood and severity of cardiovascular disease, diabetes and some cancers (Gould et al. 2008). As Lila (2004) notes, "Anthocyanin pigments and associated flavonoids have demonstrated ability to protect against a myriad of human diseases."

Physical activity: Physical inactivity is a major contributing factor to obesity, and a recognized risk factor for over twenty chronic diseases and conditions (Kendall 2010, Medibank 2008, Forum 2007, Coleman & Walker 2004, DH 2005, National Heart WHO 2002).

The work of Altpeter et al., (1997, 1995) indicates that exposure to power densities of 0.002 $\mu\text{W}/\text{cm}^2$ – below the levels created by the wireless smart meters FortisBC wish to use (refer to the Response to Question 18.1) – may result in fatigue and weakness (along with sleep disorders, joint & limb pain, abnormal blood pressure, nervousness and digestive problems). Refer also to the 'Health Matters' Chapter for details on other studies health discussing this and other health related problems associated with raised field exposures.

The EMF Safety Network online survey found 34.3% of the 318 respondents reported that either they or members of their family reported fatigue, muscle or physical weakness after the installation of smart meters (Halteman 2011).

As it is indicated that the field exposure levels that FortisBC's proposed smart metering infrastructure would create may negatively impact on healthy active living, it is proposed that safer alternatives are considered.

(c) Mental health

94. "A significant number of children in Canada have mental health issues that are serious enough to warrant clinical intervention. ... if there are too many problems at once or if they are not resolved, then the child may find it difficult to adjust and become prone to dysfunctional relationships and to making unhealthy choices."

There are associations indicated between raised field exposures and irritability, headaches, dizziness, and depressive tendencies (Oberfeld et al. 2004, Simonenko et al. 1998). Unpublished research by Klinghardt (2008) also indicates a possible link between raised exposures and risk of autism (Refer to Chapter on 'Health Matters'). Details of how depression is linked with heightened risk of medical illness are shown in Table 2.1. It is indicated that FortisBC's presently proposed metering system is possible an unhealthy choice.

95. All children benefit from opportunities to experience success, to make constructive choices, to understand emotions, and to share thoughts and feelings safely with one and another and with adults. We in Canada will create and maintain the conditions that promote the mental health of children, young people and their families, and will strive to prevent or minimize the adverse consequences of emotional problems and mental illness. Depression in children is a growing concern. ..."

Several studies indicate a possible link between increased exposures to RF/microwaves and likelihood of depression (Eger & Jahn 2010, Bortkiewicz et al. 2004, Oberfeld et al. 2004, Santini et al. 2002). Refer also to Chapter on 'Health Matters.'

Oberfeld et al. (2004) noted depressive tendency was associated with exposures to 900/1800 MHz radiation levels of 0.25-1.29 V/m (0.0165-0.4400 $\mu\text{W}/\text{cm}^2$) compared to levels of 0.05-0.22 V/m (0.0006-0.0128 $\mu\text{W}/\text{cm}^2$) ($p = 0.0016$). The levels indicated as being of concern (in the frequency range used by part of FortisBC's metering infrastructure) are below those created by FortisBC's proposed smart meters.

As Canada seeks to create and maintain the conditions that promote the mental health of children, young people and their families, it appears appropriate that an alternative metering structure to that which FortisBC presently propose should be seriously considered. Creating the kinds of electromagnetic environments that enable all children to thrive is good for Canada and good for BC.

96. "We will make the promotion of mental and emotional health a key element of health promotion and protection strategies. ... "

Refer to the comments given above.

(e) The physical environment and the prevention of injuries

100. "Natural and constructed environments play a crucial role in the healthy growth and development of children. ... Children are particularly vulnerable to environmental contaminants and questionable consumer products due to their unique physiology, behaviours and exposures. Protecting children from the hazards in the natural as well as the constructed environments in which they live and grow yields tremendous benefits for Canada and the world."

RF/microwave radiation can be an environmental pollutant. Research already indicates that RF/microwave exposures at intensities similar to those that FortisBC's AMI structure may emit may be injurious to health – Refer to Chapter on 'Health Matters'.

It may be prudent to investigate the possibility of using an alternative type of infrastructure. The widespread introduction of RF/microwave emitting smart appliances and technologies is also questionable on health terms. Protecting children from the risks of such hazards is in keeping with the aims of A Canada Fit for Children, particularly as they can spend a large proportion of their time indoors. Pregnant women, young infants and mothers with young children tend to spend more time at home. Studies (Leech et al., 2002,1996, Klepeis et al., 2001) suggest that children under the age of 11 spent more time inside their houses than adults. As an example, the CHAPS survey found that Canadian children spent 72% of their time at home compared to 66% for adults (Leech et al., 2002).

(f) Sexual and reproductive health

103. "... Sexual and reproductive health needs to be promoted as an important component of healthy living, with the recognition that all people, including girls, boys and adolescents, have the right to access information, information, education and services required to protect their overall health. ..."

As noted by FortisBC's Response to Question 18.1, the microwave exposure from their proposed smart meters, at a mean duty cycle of 0.06%, is 0.056 $\mu\text{W}/\text{cm}^2$.

Research by Behari (2006) found chronic exposure to pulsed microwave radiation at a power density of 0.00034 $\mu\text{W}/\text{cm}^2$ is linked to a significantly reduced sperm count in rats. Magras & Zenos (1997) found that exposures of 0.168 $\mu\text{W}/\text{cm}^2$ were linked with total infertility in mice after 5 generations. Such findings suggest that the field regimes that children would be exposed to from FortisBC's present proposal (particularly if ZigBee Radio is activated and wireless emitting smart appliances are nearby) may put their sexual and reproductive health at risk.

104. "Canada will support research, policies and programs related to sexual and reproductive health that are inclusive and ... recognize the positive role that parents can play with respect to their own children. ... Comprehensive, evidence based, accessible programs and services will continue to be promoted to ensure that children and adolescents have the knowledge and skills they need to achieve sexual health and avoid negative outcomes. ..."

One of the positive roles that parents can play is actively seeking to reduce their children's exposure to risk factors that may damage their sexual and reproductive health. The RF/microwave radiation that the FortisBC proposal seeks to expose them to is one of these risk factors. The Fortis proposal appears to be at odds with Canada's aim to help children avoid negative outcomes with their own sexual and reproductive health.

(i) Paediatric health care and research

110. "In spite of our best efforts many children in Canada still fall seriously ill, sustain injuries or are medically fragile from birth or as the result of serious trauma. These children need specialised health care. While the delivery of health services is a provincial-territorial responsibility, ... all of us have a duty to ensure that the child's right to health is respected in a holistic manner"

Increased exposures to RF/microwaves, at levels below those created by the smart metering system FortisBC currently wishes to use, have been implicated in detrimentally contributing many childhood conditions. Creating a more biologically friendly metering system would help comply with the duty to ensure that children's right to health is respected in a holistic manner. Refer also to the Chapter on 'Health Matters.'

119. "Canada will work with the international community to address sexual and reproductive health within the framework of the MDGs, as well as the goals agreed upon at the Cairo International Conference on Population and Development in 1994 and the Beijing Declaration and Platform Action in 1995 and their five-year reviews. At these events [ICPD and Beijing] the international community agreed that all women and men, boys and girls, have the right to the highest attainable standard of health, with access to high quality sexual and reproductive health care and services, including family planning information and sexual and reproductive education. ..."

Refer to earlier comments within this section and the Chapter on 'Health Matters.'

3. Protecting from Harm

121. "... When children are maltreated, or at significant risk of being maltreated, state authorities have an obligation to intervene to protect them and/or assist them, ..."

It is suggested by some that the mandatory exposure to a Class 2B carcinogen (WHO/IARC 2011) that FortisBC wishes to inflict on children, whilst in their own homes and elsewhere within BC, may amount to a form of maltreatment, particularly as safer, cost effective alternatives are available and being apparently ignored by FortisBC. State authorities have an obligation to intervene to protect the children of BC on this issue.

122. "We are committed to protecting children from harm ... and will continue to support approaches that promote effective prevention and intervention, ... We will work together to create safe and caring environments that are free from discrimination ... which celebrate diversity and promote the healthy development of children."

It appears that the present AMI system that FortisBC propose may increase the risk of harm to children from RF/microwave radiation, a recognised Class 2B carcinogen (WHO/IARC 2011), and also risk discriminating against children who are EHS or have other conditions that may be worsened through increased exposures to such radiation. Safer more environmentally friendly alternatives are available.

Priorities for action

(a) Child maltreatment

123. "Child maltreatment, which includes physical and sexual abuse, emotional maltreatment and neglect, continues to be a significant issue in Canada. ..."

FortisBC's intention to expose children 24/7 to raised levels of microwave radiation, a Class 2B carcinogen, indicated as being able to affect both their biological development and mental functioning, may be seen by some as a type of maltreatment neglecting their true needs. Refer to Chapter on 'Health Matters.'

FortisBC's present intention to cut off the power supply/suspend customers' services of those refusing the installation of 'advanced' meters – if it does not judge there to be extenuating circumstances (as noted in its response to Question 34.1), may be perceived by some as potential emotional maltreatment of the children of customers who wish to retain their analog meters.

The possibility that the field regimes they may be exposed (particularly if exposed to extra radiation from the smart meters if ZigBee Radio is activated and wireless emitting smart appliances are nearby) may also put their future fertility at risk is another factor to be considered. [As an example, according to FortisBC's Response to Question 18.1, the microwave exposure from their proposed smart meters, at a mean duty cycle of 0.06%, is $0.056 \mu\text{W}/\text{cm}^2$. Research by Behari (2006) indicated that chronic exposure to pulsed microwave radiation at a power density of $0.00034 \mu\text{W}/\text{cm}^2$ was linked to a significantly reduced sperm count in rats, with earlier research by Magras & Zenos (1997) had found that exposures of $0.168 \mu\text{W}/\text{cm}^2$ were linked with total infertility in mice after 5 generations].

The claims of FortisBC's intention to expose children 24/7 to raised levels of microwave radiation in their own homes being a form of maltreatment may be thought to be particularly true for those children who are EHS.

124. "We in Canada are committed to protection of children from all forms of child maltreatment. We will continue to support strategies in the home, in out-of-home care, and in our communities that promote the healthy development and well-being of children, and assist those who have been maltreated. We will ensure appropriate criminal justice responses to incidents of abuse ... We recognize the ongoing concerns of specific populations such as ... children with disabilities ..."

FortisBC's intention to expose children 24/7 to raised levels of microwave radiation, a Class2B carcinogen, indicated as being able to affect both their biological development and mental functioning, may be seen by some as a type of maltreatment. Refer to Chapter on 'Health Matters.'

The creation of an alternative type of metering infrastructure to that presently proposed by FortisBC, which avoids this unnecessary risk to children's well being, is an environmentally sound investment for British Columbia.

It is indicated that unborn children, newborns, those with disabilities, and children with EHS, are all at risk from the raised EMF regimes that the present FortisBC proposal seeks to introduce.

125. "Partners will seek to understand the complex and multi-faceted nature of child maltreatment, and will identify and promote approaches that include improved prevention and intervention, ... An awareness and understanding of the rights of the child has the power to reduce child maltreatment by increasing respect for the child's dignity and physical integrity."

As above. Refer also to Chapter on 'Health Matters.'

(c) Violence, bullying and other forms of intimidation

130. "The issue of violence, bullying and other forms of intimidation in schools, communities and society at large is receiving increasing attention. These types of aggression can take many forms, ... and have negative consequences both for those who are victimised and those who are perpetrators. ... All children have a right to feel and to be safe." (Emphasis added by present author).

131. "We in Canada are committed to taking action to prevent violence, bullying and other forms of intimidation, ... and to intervene effectively when they occur. By increasing knowledge and awareness we will bring attention to the damage such action causes children. We will also promote and model a culture of respect for all children and strive to create environments that are safe, responsive and free from discrimination." (Emphasis added by present author).

FortisBC's present intention as documented in its response to Question 34.1 (as stated in the Application (Exhibit B-1) at page 142) to cut off the power supply/suspend customers' services of those refusing the installation of 'advanced' meters – *if it does not judge there to be extenuating circumstances* – may be seen by some as a form of bullying, intimidation and/or victimisation that may have negative impact on customers' children (and the utility's reputation).

132. "We will identify effective school- and community-based prevention and intervention strategies, ... We will also promote diversity and increase understanding about social inclusion. Our strategies will be multi-dimensional, addressing the concerns of the individuals who are victimized, as well as those who perpetrate aggression or witness it."

The FortisBC smart metering proposal ignores the needs of the vulnerable, who can be adversely affected by increased exposures to RF/microwave radiation, and is likely to increase the social exclusion of children who are EHS.

(i) Protecting marginalized groups

151. "The children most marginalized by society often experience violations of their rights through exploitation, abuse and discrimination. ..."

The FortisBC smart metering proposal discriminates against children who are EHS or who are particularly likely to be at risk from increased levels of exposure to RF/microwave radiation. It may be claimed by some that this is a form of abuse. Refer also to Chapter on 'Health Matters.'

4. Promoting Education and Learning

(b)

162 "... education should develop an understanding of human rights and fundamental freedoms, as well as respect for the natural environment."

The FortisBC proposal presently breaches a number of basic human rights and fundamental freedoms. Scientific research additionally indicates that it may be harmful to the natural environment. These matters are discussed in detail in this present Chapter and in the Chapter on 'Environmental Concerns.'

(c) Human rights education and global citizenship

163 "Respect for human rights and fundamental freedoms are core Canadian values. These rights, as defined in the Convention on the Rights of the Child and in the Canadian Charter of Rights and Freedoms, affect not only children but those who are responsible for them. We are committed to educating Canadians about how these rights and freedoms affect their lives. By helping children and other partners to understand the nature of human rights, we will increase their awareness of the rights and responsibilities of our shared citizenship and the problems created by discrimination and intolerance."

The FortisBC smart metering proposal possibly ignores and breaches a number of basic human rights and freedoms. These are discussed in detail throughout this present Chapter.

(e) Environmental learning and sustainability

168. "Despite the many successes of the environmental movement, much more needs to be done if our society is to understand the complexities of environmental conditions. Children in Canada are concerned about the quality of air that they breathe, the water they drink, safe food production, the recycling of waste, threats to biodiversity, climate change and the integrity of our ecosystems. They are looking for opportunities to learn about and engage in ensuring environmental sustainability for both Canada and the world."

Scientific research indicates that the levels of radiofrequency and microwave radiation that would be created by FortisBC's presently proposed Advanced Metering Infrastructure (AMI) Project may be damaging to the environment. Refer to Chapter on 'Environmental Concerns' for further details.

169. "We in Canada will support the United Nations Decade of Education for Sustainable Development beginning January 1, 2005, that resulted from the Johannesburg World Summit on Sustainable Development. We will acknowledge the concern and energy that children have for environmental issues and recognize their achievements. We will continue to provide children with opportunities to engage and contribute to improving the quality of the environment through activities such as the Youth Roundtable on the Environment. We will produce up-to-date educational materials to increase environmental learning and sustainability. Our efforts will support greater community awareness and capacity, social engagement and corporate action."

The FortisBC proposal could be made much more environmentally friendly than it currently is to help improve sustainability and the quality of the environment.

(f) Literacy

170. "... Literacy is strongly linked to scholastic achievement among children, and to adults' success in finding and keeping employment. Improved literacy skills can influence individual growth and development, as well as contribute to economic well-being."

Research by Oberfeld et al. (2004) found statistically significant associations between increased microwave exposure and symptoms for 13 out of 16 health-related symptoms. The field levels assessed were 0.05-0.22 V/m (0.0006-0.0128 $\mu\text{W}/\text{cm}^2$) and 0.25-1.29 V/m (0.0165- 0.4400 $\mu\text{W}/\text{cm}^2$). The trend observed for difficulties in concentration was ($p = 0.0001$) and that for loss of memory was ($p = 0.0031$). In FortisBC's Response to Question 18.1, the microwave exposure from their proposed smart meters, at a mean duty cycle of 0.06%, is noted as being 0.056 $\mu\text{W}/\text{cm}^2$.

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In addition to creating possible health problems for vulnerable children, it appears that the levels of microwave radiation FortisBC wish to expose children to may also hamper their learning abilities, thereby possibly affecting their literacy levels.

As increased exposures to RF/microwaves - in the frequency ranges used by FortisBC's AMI - appear to be linked with reduced educational performance, further increasing children's (and adults') exposures to such electromagnetic frequencies appears possibly unwise. Refer also to the Chapter on 'Health Matters.'

3 Environmental Concerns

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3.1 Impact on pollinating insects/birds – is Fortis aware of concerns? (Q27.1) & Impact on pollinators – consideration? (Q27.2) & Impact of continuous, long term exposure to strobe flashes – studies (CSTS IR2, Q4.4)

Document: CSTS IR No. 1 - Questions 27.1, 27.2 and CSTS IR No. 2 - Question 4.4

<i>CSTS IR No. 1</i>	
27.0	<i>Reference - Application - pollinating insects</i>
27.1	<i>Is FortisBC aware that there has been concern over the potential impact of the AMI Project on pollinating insects and/or birds?</i>
<i>Response:</i>	
<i>FortisBC understands that concerns have been raised regarding advanced meters impacting bee colonies. Please refer to the response to WKCC IR No. 1 Q6.</i>	
27.2	<i>Has there been any consideration as to the potential impact of the AMI Project on pollinating insects and/or birds?</i>
<i>Response:</i>	
<i>Exponent is not aware of a body of scientific evidence that confirms any adverse effect of RF fields on insects and/or birds at the frequencies and intensities of RF fields produced by the FortisBC smart meters.</i>	
6.	<i>How have the biological considerations of bees, birds and pollinators been considered in the AMI program? Bees and birds use a magnetic field, not a high speed electromagnetic field.</i>
<i>Response:</i>	
<i>Birds and bees are widely reported to 'sense' the earth's static geomagnetic field or man-made sources of static magnetic fields. Exponent is not aware of a body of scientific evidence that confirms any adverse effect of RF fields on bees or birds at the frequencies and intensities of RF fields produced by the FortisBC advanced meters.</i>	
<i>CSTS IR No. 2</i>	
4.4	<i>What studies have been done on the effect on birds and/or bees of continuous, long term-exposure to strobe flashes (of any emission of any duration or any strength) on an on/off basis 1,268 times per day?</i>
<i>Response:</i>	
<i>Several studies looked at geographic correlations between bird populations and mobile phone base stations (Everaert and Bauwens, 2007) or measured radiofrequency fields (Balmori, 2005; Balmori and Hallberg, 2007) but design limitations, e.g., the lack of investigation of confounding factors, precludes any clear interpretation of these studies. Two experimental studies in which migrating birds were directly exposed to far higher intensities of radiofrequency fields from X-band radar reported no effect on flight behaviour (Bruderer and Boldt, 1994; Bruderer et al, 1999). In contrast a strong search light had a quite profound effect on flight behaviour (Bruderer et al, 1999). A claim that a cell phone affected bee behaviour has been reported without direct evidence that the radiofrequency field was involved (Shabib, 2011). In short, there is no clear, confirmed adverse effect of radiofrequency fields on bird or bee health.</i>	

Comments:

Scientific evidence exists indicating adverse biological effects from some types of RF/microwave exposures on pollinating insects, birds and their food supplies.

3.1.1 Background information on pollinators

The following are extracts from a document by US National Resources Conservation Services (NRCS 2005) on the value of pollinators:

“Animals pollinate approximately 75 percent of the crop plants grown worldwide for food, fiber, beverages, condiments, spices, and medicines. ... one out of every three to four mouthfuls of food we eat and beverages we drink is delivered to us by pollinators. ... agricultural products that are produced with the help of pollinators make a significant contribution to the economy. ... it has been estimated that insect-pollinated crops directly contributed \$20 billion to the United States economy in the year 2000. If this calculation were to include indirect products ... the value of pollinators to agricultural production would be raised to \$40 billion in the United States alone.

“Not only do native pollinators provide us with a significant amount of the food we eat and contribute to the economy, they also perform key roles in natural ecosystem. By helping to keep plant communities healthy and able to reproduce naturally, native pollinators assist plants in providing food and cover for wildlife, preventing erosion, and keeping waterways clean. Pollinated plants produce fruit and seeds which are a major part of the diet of approximately 25 percent of bird species, as well as many mammals. ...”

The species of animals that act as pollinators are far more diverse than generally envisaged. They include: bats; bees; beetles; birds; butterflies; flies; and moths (NRCS 2005). Amphibians and mice can also act as pollinators (Native Bee Conservancy 2013, Wang et al. 2008). It is necessary to take into account both the direct and indirect effects of radiofrequency and microwave exposures on these species.

3.1.2 Insect pollinator decline

“Insects perform a vast number of important functions in our ecosystem. They aerate the soil, pollinate blossoms, and control insect and plant pests; they also decompose dead materials, thereby reintroducing nutrients into the soil,” Warren (2002). There are many possible contributors to the present losses being registered in insect populations. These include: habitat degradation; habitat loss; insecticides; and manmade electromagnetic fields.

There is widespread concern about the decline of both wild and managed pollinator populations in a number of geographic regions. The decline in insect pollinators is also in part responsible for the large drops in insectivores that are being reported worldwide.

Cameron et al. (2011) indicate that there have been sharp declines in the abundance of bumblebees (*Bombus*) in the USA. For the eight species they assessed, the relative abundances of four of these had declined by up to 96% and their surveyed geographic ranges contracted by 23–87%, some within the past 20 years. (Bumblebees are key pollinators of wild plants and agricultural crops worldwide and are of high importance to food security and diversity). Honeybee numbers too have suffered drastic decline, van Englesdorp et al. (2008) noted that there had been a 58.5% decline in domesticated honeybee colony numbers in the USA between 1947 and 2008 (5.9 million honey-producing colonies in 1947 compared to 2.44 million as of February 2008). No figures appear available for Canada as a whole. Other insect pollinators too have declined in abundance, though there is less information available on their numbers.

Some insect pollinator communities have gradually become dominated by a few common species as a result of the ongoing decline in their numbers. The University of Leeds (2012) notes that “Reliance on a such a small group of pollinators for plant pollination is risky because the community may not be resilient to future variations in climate, resource provision and disease outbreaks.” Risk factors, such as exposures to manmade electromagnetic fields, which may impact on species diversity should be properly addressed.

The detailed literature review conducted as part of this appraisal, indicates that exposure to inappropriate electromagnetic field (EMF) regimes can adversely affect insects, including bees and other insect pollinators. Greatly reduced insect numbers and insect diversity can adversely affect Nature’s food chain, and may partially explain reduced numbers of some bat and bird species. The following documents some of the findings made with regard to the relationships found at particular exposures:

3.1.3 Ants

Ants perform many vital functions in the World’s ecological cycle, including pollination (Ashman & King 2005, Gómez 2000, Gómez & Zamora 1992), predation (Niemela & Laine 1986) and seed removal and dispersion (Zhou et al. 2007, Howe & Smallwood 1982). The tasks they perform are vital for the continued survival of many crops and species. They are regarded as both ‘Keystone Species’ (Gove et al. 2007) and ‘Ecosystem Engineers’ (Sanders & van Veen 2011, Zelikova et al., 2011, Frouz & Jilkova 2008, Jouquet et al. 2006, Folgarait et al. 2002, Jones et al. 1994). As noted by Ashman & King (2005), “ants can be as good as bees and flies as pollinators.”

3.1.3.1 Effects of EMFs on ant behaviour

Ants use the Earth’s geomagnetic field to orient and navigate around their nests and along migratory paths (Wajnberg et al. 2010). They have also been discovered to orientate themselves to manmade microwaves. Jaski (1960), commenting on research at the University of California carried out under Professor Charles Susskind, noted that when large ants were exposed to 10 GHz frequencies (field-strength not given) they oriented their antennas along the electric lines of force and were no longer able to indicate to other ants the location of food. Interestingly, Jaski mentioned that the length of their antennas was nearly a quarter of the 3 cm wavelength of the 10 GHz fields – similar, the present author has observed, to that found with some bees and other insects.

Measurements undertaken by Wajnberg et al. (2004), determined that antennae are the strongest magnetic part of the migratory ant, and also demonstrated that “the antennae give the strongest saturation magnetization [42±3%, compared to 24±3% for the head, 19±3% for the thorax and 15±3% for the abdomen contributions], suggesting this sensory organ as being also a magnetic sensory organ.”

Research indicates that ant colonies may be detrimentally affected by even very low levels of RF/microwave radiation, indicating that the levels of RF/microwave emissions that would be produced by the FortisBC smart meters, and their related Advanced Metering Infrastructure, may be harmful.

Cammaerts et al. (2012), investigating the effects of exposure to simulated GSM 900 MHz radiation on ants, found that it significantly inhibited (p = 0.016) the ants’ memories and association between food sites and encountered visual and olfactory cues. Additional physiological impacts were also observed. The exposure level of 0.0795 µW/cm² used was noted as being “realistic (and [of] even lower) power intensity than those usually encountered by living organisms.”

The 900 MHz microwave emissions from a proposed average single FortisBC smart meter, which are said to be $0.056 \mu\text{W}/\text{cm}^2$ at a distance of 0.5 metres when on mean duty cycle, will further add to the effects of cumulative exposures from other devices already operating in this range (i.e., *Wi-Fi, ham radio, baby monitors, remote car starters, cordless phones, DirecTV systems, garage door openers, motion detectors, patio speakers, wireless headphones, wireless microphones and security systems*); as will the presence of multiple meters, relays and other components of the AMI. At closer than the 0.5 metres distance the power density measurement was taken, the emissions from the proposed wireless smart meters alone would be above the level indicated in Cammaerts et al. (2012)'s research as giving cause for concern.

As noted in the response to Question 28.2, the maximum transmission time for a neighborhood "collector" smart meter (actual smart meter installed at a residential home) would be approximately 8 minutes per day (compared to an average meter transmitting for about one minute per day). Its emissions alone would therefore be higher than the level Cammaerts et al. (2012) indicated was cause for concern.

The main findings of Cammaerts et al. (2012)'s research on how low level microwave radiation can affect ants are documented below:

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

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

- Foragers proceeded more "slowly, hesitantly, often turning back or stopping instead of going quickly and directly towards their food sites or their nest entrances."

- **Some ants displayed 'locomotor ataxia' (inability to precisely control their own bodily movements).** [A video presentation by Ott (1975) dramatically illustrating this phenomenon in aphids exposed to radar radiation is available at the following link:
<http://www.youtube.com/watch?v=018C2oG2Rcs>]

- The ants' food intake lessened during RF/microwave exposures.

- **Ant larvae in exposed nests either ceased development or died before the end of the final test exposures.** Some RF/microwave exposed nymphs (young ants) did not develop into callows (newly emerged workers) and were found either unchanged or dead. By comparison, the broods of every unexposed colony changed into callows and/or imagos (sexually mature insects).

- Approximately 50 adult ants in each exposed colony, along with 1 colony's queen, were discovered dead in the foraging area. Unlike normal, other ants did not take them to colony cemeteries.

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

The above scientific evidence indicates that adverse effects can occur to insects at the frequencies and intensities of microwave fields that would be produced by FortisBC's proposed smart meters. It would appear that additional cumulative exposure could worsen such effects.

3.1.4 Bees

In 1995 the annual benefit to Canada of honeybee pollination was estimated at \$443 million (Scott-Dupree et al. 1995). In recent years, the increasing incidence of the phenomenon now known as Colony Collapse Disorder (CCD) has drawn the focus of experts worldwide on the plight of the honeybee. As noted by Favre (2011), "*Never before have honeybees disappeared globally ... at such a high rate.*"

Numerous potential causes for bee decline have been suggested. These include: biotic factors (such as viruses and varroa mite); environmental change-related stressors (such as farming practices including monoculture); genetic diversity issues of the bees themselves; climate change (and exceptionally cold winters); genetically modified (GM) crops; malnutrition; migratory beekeeping; pesticides (such as neonicotinoids); and manmade electromagnetic radiation.

It is the opinion of the present author, that whilst one of these factors alone may be enough to cause CCD in certain cases, *a combination of risk factors may often be to blame in others.* The latter view is shared by the United States Department of Agriculture (2010), which in its Colony Collapse Disorder Progress Report states that "*... a combination of environmental stressors may set off a cascade of events and contribute to a colony where weakened worker bees are more susceptible to pests and pathogens.*"

According to the Canada Agricultural Museum (2013) CCD initially became evident in Canada in the early 2000s. Whilst this is strongly debated, a third of Canadian bee colonies died in 2007, and "Experienced beekeepers and some regulators are saying CCD is already in Canada, and that it's just a matter of time before it's proven" (Flottum 2008). The decline in bee numbers in Canada, and worldwide, could have serious ecological and economic implications. Bees and other insect pollinators are vital for many agricultural crops. Around 35% of crops produced worldwide are pollinated by bees (Klein et al. 2007). Gallia et al. (2009), estimated that the total economic value of insect pollination worldwide is €153 billion.

3.1.4.1 Research indicates bees may be detrimentally affected by manmade EMFs

Magnetite crystals are active parts of honeybees' magnetoreception systems (Favre 2011). It has been recognised for several decades that electromagnetic fields can influence bees' behaviour (Korall et al. 1988, Warnke 1976, Lindauer & Martin 1968).

Walker & Bitterman (1989) found that honeybees can be trained to respond to very small changes in the constant local geomagnetic field intensity, with magnetic anomalies as low as 0.026 μ T being responsible for changes in the foraging behavior. Walker & Bitterman (1989a) additionally demonstrated that attaching magnets to honeybees impaired their magnetic field discrimination.

Hsu & Li (1994) noted the presence of superparamagnetic magnetite in trophocyte iron granules formed in honeybees, and hypothesised that external magnetic fields may cause expansion or contraction of these superparamagnetic particles in an orientation-specific manner with the signal being relayed via cytoskeleton.

This research was built upon by Hsu et al. (2007) who “observed changes in the size of the magnetic granules in the trophocytes upon applying additional magnetic field to the cells.” **They also noted that a concomitant release of calcium ions was observed when that field was applied, and hypothesised that the honeybees cytoskeleton may thus relay the magnetosignal, initiating a neural response, and that the proposed mechanism of magnetoreception in honeybees is applicable to most - if not all - magnetotactic organisms (organisms which exhibit movement in response to a magnetic field).**

From the above, it appears highly likely that transmission bursts from AMI may be detected by honeybees and other insects and influence their behaviour.

As is the case with ants, as documented above, bees also use the Earth's geomagnetic field to orient and navigate (Wajnberg et al. 2010). Tests by Schmitt & Esch (1993) determined that magnetic field exposure affected the flight orientation of honeybees by conducting tests on bees exposed under conditions of complete darkness. In the laboratory tests they undertook, the flight orientation of the honeybees changed as predicted when the magnetic field was shifted 90°.

Korall et al. (1988) noted transient 250 Hz magnetic field pulses at between 0.01-1.4 μT could induce **immediate** “jumps” of misdirection of $\leq 10^\circ$ by the bees. They also noted that pulse intensities of $>20 \mu\text{T}$ “have no effect, indicating a ‘window’ of stimulus efficacy.”

To what extent the pulsed microwave emissions from FortisBC smart meters may induce jumps of misdirection and/or adverse health effects in bees (*and if they do how these may be remedied*) has yet to be properly assessed.

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

Neelima et al. (2011), investigating the effect of short-term 900 MHz mobile phone radiation on adult worker honey bees found that exposure to RF/microwave radiation for up to 40 minutes altered worker bees' behaviour and physiology. **Favre (2011), additionally found RF/microwave radiation from active mobile phone handsets had a dramatic effect on worker bee behaviour, principally by inducing a piping signal that announces either that a colony is disturbed or that it is going to swarm.** Negative control runs using a radio did not induce changes in behaviour.

As noted in the recent review of the ecological effects of radiowaves and microwaves by Cucurachi et al (2013), studies undertaken by Sharma and Kumar (2010), Kumar et al. (2011) and Sahib (2011) all indicated a critical reduction in all studied parameters for honeybee colonies exposed to 900 MHz microwave radiation. **“In all cases, an acute decrease in the breeding performance or even a collapse of the entire colony resulted as a consequence of exposure ...”** (Cucurachi et al 2013).

Sharma & Kumar (2010) undertook their pilot study investigating changes in honeybee (*Apis mellifera* L.) behaviour and biology under exposure to 900 MHz radiation. In that work, two colonies were exposed to the radiation for 15 minutes twice per day, twice per week, from February to April (during two brood cycles), whilst two other honeybee colonies were sham exposed. The electric field strength and power flux density that the exposed colonies encountered were 56.8 V/m and $8.549 \mu\text{W}/\text{cm}^2$.

In that research Sharma & Kumar (2010) stated they had found a significant decline in colony strength ($p < 0.05$) and egg-laying rate of the queen related to exposure. *Such findings indicate the need for a full-scale study to be undertaken where greater numbers of colonies can be assessed and variables reduced.*

At the start both the control group and the exposed bees occupied seven comb frames each. At the end this, the figure had changed to five comb frames in the exposed hive versus nine comb frames in the sham-exposed hive, apparently as a result of total exposure to cell phone radiation for 1 hour per week. The queens' egg laying rates were considerably different - 144.8 eggs/day in the exposed colony versus 376.2 eggs/day in the sham exposed colony.

Additionally, the returning abilities of bees and their foraging abilities were shown to differ markedly during exposure (Figure 3.1). Whilst a number of the results found might be claimed to be down to chance due to the small sample size used, *the evidence presented on the bees' behaviours before and during exposures appears further suggests that their behaviour can be influenced by 900 MHz radiation. At the conclusion of the experiment it was reported that there was no honey, pollen, brood or bees in the exposed hive.*

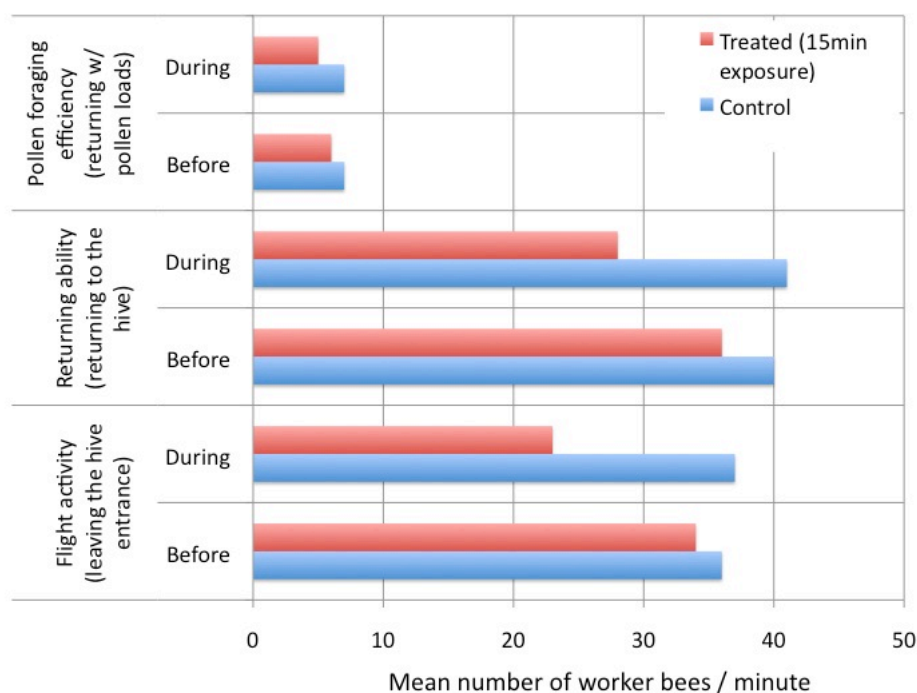


Figure 3.1 Changes in foraging behaviour of *Apis mellifera* exposed to cellphone radiations: Before & During 15-minute exposure (Sharma & Kumar, 2010)

The research undertaken by Kumar et al. (2011) investigating the effects of 900 MHz cell phone radiation on biochemical parameters in worker honeybees, as compared to controls, noted that distinct changes arose in both behaviour and physiology as a result of exposure to a cell phone on 'talk mode.' The exposed worker bees on the comb initially exhibited reduced motor activity before en masse migration toward the 'talk mode' cell phone – *this did not occur with the cell phone in 'listen mode' when radiation exposure would be less.* During the initial quiet period a rise in concentration of biomolecules including carbohydrates, lipids and proteins was observed, which Kumar et al (2011) thought may be as a result of "stimulation of body mechanism to fight the stressful condition created by the radiations." *Whether the audible noise created as a result of transmissions to the 'talk mode' cell phone (from a tape recorder) could have acted as an additional potential stressor does not appear to have been addressed – present author's comment.*

Metabolic changes were shown with regard to carbohydrates, lipids and proteins recorded in the hemolymph (circulatory fluid which is analogous to blood) of worker honeybees exposed to a cell phone on 'talk mode' compared to the control. A slight decline was shown in the concentrations of biomolecules as the test progressed which Kumar et al (2011) considered was probably due to the bees adapting to the stimulus. The degree to which the audible noise from the cell phone may have acted as a potential confounder is open to question. The main results from that study, where exposed ten bees and ten controls were assessed for each selective sampling, are shown in Table 3.1.

Table 3.1 Recorded variation in the hemolymph (mg/ml) of worker bees as a result of exposure regimes (Kumar et al. 2011)

	Non-treated sample	Treated sample at 10 min.	Treated sample at 20 min.	Treated sample at 40 min.
Cholesterol concentration	0.230 ±0.001	1.381±0.002	2.565±0.002	1.578±0.002
Glucose content	0.218±0.0005	0.231±0.002	0.277±0.001	0.246±0.002
Glycogen content	0.019±0.001	0.047±0.001	0.076±0.001	0.028±0.002
Total lipids	2.06±0.02	3.03±0.02	4.50±0.035	3.10±0.02
Protein concentration	0.475±0.002	0.525±0.003	0.825±0.0001	0.650±0.0003

Sahib (2011) assessed the impact of 900 MHz radiation from cell phones on the colony status of honeybees. In that work six colonies of honeybees were selected, three acting as control colonies and the rest acting as test colonies. The latter were exposed to 900 MHz radiation from the cell phones for 10 minutes per day for 10 days. Whilst the power density the bees were exposed to was measured, it is not stated in the paper. Unlike the work of Sharma & Kumar (2010), the controls were not sham exposed. Totally weekly exposure times were however similar.

The total bee strength was shown to be significantly lower in the 900 MHz exposed colonies than in the control colonies (nine comb frames for the latter throughout the test period compared to a reduction from occupying nine comb frames at the start to only one at the end of the 10-day test-period for the exposed colonies.

The egg-laying rates of queens in the exposed colonies were also indicated as being affected by the 900 MHz exposure, with them producing only 100 eggs per day at the end of the test compared to 350 for the control. At the end of the 10-day test all mature worker bees in exposed colonies had abandoned the colonies and only queens, eggs and hive bound immature worker bees remained from the colonies that had been exposed. The main findings from that work are shown in Table 3.2 and Figure 3.2.

Table 3.2 Change in colony status of honeybees exposed to 900 MHz radiation (Sahib 2011)

Parameter	Control	Treated (10 minute daily exposures for 10 days)
Bee strength		
Before exposure	9 Frame	9 Frame
During exposure	9 Frame	5 Frame
After exposure	9 Frame	1 Frame
Egg laying rate of queen /day		
Before exposure	365.25	355.10
During exposure	362.15	198.60
After exposure	350.15	100.00

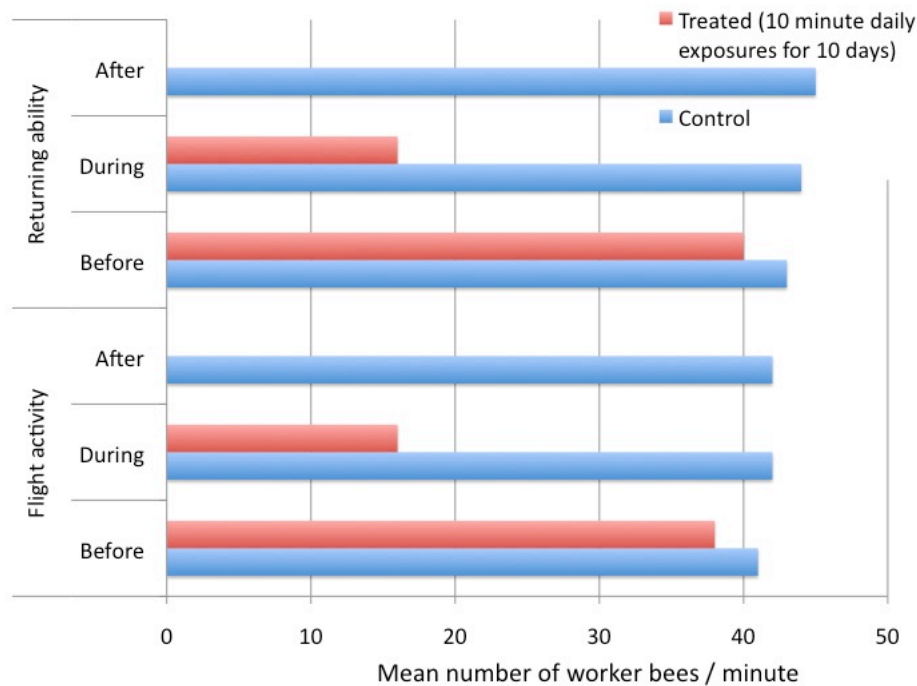


Figure 3.2 Change in colony status of honeybees exposed to 900 MHz radiation: Before, during and after Treated 10 minute daily exposures for 10 days (Sahib 2011)

Favre (2011) undertook what is perhaps the best-designed study to date investigating the effects of exposure to 900 MHz radiation on honeybees as compared to controls with sham exposures. The audiograms and spectrograms made during that research revealed that microwave emissions created by active cell phones (operating at that frequency) strongly influenced bee behaviour, specifically by inducing the worker-piping signal that normally announces the swarming process or indicates a stressed and disturbed bee colony. [The sum of the SAR values of the two cell phones used to create exposures were always less than the 2-W/kg maximum upper limits recommended in the guidelines of the International Commission on Non-Ionizing Radiation Protection (ICNIRP 1998).

The bees appeared undisturbed by the cell phones being inactive or on standby. The exposed bees exhibited increased sound in terms of intensity and frequency about 25 to 40 minutes after onset of exposure. It was indicated that the bees remained perturbed for up to 12 hours after the end of exposure (Favre 2011).

It appears important to replicate this experiment to assess the possible effects of the information bursts from FortisBC smart meters and other parts of its proposed AMI (additionally including smart appliances that may be introduced by others) in a variety of different scenarios.

As stated by Favre (2011), "It remains to be established which minimal level in variations of the local pulsed electromagnetic fields ... might trigger changes in the bees' behavior ..."

3.1.4.2 Effects on Honeybees of Exposures >900 MHz

Harst et al. (2006) undertook a pilot study investigating the non-thermal influence of microwaves on honeybees. In that work four bee colonies were exposed to 1900 MHz radiation (created using the bases of DECT cordless phones) whilst four unexposed colonies acted as controls. The parameters investigated included: averaged honeycomb weight; and returning behaviour of exposed and non-exposed honeybees

Averaged honeycomb weight

The weight of the frames for the honeycombs was similar at the beginning and changed throughout the experiment. For the non-exposed controls, the average total weight of the honeycombs was 1326 g. For the exposed colonies, the average honeycomb weight was 1045 g - 21.1% less than the field free group.

Returning behaviour of exposed and non-exposed honeybees

The returning behaviour of honeybees to their hives from the period of 12:10 to 12:55 on July 7th 2005 is shown under the same weather conditions (Figures 3.4 and 3.5). The number of non-exposed honeybees returning was greater (16 out of 25 bees returned in 45 minutes.) and their return times quicker than those of exposed bees. In one exposed hive no honeybees returned (for the other exposed hive only six bees returned).

Harst et al. (2006) noted that the physical design of their pilot study could be modified to assess the affects of different frequencies and field intensities on honeybees. They suggested that testing of the following physical modifications could be undertaken:

1. A worse case scenario where the effects of maximum sending power was assessed.
2. Frequency-modification, so that the effects of different frequencies could be assessed.

They additionally proposed that the period of exposition and studying honeybee behaviour could be modified or extended so that the effects of exposures on different stages of bee development could be assessed.

It may prove prudent to do similar testing for the FortisBC AMI systems (and smart appliances from different sources) to allay environmentalist's concerns. It is further proposed that typical background RF/microwave radiation levels should also be factored in as a variable to make the exposures tested as realistic as possible.

3.1.5 Fruit flies

Fruit flies are an important food supply for insectivores, and in some instances act as pollinators in their own right (*they can be tricked into performing non-rewarded pollination by certain types of plants*). An example of the non-rewarded pollination they perform exists between Arum lilies (*Arum palaestinum*) and drosophilid flies. (The lily odor is composed of volatiles characteristic of yeast, which in *Drosophila melanogaster* registers as an antennal detection pattern similar to that caused by fermentation products) (Stökl et al. 2010). Fruit flies also act as pollinators to orchids (Tan 2006).

Research shows that fruit flies can be detrimentally affected by microwave radiation. Work by Panagopoulos et al. (2004) shows that exposing *Drosophila melanogaster* to GSM 900 MHz (Global System for Mobile telecommunications) radiation can cause significant reductions in their reproductive capacity. They exposed the fruit flies to microwave radiation from a cell phone operating at 900 MHz for the first 2-5 days of their adult lives.

- **Reproductive capacity decreased 50-60% through exposure to modulated 900 MHz radiation** (emissions created whilst cell phone on talk mode). Mean power density for 6 minutes of modulated emission was $436 \pm 60 \mu\text{W}/\text{cm}^2$. The mean electric field intensity was $37.21 \pm 7.10 \text{ V/m}$. Statistical analysis (single-factor ANOVA test) revealed the probability that mean oviposition (deposition of eggs) differed between exposed and sham exposed groups owing to random variations was $P < 5 \times 10^{-5}$.

- **Reproductive capacity decreased 15-20% through exposure to unmodulated radiation** (nonspeaking emission). Mean power density for 6 minutes of modulated emission was $41 \pm 6 \mu\text{W}/\text{cm}^2$. The mean electric field intensity was $16.68 \pm 3.68 \text{ V/m}$. Statistical analysis (single-factor ANOVA test) revealed the probability that mean oviposition differed between exposed and sham exposed groups owing to random variations was $P < 5 \times 10^{-4}$.

- **The reduced reproductive capacity was exhibited in both genders, with females being affected to a greater extent.** Panagopoulos et al. (2004) noted that the results obtained indicated that exposure to 900 MHz radiation could decrease the rate of cellular processes during gonad development in insects. Statistical analysis (single-factor ANOVA test) revealed the probability that mean oviposition differed between exposed and sham exposed groups owing to random variations was $P < 5 \times 10^{-7}$.

Later research by Panagopoulos et al. (2007) indicates that both GSM 900 MHz (Global System for Mobile telecommunications) radiation and DCS 1800 MHz (Digital Cellular System) radiation can cause significant reductions in the reproductive capacity of *Drosophila melanogaster*. They exposed the fruit flies to microwave radiation in the same manner and period of time (6 minutes per day for five days) as the Panagopoulos et al. (2004) experiments.

“Both types of radiation were found to decrease significantly and non thermally the insect’s reproductive capacity, but GSM 900 MHz seems to be even more bioactive than DCS 1800 MHz. The difference seems to be dependent mostly on field intensity and less on carrier frequency” (Panagopoulos et al. 2007). This would appear to suggest a possible need for caution with regard to the intensity of bursts emitted by wireless smart meters in relation to potential bio-effects.

Reproductive capacity decreased 31.08-48.25% through exposure to the modulated microwave radiation (emissions created whilst cell phone on talk mode). Mean power density for 6 minutes of modulated emission for GSM 900 MHz at zero distance was $407 \pm 61 \mu\text{W}/\text{cm}^2$ and $286 \pm 50 \mu\text{W}/\text{cm}^2$ at a distance of 1cm. The latter distance was chosen so that exposure intensity could be close to that created by DCS 1800 MHz radiation at zero distance, a figure of $283 \pm 043 \mu\text{W}/\text{cm}^2$.

The reproductive capacity of microwave-exposed fruit flies was significantly lower than sham-exposed groups. Maximum was decrease found in groups exposed to highest level of 900 MHz radiation (48.25% decrease compared to sham-exposed), followed by a decrease in reproductive capacity of 32.75% and 31.08%, respectively for the 900 MHz and 1800 MHz exposures at similar intensities. Statistical analysis indicated that the probability of reproductive capacity differing between the groups as a result of random variations was negligible, $P < 10^{-18}$.

Panagopoulos et al. (2007a) revealed that the sizeable decrease found in reproductive capacity for the female insects caused by exposure to 900 MHz and 1800 MHz radiation was as a result of the elimination of large numbers of egg chambers during early and mid oogenesis (period of creation of egg cells) after the death (DNA fragmentation) of their constituent cells, induced by both types of microwave exposures. Later research by Panagopoulos (2012) on GSM 900 MHz radiation showed that the ovarian development of virgin *Drosophila melanogaster* female insects exposed to that radiation was significantly less than that found in sham-exposed insects “due to destruction of egg chambers by the GSM radiation, after DNA damage and consequent cell death induction in the egg chamber cells of the virgin females ...” Similar had been indicated in previous tests on inseminated insects. 1800 MHz radiation was not assessed at that time.

Further tests were undertaken by Panagopoulos & Margaritis (2010) to investigate if short daily exposures of between 1 minute up to 21 minutes of GSM 900 MHz and DCS 1800 MHz radiation for five consecutive days affected the reproductive capacity of fruit flies at intensities of around $10 \mu\text{W}/\text{cm}^2$. The results are as shown below (Tables 3.3 and 3.4) for exposed versus that of sham-exposed groups. It may be worth replicating this type of research to mimic typical exposures nearby wireless smart meters, wired smart meters and areas without meters.

Table 3.3 Effect of different exposure durations of GSM 900 MHz radiation on the reproductive capacity of *Drosophila melanogaster* (Panagopoulos & Margaritis 2010).

Groups (daily exposure duration for five consecutive days)	Mean number of F ₁ pupae per maternal fly (Average \pm SD)	Deviation from sham-exposed (SE) groups
SE (0 min)	13.10 \pm 0.95	
E1 (1 min)	8.33 \pm 0.71	-36.4%
E2 (6 min)	7.53 \pm 0.60	-42.5%
E3 (11 min)	6.65 \pm 0.63	-49.2%
E4 (16 min)	5.75 \pm 0.62	-56.1%
E5 (21 min)	4.85 \pm 0.69	-63.0%

Table 3.4 Effect of different exposure durations of DCS 1800 MHz radiation on the reproductive capacity of *Drosophila melanogaster* (Panagopoulos & Margaritis 2010).

Groups (daily exposure duration for five consecutive days)	Mean number of F ₁ pupae per maternal fly (Average \pm SD)	Deviation from sham-exposed (SE) groups
SE (0 min)	13.05 \pm 0.96	
E1 (1 min)	8.38 \pm 0.72	-35.8%
E2 (6 min)	7.60 \pm 0.66	-41.8%
E3 (11 min)	6.65 \pm 0.61	-49.0%
E4 (16 min)	5.77 \pm 0.73	-55.8%
E5 (21 min)	4.90 \pm 0.67	-62.4%

Their results indicate that “the reproductive capacity decreases almost linearly with increasing exposure duration to both GSM 900 and DCS 1800 radiation, suggesting that short-term exposures to these radiations have cumulative effects on living organisms” (Panagopoulos & Margaritis 2010). *As with their previous work it was indicated that 900 MHz radiation appears slightly more bioactive than 1800 MHz radiation under similar exposure durations and equal radiation intensities.*

As noted by those authors, referring to their search shown above, there appears to be a ‘window’ of increased bioactivity at around 10 $\mu\text{W}/\text{cm}^2$, compared to the higher intensities at these frequencies that were also shown to reduce reproductive capacity. *Even lower intensities were shown to still be biologically active and capable of causing reduced reproductive capacity. As an example, Panagopoulos et al. (2010) state that “bioactivity is highest for intensities down to less than 10 $\mu\text{W}/\text{cm}^2$ and still evident until 1 $\mu\text{W}/\text{cm}^2$ exhibiting ‘window’ effects.”*

Panagopoulos et al. (2010) suggest that in light of their findings there should be a “reconsideration of the current exposure criteria in order to restrict public exposure ... to intensities not higher than 1 $\mu\text{W}/\text{cm}^2$. **According to the present study, even some of the lowest national current corresponding exposure limits might not be safe enough, like for example, the Chinese limit for public exposure (40 $\mu\text{W}/\text{cm}^2$) or the corresponding limit of Russia, Italy and Poland (10 $\mu\text{W}/\text{cm}^2$)** (International EMF Project). In contrast, the recent decision of Liechtenstein to reduce its national exposure limit from 9.5 $\mu\text{W}/\text{cm}^2$ (6 V/m) to 0.095 $\mu\text{W}/\text{cm}^2$ seems to be in agreement with the results of the present study, moreover including a safety factor of more than 10 times a lower limit than 1 $\mu\text{W}/\text{cm}^2$.”

The above results indicate that electromagnetic radiation at levels significantly lower than those allowed under Health Canada’s Safety Code 6 (2009) can detrimentally alter the physiological function of insects and that the effects can be cumulative.

3.1.6 Amphibians can be pollinators too

Amphibians are an important part of the ecosystem. It is little realised by many that amphibians can also act as pollinators (Native Bee Conservancy 2013). Their development too can be affected by exposure to manmade electromagnetic radiation.

Nearly one-third of amphibians are threatened with extinction. “The world’s amphibian species are under unprecedented assault and are experiencing tens of thousands of years worth of extinctions in just a century...” (ScienceDaily 2004).

“Amphibians are more threatened and are declining more rapidly than either birds or mammals. Although many declines are due to habitat loss and overutilization, other, unidentified processes threaten 48% of rapidly declining species and are driving species most quickly to extinction,” Stuart et al. (2004). There is presently a drastic deterioration in wild amphibian populations, and an increase in the number of deformed amphibians being found. The dramatic decline has been noted as a global concern since 1989 (Stuart et al. 2004, Blaustein & Johnson 2003). Balmori (2006) suggests that electromagnetic pollution, along with other environmental factors (chemical pollutants; climatic change; pathogens and parasites; and ultraviolet radiation), may have a key role to play in this.

Balmori (2010) investigated whether RF/microwave emissions, at levels that could be found in an everyday environment, could affect frogs’ biological development. In that research he exposed eggs and tadpoles of the common frog (*Rana temporaria*) to radiation from several cell phone antennae at a distance of 140 m over a 2-month period. For both experimental and control groups (n = 70 in each) the experiment lasted from the egg phase to an advanced phase of tadpole preceding metamorphosis. The group that acted as control was kept inside a Faraday cage enclosure during that period.

According to an official database, the frequency range of emissions from the base stations was: GSM 948.0–959.8 MHz; DCS 1,830.2–1,854.8 MHz; DCS 1,855.2–1,879.8 MHz; UMTS 1,905–1,910 MHz; 1,950–1,965 MHz; and 2,140–2,155 MHz.

The group exposed to environmental RF/microwave fields of 1.8-3.5 V/m (n = 70) had poor coordination of movements, exhibited asynchronous growth (resulting in big and small tadpoles) and had high mortality (90%). In comparison, **the control group (n = 70)** under the same conditions (with the exception of being protected from those fields by a Faraday cage), exhibited normal coordination of movements, synchronous development and **had only 4.2% mortality.** Refer also to the video link: <http://bemri.org/component/content/article/43-heseuk/100-amphibians-eggs-and-tadpoles-of-common-frog.html>

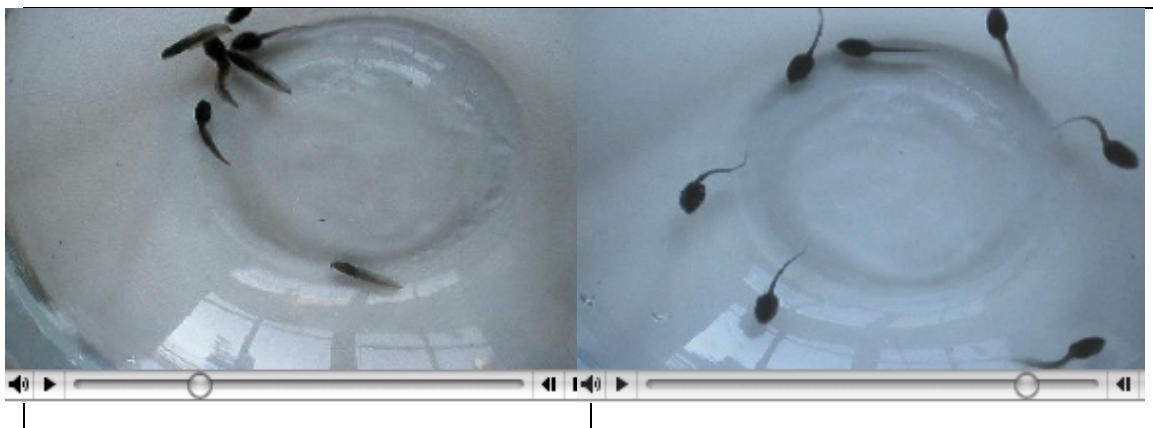


Figure 3.6 Videos of tadpoles exposed to antenna radiation (left) & shielded controls (right).
Source: Bio Electromagnetic Research Initiative (2011) © Balmori, A. 2008.

The extent to which potential confounders may have influenced the results is open to debate. It has already been demonstrated in laboratory research that brief exposure of amphibian eggs and embryos to high magnetic fields can result in abnormalities including: microcephaly (a neurodevelopmental disorder in which the head's circumference is over than three standard deviations smaller), retarded (abnormal) growth, edema (dropsy), and scoliosis (curved spine) (Levengood 1969). It is hypothesised by the present author that replications of the field levels recorded by Balmori (2010) may reveal similar results. As a control measure it is proposed that both real and fake Faraday cages are used in tests to reduce possible variables.

As the research on insects by Panagopoulos & Margaritis (2010) found "a "window" of increased bioactivity [existed] around the intensity value of $10 \mu\text{W}/\text{cm}^2$, where the biological effects of these radiations become as strong or even stronger than for intensities above $250 \mu\text{W}/\text{cm}^2$. Similar may occur with amphibians, indicating a need to conduct tests at exposures to types and levels of radiation that may be found in "real life" conditions with the proposed AMI technology.

Laboratory research, and a revised version of Balmori's research (taking into account potential confounders as documented above), could be inexpensively undertaken to help determine if the technology is safe or harmful.

"Amphibians are one of nature's best indicators of overall environmental health," Russell A. Mittermeier, President of Conservation International (ScienceDaily 2004).

It is important to realise amphibians' vital role in ecology, as an example for frogs: "Tadpoles keep waterways clean by feeding on algae. Adult frogs eat large quantities of insects, including disease vectors that can transmit fatal illnesses to humans (i.e. mosquitoes/malaria). Frogs also serve as an important food source to a diverse array of predators, including dragonflies, fish, snakes, birds, beetles, centipedes Thus, the disappearance of frog populations disturbs an intricate food web, and results in negative impacts that cascade through the ecosystem," (Kriger 2011).

The possible serious effects of RF/microwave exposures on *Rana temporaria* as indicated above; taken alongside the other work reviewed in this commentary, suggest that RF/microwave radiation levels, even within current Health Canada's Safety Code 6 (2009) safety guidelines, may be harmful to wildlife, and that 'best practice' measures may be required to reduce such risks.

Given the important role of amphibians to the environment, and the possible link with electromagnetic field exposure with their decline, it would appear prudent to assess the likely biological effects of the proposed FortisBC's system before a potential roll out begins.

3.1.7 Mammals as pollinators

Mice and rats can act as pollinators (Pattimore & Wilcove 2012, Wang et al. 2008), and they also form an important part of Nature's food cycle. It has been indicated that their biological wellbeing can be affected by electromagnetic field exposures.

3.1.7.1 Long-term exposures of mice to 900 MHz and 1800 MHz radiation

The effects of long-term exposures to 900 MHz and 1800 MHz microwave frequency radiation on Swiss albino mice were assessed by Usman et al. (2012). The exposure period was 7 hours per day, 7 days per week for 12 weeks, with average **peak** field strength of $0.6 \mu\text{W}/\text{cm}^2$. 158 mice were used in the study, divided into 4 groups of control, sham, and 900 MHz and 1800 MHz groups. [***That peak field strength is considerably less than the $227 \mu\text{W}/\text{cm}^2$ peak value created by 900 MHz RF Mesh Radio FortisBC intends to use. (The 2.4 GHz ZigBee Radio that is proposed, has a peak field strength of $31 \mu\text{W}/\text{cm}^2$) – Refer to Response to Question 57.7]***].

Usman et al. (2012) found that “The histopathology examination on some internal organs shows that spleen and bone marrow of the mice were normal for all the three experimental groups, while **a sign of tissue degeneration and inflammations were observed after 8 weeks of [microwave] exposure on the brain, liver and lungs of the mice in the exposed groups.** These signs increase in severity with prolonged exposure.”

Cognitive function has been shown to suffer as a result of exposure to 900 MHz radiation. Research by Fragopoulou et al. (2009) demonstrated that exposing mice for approximately 2 hours per day to 900 MHz radiation from a cell phone for 4 days caused cognitive deficits in spatial learning and memory. In that study, the exposed mice were shown to be less proficient in transferring learned information to the following day, and exhibited deficits in consolidation and/or retrieval of learned information.

Offspring of rats exposed to 900 MHz cell phone radiation 1 hour daily during pregnancy had far fewer nerve cells in part of brain used for consolidating information from short-term to long-term memory ($p < 0.01$) (Odaci et al. 2008).

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

Narayanan et al. (2009), undertaking tests on 10-12 week old male rats, found exposing them to the 900/1800 MHz RF/microwave radiation of 50 missed calls a day from a mobile phone daily for 4 weeks induced behavioural changes though the exact cause of these undetermined. The rats exposed to RF/microwave radiation took longer to undertake tasks, had poorer spatial navigation and exhibited poorer memory function than those unexposed. Tamir et al. (2012) found that fetal exposure of mice to 800-1900 MHz radiation can affect both neurodevelopment and behaviour. Mice that had been exposed to such radiation tended to be more hyperactive and exhibit reduced memory capacity.

Increased exposures have also been linked with cancer risk. Repacholi et al (1997) found long-term (up to 18 months) intermittent exposure to pulsed 900 MHz fields resulted in significantly enhanced probability of cancer in cancer-prone mice.

Research by Magras & Zenos (1997) recorded irreversible infertility in mice after 3 generations at exposures of $1.053 \mu\text{W}/\text{cm}^2$ in the 80–900 MHz range. Lower exposures of $0.168 \mu\text{W}/\text{cm}^2$ were linked with total infertility in mice after 5 generations.

Mailankot et al. (2009) found exposing male Wistar rats to active mobile phone radiation at frequencies of between 900 MHz to 1.8 GHz [frequencies that Fortis BC is intending to use – *present author's comment*] for 1 hour per day for 28 days significantly decreased sperm motility. They too suggested that exposure to RF/microwave radiation may impair fertility. **The review by Desai et al. (2009) further covers the effects of RF/microwave radiation on animal fertility and also discusses possible mechanisms that might lead to the RF/microwave related infertility in human males.**

3.1.8 Birds

Comment on 4.4: “What studies have been done on the effect on birds and/or bees of continuous, long term-exposure to strobe flashes ... ?” Response: “Several studies looked at geographic correlations between bird populations and mobile phone base stations (Everaert and Bauwens, 2007) or measured radiofrequency fields (Balmori, 2005; Balmori and Hallberg, 2007) but design limitations, e.g., the lack of investigation of confounding factors, precludes any clear interpretation of these studies. ...” “In short, there is no clear, confirmed adverse effect of radiofrequency fields on bird or bee health.”

It is contended by the present author that despite a number of potential confounding factors not being investigated in the studies just mentioned above, their findings still warrant serious attention. Efforts should be made to seek to replicate them to test their validity taking potential confounding factors into consideration.

3.1.8.1 Electric field strengths (925-960 MHz) and (1805-1880 MHz)

The preliminary research carried out in Belgium by Everaert & Bauwens (2007) found a strong correlation between raised exposures to microwave radiation and reduced House Sparrow (*Passer domesticus*) numbers. In that work, undertaken during the sparrow-breeding season, the maximum value (peak hold) of electric field strengths from the downlink frequencies of GSM 900 MHz (925-960 MHz) and GSM 1800 MHz (1805-1880 MHz) base station antennas was assessed alongside numbers of male House Sparrow.

The mean values of the peak electric field strengths recorded were between 0.043-0.245 V/m for GSM 900 MHz, 0.017-0.083 V/m for GSM 1800 MHz and 0.121-0.247 V/m for the sum of these bands.

Spatial variation in the number of male House Sparrow recorded was highly significantly related to the electric field strengths for both frequency bands and the sum of these bands ($p < 0.001$). Raised fields were linked to reduced House Sparrow numbers, supporting “the notion that long-term exposure to higher levels of radiation negatively affects the abundance or behavior of House Sparrows in the wild,” (Everaert & Bauwens 2007).

As species such as the House Sparrow often nest at high level off the ground, they will potentially be exposed to higher levels of radiation than those documented in the text above (which appear to have been taken around ground level).

Balmori (2005) investigated possible effects of GSM 900 MHz and DCS1800 MHz microwave radiation from cell phone masts on a population of White Stork (*Ciconia ciconia*). 60 nesting sites, with similar physical characteristics within urban areas, were chosen for observation. 30 nests were situated within 200 m of one or several antennae masts, with the other 30 nests being chosen from areas >300 m from any transmitter.

The mean electric field strengths recorded at the 30 nests within 200 m of the cell phone masts was 2.36 ± 0.82 V/m, compared to 0.53 ± 0.82 V/m for nests located further than 300 m from the masts. **Very significant differences among the total productivity were found ($p = 0.001$).**

Significantly fewer fledglings were reported for the nests within 200 m of the antennae masts (0.86 ± 0.16), compared to those further away (1.6 ± 0.14). 1 nest far from the antennae was without young, compared to 12 nests without young close to the antennae masts.

The White Storks nesting under the higher field regimes exhibited increased levels of aggression, compared to those in low field regimes, and in some cases their nests remained unfinished. Unexplained death of young was also noted in the higher field areas.

3.1.8.2 Electric field strengths (1MHz–3GHz range)

In order to investigate if there may be a relationship between reduced bird numbers and exposures to electromagnetic fields, Balmori & Hallberg (2007) monitored populations of House Sparrows in 30 areas of an average-sized city in Spain, along with measuring mean electric field strengths of radiowaves and microwaves in those areas.

Their results, like those of Everaert & Bauwens (2007), indicate that House Sparrow decline may be linked to raised levels of electromagnetic exposure. It was again noted that reduced bird density was found in areas with increased field strength ($p = 0.0001$).

In one of the areas monitored, a picocell (a small cellular base station) was installed for 3 months, resulting in a mean field strength greater than 3 V/m. During that period, House Sparrow numbers decreased greatly, during a time of year when their numbers normally rise. Once the radiation was removed House Sparrows once again became abundant in that area.

According to calculations Balmori & Hallberg (2007) undertook using data from the whole project (comparing mean bird density vs. field strength), no House Sparrows would be expected to occupy areas with mean electric field strengths of greater than 4 V/m. They concluded that, “electromagnetic pollution may be responsible, either by itself or in combination with other factors, for the observed decline of the species ... during recent years.”

They noted that if the projected 5% annual decline in house sparrows continued, that species may be extinct by 2020.

It is becoming increasingly reported that the dramatic decline being noted in some bird species is also partly due to falling insect numbers (Bentham 2012), which might in part be brought about by inappropriate exposure to manmade field regimes – *present author’s comment*.

3.1.8.3 Pulse shape and field intensities

Ubeda et al. (1994) recorded that chick embryo development can be irreversibly altered by early exposure to weak ELF magnetic fields. In that work, eggs were exposed during the first 48 hours of being laid to pulsed magnetic fields of 500 microseconds pulse duration with 100 Hz repetition rate and 1.0 μT peak-to-peak amplitude. The effects of two different types of pulse waveform were accessed.

Both groups exposed to the pulsed waveforms exhibited more developmental anomalies than the sham-exposed samples. In one group, the excess number of anomalies was not significant ($p = 0.173$), whereas in the group was exposed to the other type of wave it was significant ($p = 0.007$). The latter group also had very high rates of early embryonic death as a result of exposure.

Earlier research by Ubeda et al. (1983), whilst investigating different waveforms at intensities of 0.4 and 1.0 μT , had additionally shown that whilst some waveforms were teratogenic (caused malformations of the embryos) – *one of them particularly so* – one waveform when used at an intensity of 0.4 μT was indicated as creating beneficial effects. The effects of different field intensities on the results obtained were also apparent. Such findings are not unusual in electromagnetic research, and provide one example of why research can sometimes be difficult for other scientists to replicate.

The following on this subject is quoted from Balmori (2005) (the present author has amended it slightly to show the references he has given by name instead of numerically):

“The low intensity pulsed microwave radiation from cell sites produces subtle athermal influences in the living organisms, because this radiation is able to produce biological responses by the microwave carrier and by the low frequency of pulses from GSM system. “Windows” exist in whereby EMFs produce biological effects at specific frequencies (window effect) [Adey 1981]. Some effects are manifested exclusively with a certain power density [Daniells et al. 1998], while others are manifested after a certain duration of the irradiation, which indicates long-term cumulative effects [Adey 1996]. During lingering exposure, the effects can change from stimulant to inhibition, depending on the pulse shape [Ubeda et al. 1994, Ubeda et al. 1983], the duration, development, and differentiation and the physiologic condition or health of the receiving organism [Nikolaevich et al. 2001], and their genetic predisposition [Farrel et al. 1997]. These waves seem to cause different, and even contrary effects, depending on their frequency, intensity, modulation, pulses or time of exposure [Daniells et al. 1998, Nikolaevich et al. 2001, Grigoriew 1996]. The pulsed waves (in bursts) and certain low frequency modulations, produce great biological activity [Grigoriew 1996, Ubeda et al. 1994, Ubeda et al. 1983]. The dose-response relationships (athermal) are nonlinear [Marino et al. 2003].”

3.1.8.4 Egg production and chick growth under different field regimes

Egg production (at 5 to 1000 $\mu\text{W}/\text{cm}^2$)

Krueger et al. (1975) investigated the effects of exposure to CW 260 MHz radiofrequency radiation and 915 MHz and 2.435 GHz microwave radiation on flocks of chickens, as compared to an unexposed control flock. The effects of exposures to 60 Hz electric and magnetic fields were also assessed. Despite the small sampling size used ($n = 30$, one cock bird and four young hens for each of the six groups), the results shown below appear worth serious consideration:

RF/microwave exposures

The young laying hens in the unexposed control group had an average daily egg production rate of 80.1% for the 112-day test period. This is significantly more ($p \leq 0.01$) than the 64.8% production rate for the flock exposed continually to 2.435 GHz (calculated at 1000 $\mu\text{W}/\text{cm}^2$) during the trial, and the 65.9% production rate of hens exposed to the 260 MHz radiation (calculated to be at levels of 125 $\mu\text{W}/\text{cm}^2$ and 5 $\mu\text{W}/\text{cm}^2$). The 915 MHz regime (which was interrupted for a week then continued at a lower level of radiation) produced 7.8% fewer eggs than the unexposed group.

There is some doubt whether the calculated values for the power densities given in Krueger et al. (1975)'s research accurately indicated the quantities of energy absorbed by the exposed chickens. Despite such possible shortfalls, the Department of Energy and NASA (DOE/NASA 1978) stated their concern “that prolonged irradiation at seemingly low power densities may be harmful.”

Egg production (at 1 to 400 $\mu\text{W}/\text{cm}^2$)

Bigu Del Blanco et al. (1973) found hens exposed to continuous 7 GHz waves at 1-400 $\mu\text{W}/\text{cm}^2$ increased their egg production by 14%. **However, the death rate of exposed birds was twice that of those unexposed to microwaves.**

Egg production (at 0.19 to 360 $\mu\text{W}/\text{cm}^2$)

Tanner & Romero-Sierra (1982), investigating effects of chronic exposure to very low intensity 7.06 GHz continuous wave RF/microwave radiation on domestic fowl compared to non-irradiated birds, found that exposure levels could greatly influence both egg production and health. In that work, the measured power densities in the exposed cages ranged from 0.19 to 360 $\mu\text{W}/\text{cm}^2$.

It was found that the egg production in the birds that were irradiated was 13.7% greater than the in the control group but almost twice as many birds died (26 deaths compared to 15 in the non-irradiated group). Those that did survive in the irradiated group exhibited profound health deterioration. Marked deterioration was also noted in the plumage of all exposed birds, with "pronounced deterioration of their plumage with feathers lost, broken or with twisted and brittle shafts."

The post mortems on the irradiated birds who had died during the course of the experiments uncovered two main types of diseases that seemed to provide explanation for the increased deaths. These were avian leukosis - *a leukemia-like malignant viral disease* - and tumors.

Avian leukosis was found in the ovaries, intestines, etc., of exposed dead birds. Tumors of the central nervous system were also documented. **It was noted that "In some birds leukosis reached "massive proportions", i.e. a scale never seen before by veterinarians experienced with avian diseases,"** Tanner & Romero-Sierra (1982).

Whilst increased egg production (due to RF/microwave exposure) might at first glance appear desirable, this has to be balanced with the increased death rates and potential long-term effects on the robustness of the species.

Egg production (at 0.00000002 to 0.0004 $\mu\text{W}/\text{cm}^2$)

Hens continuously exposed from 1 day old to the levels created by Kondra et al. (1970) - 6 GHz CW microwave radiation at power densities of 0.00000002 and 0.0004 $\mu\text{W}/\text{cm}^2$ - laid significantly more eggs ($P < 0.01$) during 169 to 476 days of age than those that were unexposed (at levels of < 0.000000005 $\mu\text{W}/\text{cm}^2$), though the eggs of exposed chickens also weighed significantly less. Chick weight also followed this trend. **They stated that the increased rate of egg production in exposed birds was due to increased frequency of ovulation, possibly as a result of the pituitary being stimulated.** As noted by Firstenberg (1997), "These [findings] are food for thought for anyone who wonders why twentieth century human females are ovulating at ever earlier ages."

When Kondra et al. (1970) calculated the egg production of hens in terms of average grams of egg produced per hen day over the entire test period, there was no significant difference between exposed and unexposed groups. In the tests where continuous exposure was undertaken, the birds exposed to levels of 0.00000002 $\mu\text{W}/\text{cm}^2$ had significantly higher levels of fertility than the birds exposed to 0.0004 $\mu\text{W}/\text{cm}^2$, though neither group was significantly different from the fertility levels of the unexposed birds that acted as controls.

These findings were not replicated by Kondra et al. (1972). However, in that later work, the chicks were continuously exposed to light for the first 3 weeks after hatching, with that exposure to light stimulating ovulation to around the same degree as the very low levels of microwave radiation (Firstenberger 1997). It therefore appears that the findings of the earlier research may still hold true.

Chick growth (24 $\mu\text{W}/\text{cm}^2$)

The effects of exposing chicks continuously for 23 days to 880 MHz CW radiation at a power density of 24 $\mu\text{W}/\text{cm}^2$ were investigated by Giarola et al. (1971). In that work it was found that **exposure resulted in reduction of adrenal gland weight, body weight and food consumption in the crossbred male chicks as compared to unexposed controls.**

"The level of electromagnetic energy used is not only one of the lowest CW levels reported causing physiological changes in animals, but also much lower than the western protection guide ... and only slightly higher than the protection guide of 10 $\mu\text{W}/\text{cm}^2$ adopted by the Russians in 1958," Giarola et al. (1971).

3.1.8.5 Avian direction finding and flight behaviour

"The sense that allows birds to orient themselves by the Earth's magnetic field can be disabled by an oscillating magnetic field whose intensity is just a fraction of the geomagnetic field intensity and whose oscillations fall into the medium or high frequency radio wave bands," Vácha et al. (2009).

"Birds have become the most thoroughly investigated group with respect to RF effects (Ritz et al., 2004; Ritz et al., 2009; Stapput et al., 2008; Thalau et al., 2005; Wiltchko, W. et al., 2007; Wiltchko, R. et al., 2007). They lose compass orientation at low RF intensity of 5–15 nT, which corresponds to about 0.01% of the static background geomagnetic field (Ritz et al., 2009)," Vácha et al. (2009).

Experiments undertaken using particular light regimes, in conjunction with local anaesthesia of the upper beak where magnetite is found in birds, indicates that birds appear to be equipped with both magnetite-based mechanisms and radical pair-based mechanisms for alternative types of orientation functions (Wiltchko et al., 2005), with the former probably being the older of the two (Wiltchko et al., 2007). Vácha et al. (2009) notes that magnetite-based mechanisms appear "the most likely for very precise sensing of the intensity and inclination of the Earth's field, i.e. for the so-called map sense, whereas the radical pair-based model would be the most likely for the so-called compass mechanism."

Several investigators have inquired into the possible effects of the electromagnetic near-field of the Project Sanguine antenna on bird orientation. *Effects on flight behaviour were noted.* (Marino & Becker 1977):

Graue (1974) who undertook a pilot study on the effects of exposure to electromagnetic fields on the orientation of homing pigeons at Project Sanguine's Wisconsin test facility, noted that the pigeons' headings were slightly changed when in the vicinity of the antenna.

More detailed research was undertaken by Southern (1975), investigating how the orientation of 3-9 day old gull chicks altered if exposed to Project Sanguine's electromagnetic fields. In that work, the chicks were kept in cages directly over the buried antenna. It was shown that when they were released in the center of the cage, with the antenna switched off, they exhibited a directional preference for the southeast. When the antenna was activated the birds dispersed randomly with no mean bearing being displayed.

Williams (1976), conducting a radar investigation on the effects of extremely low frequency electromagnetic fields on free flying migrant birds, observed migrating birds changing the direction of their flights by between 5° to 25° when the antenna was operational.

Larkin & Sutherland (1977) undertook radar tracking of individual migrating birds flying over Project Seafarer's antenna, at altitudes of 80-300 meters, to determine how they responded to exposure to its electromagnetic fields. **When it was operational, or being switched from operational to non-operational and non-operational to operational, the birds exhibited changes in their flight patterns from straight and level flight significantly more often than when the antenna was switched off.**

Research has indicated that pulsed radiofrequency and microwave emissions can be used as bird deterrents:

1 GHz – 40 GHz (1,000 $\mu\text{W}/\text{cm}^2$ to 10,000 $\mu\text{W}/\text{cm}^2$ [average values])

The late Dr Melvin L. Kreithen, a pioneer in the sensory biology of avian species (who was nicknamed the 'Birdman of Langley Hall'), undertook and patented research on how to deter birds (*and possibly bats*) from colliding with wind farms and jet planes when a Pitt Associate Professor of Biology at the University of Pittsburgh. The assignee for the patent he invented for a "Method and system for warning birds of hazards" was The University of Pittsburgh.

The technology he patented is designed to work from 1 GHz to around 40 GHz (X-band radar, as mentioned in FortisBC's response to Question 4.4, operates within this frequency range). His system for warning birds of hazards "radiates pulses of microwave energy ... to alert and warn target flying birds of the presence of wind turbine electrical generators, power distribution systems, aircraft, and other protected areas from hazardous intrusion."

The avian warning system he developed included a control unit governing pulse control to allow outputs of pulses ranging from around 5-25 μs in duration which trigger a pulsed source of microwave energy coupled to a microwave antenna that emits the warning radiation. The microwaves are "sensed by the birds auditory system, attaining their attention to the presence of the protected area. The sensed radiation itself may cause the birds to veer from a collision course ..." (Kreithen 1998).

Discussing the frequencies Kreithen claimed "**Applicant has found that pulsed microwave radiation the range 1.0 GHz to about 2.5 GHz is quite effective**, and radiation in the approximate range 15 GHz to about 25 GHz should be similarly quite useful." He further stated in the patent that "Applicant has discovered that the emission of such pulsed microwave radiation is sensed by pigeons, apparently by affecting their auditory system in a non-thermal manner. Even without emitting a complex pattern of pulses, the resultant effect upon the birds is believed perhaps to be analogous to a buzzing, clicking, or popping sensation in the ears of a human."

During testing Kreithen "exposed pigeons to S and L band pulsed microwave radiation, using fixed pulse widths in the approximate range 5 μs to 75 μs , and more preferably approximately 5 μs to about 25 μs . In providing this microwave energy, pulse width, pulse duty cycle and repetition rate into the pulsed microwave source were controlled to limit the radiation density..." S-band covers the 2 GHz to 4 GHz range (that ZigBee Radio operates within) and L-band covers the 1 GHz to 2 GHz (1000 MHz to 2000 MHz) range frequency range (that WiMAX operates within). No testing appears to have been undertaken at 900 MHz. He stated that repulsion of species from an area could be achieved non-thermally at average intensities of 1,000-10,000 $\mu\text{W}/\text{cm}^2$. (A higher duty cycle was said to be required for narrower pulse widths than longer pulse widths for a given level of average power).

[In the response to Question 34.1, it is stated that the transmission durations for command and control signals, alarms/alerts is 29,000-33,000 μs ; and that those for scheduled and on-demand meter reads is 53,000-103,000 μs . These periods are considerably longer than those required by Kreithen in his research to obtain a conditioned avoidance response.]

"Under laboratory conditions, the ability of such birds to sense the microwave radiation was confirmed by monitoring a standard conditioned cardiac response. **Within about three seconds after exposure to this microwave radiation, pigeons having a baseline heartbeat of about 100 beats/minute were found to experience a relatively sudden increase of about 40 beats/minute, a 40% increase.** The onset of the heartbeat change occurred within a second or so of the onset of exposure to the pulsed microwave radiation. In reality, the pulsed microwave radiation is sensed instantly by the pigeons, and the delay in attaining a detectable change in heart rate represents a normal response latency," Kreithen (1998).

"As noted, applicant's pulsed microwave energy is sensed by birds, thus attaining their attention, which may include immediate communication to the birds of the presence of the area of object to be protected. Once aware, the birds can avoid knowingly colliding with the protected area or object," Kreithen (1998). There is the possibility that similar happened with the exposed House sparrows in Balmori & Hallberg (2007), with their return once the device was removed.

The use of microwaves as a potential solution to the bird hazard problem, with regard to the aviation industry, had earlier been proposed by Tanner et al. (1969) at the World Conference on Bird Hazards to Aircraft at Queen's University, Kingston, Ontario 29 years previously.

In that work they reported that:

- “proof that birds are sensitive to microwaves” had been demonstrated and reported.
- Behavioural, EEG and EMG changes can occur in birds as a result of exposures to microwaves.
- “environmental factors play an important role in the effectiveness of a particular microwave field.”
- The use of microwaves “appears promising for the solution of the bird hazard problem in aviation.”

Absorption of microwaves

2.45 GHz microwaves have a wavelength of approximately 12.24 cm in the air; when moving through solids or liquids both their velocity and wavelength decrease whilst the frequency remains constant. DOE/NASA (1978) note that for 2.45 GHz radiation passing through living tissue with high water content (*such as muscle tissue*), the wavelength decreases by around 85%, to approximately 1.75 cm. **[The wavelength of 2.4 GHz radiation in air, as created by the ZigBee Radio system FortisBC propose, is 12.49 cm. The wavelength, in air, of the 1800 MHz WAN is 16.65 cm and that of the 900 MHz Mesh Radio system is 33.3 cm].**

The penetration depth for 2.45 GHz radiation is also around 1.75 cm (*most of its energy being absorbed in the first few millimetres*), though it will penetrate further in fatty tissues which are of lower density and contain less water. Additionally, for RF/microwave radiation, the level of penetration is greater at lower frequencies which have longer wavelengths and lesser at higher frequencies.

“It is this relatively greater depth of penetration by microwaves at longer wavelengths that has raised questions about potential biological hazards, particularly for smaller animals whose vital internal organs are more likely to absorb microwave energy than are the same organs of larger animals and man, which are more deeply located,” DOE/NASA (1978).

The DOE/NASA (1978) report further documents that **as the half wavelength of the radiation gets close to matching the “electrical length of an animal” – which is approximately 80% of the animal's actual physical length – more incident energy is absorbed, and that ‘body resonance’ can occur** when there is a close match. Under such situations the animals may absorb all the radiation and “its absorptive cross-section (the energy absorbing area of the body) may increase several fold.” **From the above, at 2.45 GHz such resonance would appear to occur for small birds and animals with body lengths of around 7.65 cm.** The hypothesised resonance frequencies for different sizes of birds is shown in Table 3.5, whilst the hypothesised lengths and wingspans for resonance at frequencies that are currently intended to be used are exhibited in Table 3.6.

Table 3.5 Hypothesised resonance frequencies for different sizes of birds*

Size category	Actual length	“Electrical length”	Resonant Frequency
Very Small	7.6 –12.7 cm (3-5 inches)	6.1-10.2 cm	2.46 GHz – 1.47 GHz
Small	12.7-22.9 cm (5-9 inches)	10.2-18.3 cm	1.47 GHz – 820 MHz
Medium	22.9-40.6 cm (9-16 inches)	18.3-32.48 cm	820 MHz – 460 MHz
Large	40.6-81.3 cm (16-32 inches)	32.5-65.0 cm	460 MHz – 0.230 MHz
Very Large	81.3-182.9 cm (32-72 inches)	65.0-146.3 cm	230 MHz – 102 MHz

*Values calculated by present author based on research by DOE/NASA (1978).

Situations where birds' longest axis is parallel to the electric field created by the RF/microwaves can cause maximum resonance to occur. Such situations can be created either through alignment of the main body or wings of the bird with that E-field.

Table 3.6 Approximate hypothesised lengths and wingspans for resonance at proposed FortisBC frequencies*

	Bird length/wingspan	"Electrical length"	Resonant Frequency
900 MHz Mesh Radio system	20.75-20.25 cm	16.6-16.2 cm	928 MHz - 902 MHz
1800 MHz WAN	10.4 cm	8.3 cm	1800 MHz
Zigbee	7.8 cm	6.2 cm	2.4 GHz

*Values calculated by present author based on research by DOE/NASA (1978).

The young of birds (and other animals) that have larger body lengths than those where resonance can occur, may still experience the resonant frequency effect when their "electrical lengths" match half of the wavelength of the emitted microwaves during their growth.

The possible consequences of 'body resonance' at the frequencies wireless AMI systems create should be investigated in greater detail, as should the use of safer technologies such as fiber optics that could avoid this potential problem.

3.1.8.6 Specific Absorption Rate (SAR)

This is a measure of the rate energy is absorbed by a body when it is exposed to RF and/or microwave radiation. It is defined as *"the power absorbed per mass of tissue"* and SAR levels are given in watts per kilogram (W/kg).

When birds are facing directly towards a source of such radiation, the main absorption of it is in their heads and necks. Chou & Guy (1985) note that the SARs of birds legs are likely to be much higher than that for their necks because of their smaller cross-sectional area and that *"Energy absorbed in a relatively small volume could lead to effects that normally would not be observed if the energy were distributed evenly within the body."*

Thermograms of birds exposed to microwave radiation by Chou & Guy (1985) indicate high SAR values in their wings when in the flying position. For a test they undertook on a pigeon (*exposed as if flying towards to a source of 2.45 GHz microwave radiation*) the amount of absorption recorded was greatest at both wing tips, followed by its proximal wings, neck and body (which exhibited least absorption). In that work, the lowest power density at which it could be visually detected that a bird perceived radiation exposure was 5,800 $\mu\text{W}/\text{cm}^2$ at 775 MHz, for which the corresponding maximum SAR for the chicken's head was 3.1 W/kg and that for its neck 3.9 W/kg (Figure 3.7).

Far lower exposures than those discussed above can affect the neurons of avian brains. Beason & Semm (2002) - *seeking to mimic radiation from GSM digital cellular networks used for mobile phones* - undertook research on the effects of 10 minutes exposure to 900 MHz RF/microwaves (pulse modulated at 217 Hz, with duty cycle of 12.5% and *peak* power density of 100 $\mu\text{W}/\text{cm}^2$). The calculated SAR value for the zebra finches tested was 0.05 W/Kg. Their results showed that exposures caused changes in the degree of neural activity of more than half the brain cells. 76% of responding cells increased their firing rates (*on average*) 3.5-fold. Other responding cells decreased their rates of spontaneous activity.

Unpublished research by Semm et al. additionally found that exposing birds to a 52 GHz carrier, with 16 Hz modulated signal, resulted in similar neuron responses (extended latency with ongoing higher activity after stimulation ceased) (Beason & Semm 2002). It would be of interest to determine what effects, if any, the pulses from smart meters may cause and how long any raised activity may continue after exposure.

According to the answer given to Question 57.7, “What is the peak power density of the data signals?”, the peak power densities calculated at the FCC/IC specified distance of 20 cm during active transmission (not taking into account duty cycle) for 900 MHz RF Mesh Radio is $227 \mu\text{W}/\text{cm}^2$. (For 2.4 GHz ZigBee Radio the peak power density at 20 cm is $31 \mu\text{W}/\text{cm}^2$).

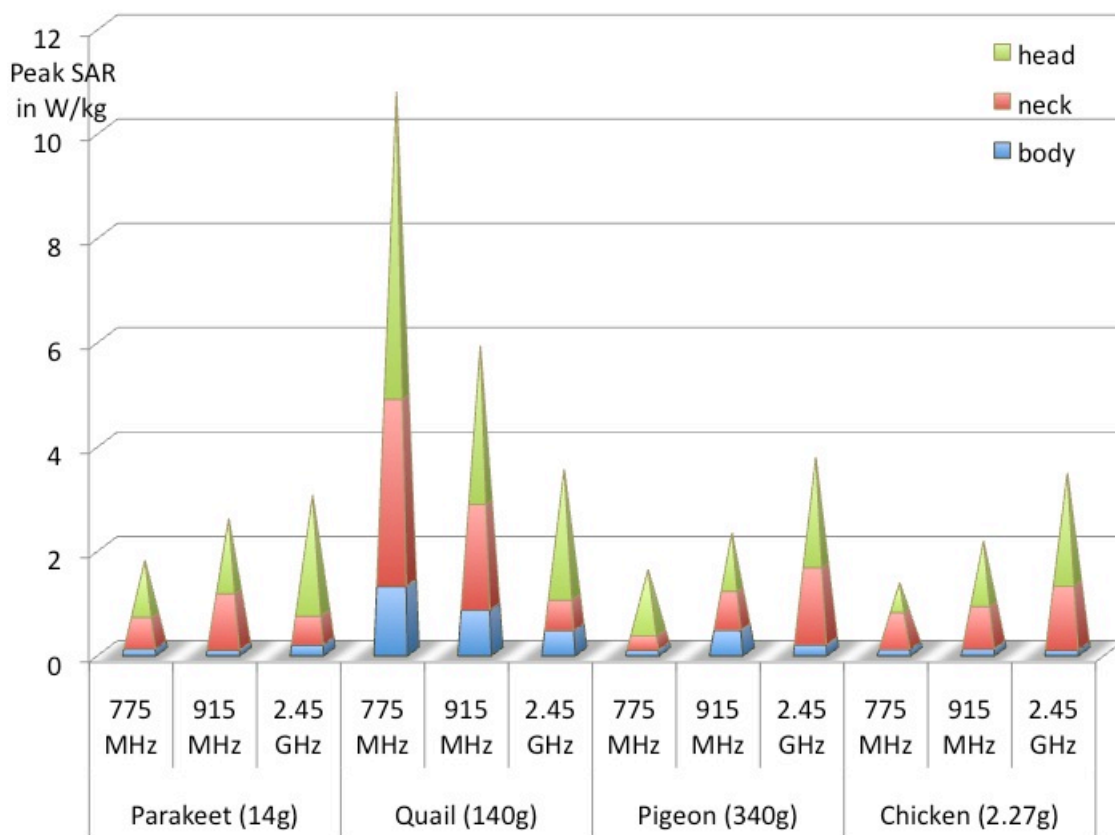


Figure 3.7 Peak SAR in W/kg (normalized to a power density of $1,000 \mu\text{W}/\text{cm}^2$ in exposed standing birds (Chou & Guy, 1985)

As the research by Beason & Semm (2002) indicated that exposure to 900 MHz microwaves at a peak power density of $100 \mu\text{W}/\text{cm}^2$ affected the neurons of avian brains, it appears probable that pulsed smart meter radiation (with peak emission values of $227 \mu\text{W}/\text{cm}^2$) may do similar.

3.2 Amount GHG emissions avoided

Document: CEC IR No. 1, Question 25.1

25.0 Reference: Exhibit B-6, BCUC 1.14.1 and Exhibit B-1, Application, Page 38 and Exhibit B-1, Application, Appendix E-3 and Exhibit B-6, BCUC 1.25.1

25.1 Please confirm that the AMI program will 'concretely avoid 180 tonnes of GHG emissions, 80,000 litres consumed in 18 meter-reader vehicles'. If not, please identify the amount of GHG emissions that will be concretely avoided.

Response:

It is estimated that the AMI Project will result in approximately 171 tonnes of GHG emissions that will be concretely avoided.

Comment on Question 25.1: "Please confirm that the AMI program will 'concretely avoid 180 tonnes of GHG emissions, 80,000 litres consumed in 18 meter-reader vehicles'. If not, please identify the amount of GHG emissions that will be concretely avoided."

In the comment given by the present author to Question 44.0, it is mentioned that one US utility was estimated as losing around \$400 million annually through smart meters being altered to under-report and that the FBI expects this type of fraud to spread (KrebsOnSecurity (2010)). It appears possible that FortisBC's presently proposed new metering may for similar reasons also increase energy theft rather than reduce it as intended.

If the meter-readers and their vehicles were retained it would be much easier to regularly check meters to see if they had been tampered with, thereby helping reduce energy theft. If smart meters are adopted in their present formats, it appears that vehicles and personnel to drive them may be required to help check against meter fraud.

Additionally, it is suggested that as an option to reduce green house gas emissions, other billing alternatives could be investigated. One of these is rather old fashioned, asking the consumer to provide the meter-readings themselves, with utility operatives physically checking the meter readings at random. This would also have the added benefit of keeping people in jobs and helping prevent meter fraud.

3.3 Improved enviro performance w/ Smart Grid – explain

Document: BCSEA IR No. 1, Question 3.3

3.0 Topic: Canadian Smart Grid Roadmap

3.3 The "Canadian Smart Grid Roadmap" document notes that the "Government of Canada's approach toward the future for Smart Grid is focused on three core energy policy objective: . . . environmental performance" ¹⁰. It also notes that "a Smart Grid will contribute to our goal of improved environmental performance, by reducing greenhouse gas (GHG) emissions" ¹¹. Please discuss the ways in which FortisBC is using the Smart Grid to improve environmental performance.

Response:

One of the benefits that FortisBC has already realized from previous smart grid projects (such as Distribution Substation Automation) is reduced travel – with a consequent reduction in fuel consumption and GHG emissions. Historically, substation equipment could only display information locally; there was no way to access protection or metering devices remotely as legacy equipment

did not support that capability. As shown in Figure 3.2.3.a on Page 26 of the application, in the 1990s FortisBC began installing microprocessor-controlled equipment which could be accessed remotely. Further, with the completion of the Distribution Substation Automation Program this year, the Company now has remote control and visibility of almost all of its 65 substations. As a result, today it is possible for an engineer in Trail to remotely interrogate devices in the Princeton substation without leaving their desk. Similarly, System Control Centre operators can turn feeder reclosers at substations on and off by remote control. Previously, in both cases it would have been necessary for a technician to drive to the location, collect the information or change the position of a control switch, and then drive back. These travel reductions result in ongoing savings and hence lower O&M and capital costs as well as improved environmental performance.

The implementation of AMI will have similar travel reduction benefits, but on a larger scale. As discussed on page 38 of the Application, the current manual meter reading process consumes approximately 80,000 litres of fuel and results in 191 tonnes per year of GHG emissions. The AMI project will reduce the need for travel associated with meter reading which will result in a consequent reduction in the environmental impact of this activity.

Future smart grid project implementations such as an Outage Management System (OMS) – in combination with AMI – would further reduce vehicle travel. This is because it would no longer be necessary for crews to drive long distances to search/patrol for the location of outages. Instead, the OMS would essentially pinpoint the location of failed equipment by using the AMI information of exactly which customers are out of power. Crews would then be able to travel directly to the work location to repair the failure.

¹⁰ The Canadian Smart Grid Standards Roadmap: A strategic planning document, October 2012, Section 2.1, Page 4

¹¹ The Canadian Smart Grid Standards Roadmap: A strategic planning document, October 2012, Section 2.1, Page 4

For info: The Canadian Smart Grid Standards Roadmap: A strategic planning document, October 2012, http://www.scc.ca/sites/default/files/publications/Smart-Grid-Report_FINAL_OCT2_EN.pdf

Comment A on Question 3.3: “The “Canadian Smart Grid Roadmap” document notes that the “Government of Canada’s approach toward the future for Smart Grid is focused on three core energy policy objective: ... environmental performance” ... “

3.3.1 Environmental Concerns: The Environment and Sustainable Development

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

Unless environmental concerns, such as the possible effects of radiofrequency and microwave radiation on plants and wildlife are properly addressed, The Government of Canada’s approach to the development of the smart grid may fail. This need not be the case if multi-factorial best practice measures are brought into play. The effects of radiofrequency and microwaves on plant life are discussed below. The effects of these on wildlife are discussed earlier in the present Chapter.

3.3.2 The Law of Unintended Consequences and Sustainable Development

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

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

The more that is known of the possible knock-on effects of smart meters, and related technologies, being rolled out across the world; the better the measures that can be taken to mitigate potential problems, and the smoother metering rollouts are likely to be. This means that potential ‘inconvenient truths’ have to be recognised and properly addressed as they arise, so that the correct decisions can be made for the benefit of all.

3.3.3 Possible environmental effects of smart meters on vegetation



Smart meters newly installed
Image source: OTLB (2011).



20 days after smart meters installed

Figure 3.8 Vegetation damages after smart meter banks installed in the USA

In the photos (Figure 3.8), taken 20 days apart in the USA, severe die off of the bush was observed after the installation of wireless smart meters. It was reported that none of the other plants or trees in the area (further away from the units) were affected.



Image: Weatherall (2010a).

Figure 3.9 Vegetation damage after smart meter installation, Canada

Similar was indicated in Canada after installation of a single wireless smart meter (shown above). The meter was in place less than two months at the time the above photo was taken. Prior to installation, leaves in the area where it was to be housed were green and healthy, again indicating that radiation from some smart meters may cause adverse effects on vegetation (Weatherall, 2010. 2010a).

A number of studies have indicated that RF/microwaves can be injurious to plants.

The possible validity of such conjecture is indicated in research by Roux et al. (2007), Sandu et al. (2005), Balmori (2004), Selga & Selga (1996), Magone (1996), Balodis et al (1996), Brauer (1950), *and that discussed by Firth (2010)*, some of which indicates that RF/microwave radiation may damage vegetation, even at levels below those typically emitted by wireless smart meters.

As noted by Roux et al. (2008), referencing Roux et al (2006) and Vian et al. (2006), “plants exposed for as little as 10 min to a low-level, high frequency isotropic and homogeneous electromagnetic field (5 V.m⁻¹, 900 MHz ...) displayed a rapid and major increase (3–7 fold) in accumulation of stress-related transcripts” **Such findings are not new, the effects that RF/microwaves can have on plant growth have been known for over a century.**

Research demonstrating that RF/microwaves could affect plant growth was first undertaken by Sir Jagadish Chandra Bose - *a pioneer in biophysics (and one of the founding fathers of radio science)* - over a century beforehand. In that work, **he discovered that “very short electric waves induce a retardation of rate of growth**; they also produce responsive movements of the leaf of *Mimosa* when the plant is in a highly sensitive condition,” (Bose 1919, 1905).

As a result of his ground-breaking research, Bose (1919a) declared the following:

- **Plants both perceive and respond to RF/microwave exposure**
- **Mechanical response to RF/microwave radiation is exhibited in the leaves of *Mimosa pudica***
- **All plants give electric response to RF/microwave exposure**
- **RF/microwave exposure modifies plant growth rates – *strong stimulation retards growth***
- **Low RF/microwave exposure levels enhance plant growth**
- **The control of nervous impulse of both plant and animal can be achieved through exposure regimes.**

“Another generalization of still greater importance is the establishment of identical nature of physiological reaction in the plant and the animal. ... the discovery of a method for immediate enhancement or inhibition of nervous impulse in the plant led to my success in the control of nervous impulse in the animal,” Bose (1919a).

3.3.4 Coniferous Trees

The possible effects of the influence of pulsed 154 to 162 MHz RF radiation from a radio station on the growth and development of Scotch Pine (*Pinus sylvestris* L.) trees was investigated by Selga & Selga (1996). Four different locations (i.e. Control, Low exposure, High exposure and Higher exposure) were assessed (Figure 3.10).

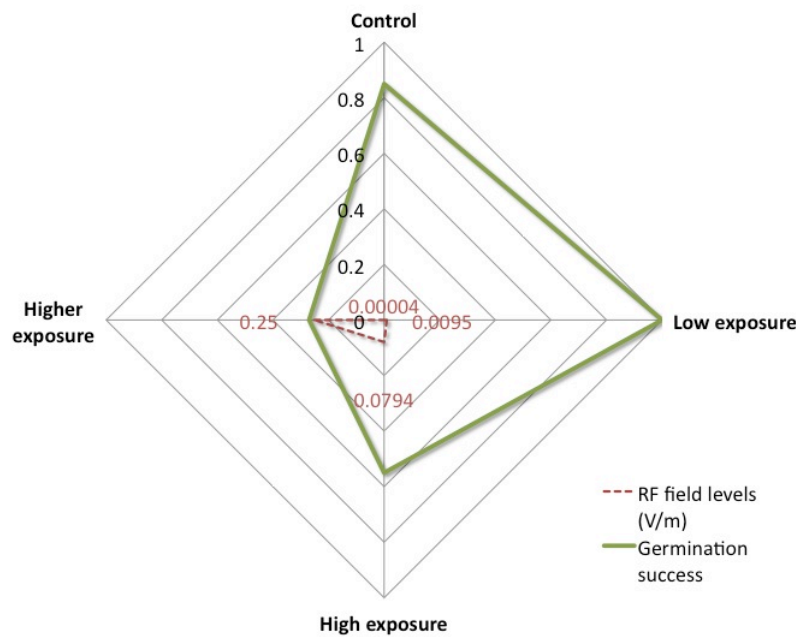


Figure 3.10 Apparent effects of different RF electric field strengths exposures on seed germination (Selga & Selga, 1996).

It is interesting to note that low relative exposure increased germination over the control situation where no fields from the transmitter was detected, and that high field conditions reduced germination levels. In research by Selga et al. (1985), similar growth stimulation was shown in plants in the early stages of development as a result of UV exposure, which later promoted reproduction and ageing.

In comparison to the control, both low and raised exposures to the RF fields in the study were shown to increase the numbers and area of plastoglobules (lipoprotein particles within chloroplasts) within exposed pine needles and accelerate their ageing as a result of stress factors. Decreases in tree ring width were also recorded.

3.3.5 Deciduous trees

Research indicates that some deciduous tree types may be particularly adversely affected by low-level background RF/microwave radiation.

Haggerty (2010), found that the general growth rate of RF/microwave shielded seedlings was far greater than that of the mock shielded group producing 74% greater length of shoots and 60% more leaf area. Additionally, unlike the shielded seedlings, the old leaves of the RF/microwave exposed seedlings exhibited areas of dead tissue during the fall/autumn period. In that work the RF background levels for the unshielded seedlings ranged from -117 dBm to -87 dBm in the frequency range 1-1,000 MHz. The mean field intensity was -109 dBm. [dBm, sometimes referred to as dBmW, is an abbreviation for the power ratio in decibels (dB) of the measured power referenced to one milliwatt (mW).]

Unlike the RF/microwave shielded seedlings, the unshielded and mock-shielded seedlings failed to produce anthocyanin during the fall/autumn period. This is presently common for aspens (Haggerty 2010). Anthocyanins protect many types of plant against stress from strong exposures to sunlight, ultraviolet-B and free-radical attacks. They can also provide defensive colouration against predators. Additionally, anthocyanins attract insect pollinators and frugivores (fruit eaters) to the plants and help protect them against drought. [Their presence in food and supplements provides a number of potential health benefits as they are potent antioxidants, which (in association with other flavonoids) may help reduce likelihood and severity of cardiovascular disease, diabetes and some cancers] (Gould et al. 2008). As Lila (2004) notes, "Anthocyanin pigments and associated flavonoids have demonstrated ability to protect against a myriad of human diseases."

In the tests undertaken by Haggerty (2010), only RF/microwave shielded aspen seedlings produced anthocyanins during the fall/autumn period. She came to the conclusion that "the RF[microwave] background may have strong adverse effects on growth rate and fall anthocyanin production in aspen, and may be an underlying factor in aspen decline."

It appears prudent to assess anthocyanin levels in other types of plant under low and high RF/microwave regimes that may be created as a result of best and worst case exposures to FortisBC's proposed metering structure.

3.3.6 Comparison between tree types

It appears that some tree types may be more sensitive to particular RF/microwave radiation regimes than others. As an example of this, research by Schmutz et al. (1996) showed that **long-term exposure to 2.45 GHz (2450 MHz) radiation initially caused reductions of concentrations of calcium and sulphur in the leaves of beech trees, no such relationships were found to exist with the needles of spruce trees.** With the former, the mean calcium levels dropped 23% in year 1 and 33% in year 2 under high field exposure (10,000-30,000 $\mu\text{W}/\text{cm}^2$) compared to low field exposure (0.7 $\mu\text{W}/\text{cm}^2$). For sulphur, the respective figures were 11% and 29%.

3.3.6.1 Forest Dieback

Forests (and even individual trees) can help act as key regulators of global carbon and hydrologic cycles. Forest dieback is increasing. **The background (non-catastrophic) death rates of every major tree species in the western US in old growth forests has doubled every 17-29 years, with replacement of trees presently lower than tree die off** (van Mantgem et al. 2009).

It is suggested by Haggerty (2010), and others, that since "tree decline incidents worldwide have similar symptoms, and since no definitive explanation has been found for those events, it seems plausible that their decline may be related to RF exposure."

The long-term viability of some forests, and individual trees, could be compromised as a result of inappropriate exposures to RF/microwave radiation at levels well below those some authorities claim would give cause for concern. The above indicates the need to actively seek to adopt more 'biologically friendly' alternatives to microwaves for data transmission.

Comment B on Question 3.3: "The "Canadian Smart Grid Roadmap" document notes that the "Government of Canada's approach toward the future for Smart Grid is focused on three core energy policy objective: ... environmental performance" ... "

Conducting suitable risk assessments and adopting inter-disciplinary "best practice" measures can aid the effective development of the "Canadian Smart Grid Roadmap."

3.3.7 The Rio Declaration – as related to smart grids

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

Principle 1

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

As noted in Chapter 3 of this present document, this principle may be compromised through the creation of inappropriate AMI regimes that may impact negatively on their health, productivity and the environment.

Principle 4

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

Many smart grid infrastructures may in their present formats have the potential to damage flora and fauna. This matter needs to be urgently addressed. This is discussed in greater detail elsewhere in this present Chapter.

Additionally, environmental protection should extend to ensuring smart grids are adequately protected against natural and manmade EMP, and extreme terrestrial weather conditions, as failure to do so could have huge negative repercussions on the environments citizens normally occupy. Refer also to Chapter on Security Concerns.

Principle 7

“States shall cooperate in a spirit of global partnership to conserve, protect and restore the health and integrity of the Earth’s ecosystem. ...”

Transparent, properly funded, unbiased research is urgently required on the possible effects of smart meters and related technologies on the health and integrity of the Earth’s ecosystem so that appropriate measures can be taken and ‘safe’ technologies adopted.

Principle 9

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

If a true spirit of cooperation and global partnership (or even local partnership) can be achieved, that takes onboard the advice of relevant specialists often excluded from such developments, this goal can be achieved to a far greater extent and can lead to the development of new generations of more ‘biologically friendly’ technologies and environments. A ‘Win/Win’ situation for all parties.

‘Open innovation’ approaches based on collaboration, mutual respect, trust, and co-creation may prove particularly worthwhile in creating environmentally cost effective solutions.

Principle 13

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

Unless suitable mitigative and low-cost best practice measures are developed/undertaken related to smart meters and related technologies; there may be numerous liability and compensation claims lodged by victims related to 'electromagnetic pollution' and other environmental damage claims related to the rollouts. A better future can be created through cooperation.

Principle 15

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

There is a growing body of evidence indicating that radiofrequency and microwave emissions, at levels that can be emitted by AMI systems, may damage the environment. Failure to address such matters is in direct contradiction of the precautionary principle and could prove very costly.

There appear to be a number of benefits in applying cost-effective precautionary measures in the design and operation of metering systems and related technologies to reduce the likelihood of serious, sometimes potentially irreversible, environmental damage. Full environmental impact assessments, which take into account the comments of those who could help address such matters, appear warranted.

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

Principle 16

"National authorities should endeavour to promote the internalization of environmental costs and the use of economic instruments, taking into account the approach that the polluter should, in principle, bear the cost of pollution, with due regard to the public interest and without distorting international trade and investment."

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

It is in everyone's interest to help ensure that the most environmentally and biologically friendly, cost-effective, energy infrastructures and technologies are chosen and developed.

Principle 17

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

It appears that some smart meter and smart grid EMF regimes may damage the environment. It is suggested that comprehensive EIA on smart meters and related technology (*covering the matters raised in this present document and others*) should be carried out at the earliest possible opportunity to help address these issues.

Smart meters do not benefit the environment without proper regulation (Stromback & Dromacque 2010).

3.3.8 Best practice initiatives from abroad: The European Commission

3.3.8.1 The European Commission Communication on the Precautionary Principle (EC 2000) states:

"The precautionary principle applies where scientific evidence is insufficient, inconclusive or uncertain and preliminary scientific evaluation indicates that there are reasonable grounds for concern that the potentially dangerous effects on the environment, human, animal or plant health may be inconsistent with the high level of protection chosen ..."

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

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

3.3.8.2 Risk assessment

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

"Risk assessment [should be] more prevention oriented.

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

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

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

Ensuring that smart meters, and other types of electronic technology, are 'environmentally sound' can create direct beneficial financial impact whilst also helping to future proof such systems. The development, adoption and application of such 'best practice' measures can be directly recouped in British Columbia through savings on overall healthcare expenditure and increased workforce productivity.

The responsibility for environmental impact lies with the provider – providing impetus for proper development and the creation of World-class environmentally-friendly technologies.

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

For true progress to be made, a fresh perspective is necessary...

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4.1 Smart Meters and Weather Extremes

4.1.1 What happens when weather is colder than smart meters can operate?

In many countries, such as Canada, most smart meters are located outdoors. In others, the opposite is true. When located indoors, such meters are normally protected from weather extremes but can increase individuals' exposures to both radiofrequency and microwave radiation. [Smart meter wireless communications are normally in the microwave range, with their switched mode power supplies creating frequencies in the radiofrequency range].

When located outdoors, it is hypothesised by the present author, that smart meters may be more likely to fail or malfunction during cold weather extremes than the analog meters they were designed to replace. **The potential seriousness of such malfunctions is further compounded when smart meters are set to automatically turn off electric power and gas supplies when they fail.** Unless suitably addressed, these factors alone could greatly damage consumer confidence.

There is also the possibility that during the prolonged absence of power, which might be caused by meters malfunctioning in severe low temperatures, additional problems (and insurance claims) might arise for damage done and reinstatement being delayed. Whether the provision of the automatic cut-off feature under such situations might lead to increased likelihood of loss of life has yet to be ascertained.

Inappropriate design specification could prohibit smart meter operations, and/or greatly reduce their reading accuracy (and increase bills), during extreme low temperatures.

4.1.1.1 Canada

As noted by Ernst & Young (2011), "Canada is more advanced in smart-grid technology than most other nations, spurred on by the vast distances and hostile terrain separating significant generation resources from electricity consumers."

From information obtained to date by the present author, it appears that in Canada smart meters are designed to only work in temperatures down to -40°C [-40°F]. This means that the Canadian weather extremes shown below could prove somewhat troublesome to this proposed alternative to analog meters.

There are presently no roll out plans for smart meters in Newfoundland and Labrador, Nova Scotia, the Northwest Territories, Nunavut and the Yukon Territory (Table 4.1, Ernst & Young 2011).

Table 4.1 Record lowest daily temperatures in Canada (Ernst & Young 2011)

Province	Location	Date	Temperature
Alberta	Fort Vermillion	January 11, 1911	-61.1°C
British Columbia	Smith River	January 31, 1947	-58.9°C
Manitoba	Norway House	January 9, 1899	-52.8°C
New Brunswick	Sussex *	January 15, 1957	-44.4 °C
Newfoundland and Labrador	Esker 2	February 17, 1973	-51.1°C
Nova Scotia	Upper Stewiacke	January 31, 1920	-41.1 °C
Ontario	Iroquois falls	January 23, 1935	-58.3 °C
Prince Edward Island	Bangor *	February 7, 1993	-37 °C
Quebec	Doucet	February 5, 1923	-54.4°C
Saskatchewan	Prince Albert	February 1, 1893	-56.7 °C
Northwest Territories	Fort Smith	December 26, 1917	-57.2°C
Nunavut	Shephard Bay	February 13, 1973	-57.8°C
Yukon	Snag	February 3, 1947	-63°C

Sources: Wikipedia (2012), *Environment Canada (2012).

In all of Canada's Provinces and Territories, with the exception of Prince Edward Island, the lowest recorded daily temperature exceeds the Maximum Permissible Exposure (MPE) design temperature for smart meters. In the worst case the lowest operational design temperature was exceeded by -23°C.

Researching incidence of weather extremes in British Columbia from all the available data revealed 25% of all meteorological stations (75 stations out of 265 stations) in BC had recorded extreme minimum temperatures less than or equal to -40°C [Canadian Climate Normals 1971-2000 – (Environment Canada, 2012)]. There were 196 monthly minimum extreme temperatures less than or equal to -40°C. The most extreme minimum temperature found was -52°C.

4.1.1.2 Smart meter errors and malfunctions

Lesser temperature extremes have been shown to cause an earlier generation of smart meters to malfunction (Frontier Utilities 2012). As this is the case, it would appear prudent to check smart meter operational abilities under worse case extreme weather scenarios at the earliest possible opportunity.

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

There appears to be a very real risk that extreme low weather temperatures may cause many smart meters to malfunction, or cease to supply power as a result of potential automatic disconnects. It would appear prudent for FortisBC to investigate these potential shortfalls with regard to the smart meter they wish to replace analog meters with.

4.1.1.3 Effects of extreme weather

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

In addition to electrical equipment not functioning properly in weather extremes it can also become damaged.

Such findings reinforce the need for the effects of extreme low weather temperatures on smart meter operation to be investigated further at the earliest possible opportunity for the benefit of the public and utilities alike.

As recent research by Greene & Monger (2012) indicates that the likelihood of more severe winters is increasing, if smart meters are unable to be able to operate effectively at a level in excess of the minimum recorded temperatures recorded to date, it may prove prudent to halt smart meter roll outs where severe conditions are likely and retain/return to the use of safer traditional analog meters in those areas until suitable alternatives can be sought.

The likelihood of smart meters causing overbilling during extreme weather conditions should also be properly assessed.

Additionally, smart meters appear to be more vulnerable than analog meters to the extreme solar weather events predicted by NASA for the next few years. It is suggested by the present author that when smart meters are installed, they should be allowed to fail in a "supply on" mode – a measure that could save many lives.

4.1.2 Present Risk from Extreme Space Weather

4.1.2.1 Solar super storms

It is predicted by NASA and by the NOAA that the Sun may be entering a particularly energetic period (similar to that in which the most powerful solar storm ever recorded occurred), with very energetic solar storms happening every couple of months instead of years, with activity peaking around 2013-2014. The electromagnetic pulse (EMP) events that such storms can create can severely damage fragile grid infrastructures and electronic components.

Scientists were already talking about the likelihood of solar "black swan event" that could knock out electronic equipment in 2012 when solar activity was less than is predicted over the next two years. **The risks posed by space weather are known and significant, a severe event could potentially have serious impacts upon infrastructure and society.** Space weather has been identified as a Tier 1 risk, the highest of identified "priority risks" (UK House of Commons Defence Committee 2012). Under the worse case scenario, large areas of the Earth could be without electricity for long periods, possibly several months, with high loss of life. **Countries, and areas, with "fragile" grid infrastructures are likely to be affected most** - smart grid electronics may introduce additional vulnerabilities to exposed grids. The use of smart meters instead of analog meters may also increase risk, as they are more likely to be damaged by solar events.

The risk from extreme space weather (and manmade EMP events) should be factored in to the design of the power grid to a greater degree. Due to their electronic circuitry, smart meters are indicated as increasing the risk of power failures from such events.

An insurer's perspective on general risk from space weather

The Executive Summary from Lloyd's 360° Risk Insight on space weather notes:

"The growth of technologies has left society more at risk from space weather. Previous periods of solar maximum have varied in their severity. However, as we become more reliant on modern technologies (and as systems become more interconnected) a major space weather event in the next 3 years could disrupt unprepared businesses."

"... space weather ... poses a much greater threat today because of the emergence of vulnerable technologies."

"Space weather could potentially create huge disturbances in the ... power sectors. Electrical power, in particular, is vulnerable to space weather and is of course of critical importance to modern economies and societies. A number of space weather incidents have already disrupted electrical transformers and grids in Canada ... following these, the sector has introduced mitigation practises. **However, more could be done: particularly to understand the risk from both extreme events (for example, a major magnetic storm) and low-level risk (often a cumulative build up of minor damage from smaller storms),**" (Lloyd's 2010).

"A very severe outbreak of space weather could create a systemic risk to society. Because space weather affects major global systems, such as power ... a very severe outbreak presents a systemic risk. For example, a loss of power could lead to a cascade of operational failures that could leave society and the global economy severely disabled." (This is discussed in greater detail in the present commentary).

"Businesses at risk from space weather need access to relevant expertise. This may be done by expanding in-house engineering expertise or by employing specialist service providers. Whichever route is followed, it is critical to have access to measurements and forecasts that allow businesses to adapt to and mitigate the effects of space weather. This will also require better understanding of the science of space weather"

"Finding defences against Space weather may also provide business opportunities. Specialist businesses can provide information and services to help other businesses at risk from space weather. ... there is also an opportunity for those businesses at risk to use their understanding of space weather impacts to gain a competitive advantage by improving the resilience and the performance of their business systems."

Comment: Properly addressing the very real risks of space weather to create robust AMI could produce numerous 'Win/Win' opportunities. Failing to adequately address such matters (including failing to ensure that smart meters can withstand such events) could be disastrous.

4.1.2.2 International perspectives

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

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

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

4.1.2.3 Space Weather

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

4.1.2.4 Solar Super Storms

It is predicted by some scientific experts that the Sun's 11-year cycle is due to hit its maximum in late 2013 or early 2014. Lloyd's 360° Risk Insight on space weather (Lloyd's 2010), suggest the solar maxim may continue to 2015 (after FortisBC's proposed smart meter roll out is presently intended to start). According to NASA and the US National Oceanic and Atmospheric Administration (NOAA), the Sun may be entering an intensely vicious solar maximum in 2013, comparable to that of the Solar Super Storm of 1859 - which is the most powerful solar storm recorded to date (Moskowitz 2011, NASA 2010, US NRC 2008a). NASA note that in the period we are now in, very energetic solar storms could take place "every couple of months instead of years," (Mosher 2011). According Riley (2012), **there is an approximate 1 in 8 chance of a solar storm of equal magnitude to the 1859 event producing devastating disruption to electric power transmission networks within the next ten years.** The UK's National Risk Register of Civil Emergencies state that the likelihood of severe space weather within the next 5 years is between 1 in 2 and 1 in 20 (UK Cabinet Office 2012). Such an occurrence could additionally result in significant (and preventable – *present author's comment*) mortalities (Pry 2011, Gaffney Jr. 2011).

"A Great solar storm has the potential of seriously damaging the North American electrical power grid. The resulting blackout will be focused on the northern tier of states and the East and West coast of the U.S. and throughout Canada," Marusek (2007). John Kappenman (NRC 2008) modeled the potential effect of exposure to a storm of similar magnitude to the great solar storm of May 1921 on the modern US power grid and calculated that over 300 large EHV transformers would be at risk of permanent damage. No detailed assessment appears to have been made to date as related to smart meters, though they will have increased likelihood of damage compared to the units they have been designed to replace.

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

It is predicted that upcoming solar flares could greatly endanger National Security and may take down key services such as electricity grids, electronics and communications for prolonged periods. It appears imperative that countries protect their power grids to the best degree possible against such events. At best, such an event could cause individuals to be without electricity for hours or days. Under the worse case scenario, large areas of the Earth would be without electricity for longer periods, possibly several months. Countries, and areas, with "fragile" grid infrastructures are likely to be affected most.

The present author contends that backup plans should also take into account the possibility that it may be necessary to deal with several severe space weather events over an extended high-risk period, and that as a result of this eventuality, the inclusion of additional components such as standard smart meters which appear sensitive to EMP should be avoided in utilities' power supply infrastructures wherever possible. The need for such caution appears indicated in the statement by NASA's Phillip Chamberlin that at present very energetic solar storms could take place "every couple of months instead of years," (Mosher 2011).

The present design of many high-tech devices (including smart meters and smart appliances) appears to make them far more vulnerable to natural and manmade EMP effects than the units and technologies they were intended to replace. Transformer designs too can often be improved (Birnbach 2011, EMPrimus 2011).

4.1.2.5 Space weather forecasting

Utilities in Canada and elsewhere rely on space weather forecasting to help systems remain operational during geomagnetic storms. [The Department of Natural Resources Canada (NARCAN) is responsible for communicating forecasts and warning alerts, through analysis of data from the Canadian Automatic Magnetometer Observatory System (CANMOS) and other agencies worldwide (Zurich 2010). Increased international collaboration on research, exchange of real time data, space weather forecasts and alerts is helping to improve such efficiency, and raise awareness on where shortfalls arise]. **As noted by the Government of Canada (2002), “Operators can implement conservative operating procedures once they have received an advance warning of a storm threat.”** The effectiveness of such measures however is related to the quality of information received and when it is received (see Table 4.2).

Table 4.2 Time Sequence of Solar Storm Events (Marusek 2007)

Parameter	Solar Flares	Solar Proton Event	Coronal Mass Ejection
Arrival time	Instantaneous*	15 minutes to a few hours	2 or 4 days
Effect Duration	1-2 hours	Days	Days

*Arrival times are in relationship to time when light from a solar flare first reaches Earth (around 8 minutes).

“Controlled” power cuts to national electricity supplies can be factored in to protect them against potential damage from large solar storms that might otherwise take months or even years to repair (Connor (2011). However, such “controlled” power cuts can only take place if warnings are given in time. Sometimes, as was the case in Quebec great geomagnetic storm of March 13th, 1989, this is not always possible. As noted by Marusek (2007), citing Kappenman et al. (1997), *“From the initial event to complete blackout, only one-and-a-half minutes elapsed—hardly enough time to assess what was occurring, let alone to intervene.”*

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

According to Michael Hesse, Director of the Modeling Center at the Goddard Space Flight Center, as quoted by Kerr (2009), these satellites “can fail any time, no one knows.” It was further noted by Kerr (2009) that *“One-third of major [solar] storms arrive unheralded and almost one-quarter of the warnings turn out to be false alarms...”* It was additionally noted in written evidence from the UK National Grid that *“CMEs can take from 18 hours to three days to reach Earth. Forecasting models are used to decide on their trajectory and timing. NASA issue forecasts of arrival time giving a six-hour window. However these forecasts are frequently inaccurate, with the actual arrival being many hours early or over a day late. ...”* (UK House of Commons Defence Committee 2012). As this is the case, it appears that forecasts may fail to provide adequate warnings, particularly during the heightened periods of activity predicted for this present period by NASA where very energetic solar storms could take place *“every couple of months instead of years,”* (Mosher 2011).

With a possible lack of accurate forecasting, and possibly overstretched staff, there is the real chance that there will be insufficient warning time for effective mitigative actions to be taken on some occasions when solar storms present danger, thereby further increasing grid and power supply vulnerability. For the space weather warnings that do come through before the event, it is noted in the report by the UK House of Commons Defence Committee (2012), and the ‘National Security Space Architecture (NSSA), Space Weather Architecture Study, SWx Impacts by 555WXS,’ as cited by Marusek (2007), that *for some events there may be two or three days warning and with others there may be only eight minutes notification.* As noted by Marusek (2007), citing Kappenman et al. (1997), sometimes this time period may be considerably less. *During the huge solar storm of 1989 in Canada, operating conditions in Quebec went from normal “to complete Provence wide blackout in an elapsed time of 92 seconds”* (Horizon 2012).

4.1.2.6 Effects of solar EMP on electronic components

Solar storms can “affect the performance of digital microelectronics systems causing increases in ‘soft errors’ ... **The GIC effects on micro and nanoscale electronic components are not fully understood.** These soft errors are generally spontaneous and non-reproducible and can lead to unexplained computational errors in computer performance” (Zurich 2010).

An apparent example of such damage caused by solar storm EMP occurred in August 1989, which “**reportedly caused unexplained computer and disc drive crashes** halting trading operations for three hours in the Toronto Stock Exchange” (Zurich 2010). The damage that such events are likely to cause to smart meters’ electronic components, or the effects of potential mitigative measures has not yet been tested. It appears likely that the detrimental effects that EMP may have on smart meters, and other smart grid technologies, (as they are presently designed) would be longer lasting and possibly place large sections of the community at jeopardy.

Single-event effects (SEEs) can cause either non-destructive or destructive effects:

- Non-destructive effects are spontaneous malfunctions which can cause data loss or loss of control. Cumulative effects, from repeated exposures, can also degrade performance.
- Destructive effects normally cause the sudden failure of a device, which for critical applications *(such as the supply of energy to whole communities through smart meters – present author’s comment)* can be catastrophic.

Solar EMP (and manmade EMP – present author’s comment) “**may degrade the performance of electronics in ‘Supervisory Control and Data Acquisition’ (SCADA)**” (Zurich 2010). As SCADA is a key component of smart grids (and computer networks and telecommunication systems), it would appear prudent to address this generally unrecognized – but very real - risk through introducing suitable mitigation measures before proposed AMI are rolled out.

Possible mitigation measures include holding back the proposed roll out until adequate testing and system development can be undertaken to address the above risks and waiting until the high risk EMP period of the present solar cycle subsides.

4.1.2.7 Expert Opinions on the Effects of Solar Storms

4.1.2.7.1 UK Government Expert Opinion

The UK Government is aware of the threat of solar storms and has already taken various contingency measures, including allowing some transformers to be switched off if necessary (Connor 2011). It has not yet addressed the issue of smart meter vulnerability to such events. The UK Government’s chief scientific adviser, when speaking at the annual meeting of the American Association for the Advancement of Science (AAAS) in Washington DC in 2011, further noted that **solar storms could cause catastrophic damage to the world’s economy.** *“The potential vulnerability of our systems [to space weather] has increased dramatically. Whether it’s the smart grid in our electricity systems or the ubiquitous use of GPS.”* Professor Sir John Beddington (Brewster 2011).

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

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

“Severe space weather can cause disruption to a range of technologies and infrastructure, including communications systems, electronic circuits and power grids” (UK Cabinet Office 2012).

4.1.2.7.2 US Expert Opinion

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

“Many things we take for granted today are so much more prone to the effects of space weather than was the case during the last maximum,” Lubchenco declared (Moskowitz 2011a). **The challenge faced may increase as the World is likely to become more ‘technologically dependent’ as it experiences 2013-2015 and other periods of solar maxima** – it appears wise to start ‘future proofing’ technology now and industry needs help from governments to do so. As noted by Tom Bogdan, Director of the US Space Weather Prediction Center, *“What’s at stake are the advanced technologies that underlie virtually every aspect of our lives.”* He also mentioned that forthcoming individual solar events could be particularly powerful (Lovett 2011).

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

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

4.1.3 Effects of Solar Storms on Canada

4.1.3.1 Solar Storm of 1989

On March 13th, 1989, at 02:45 EST, geomagnetically induced currents (GIC) from a severe solar storm inundated the Hydro-Quebec power system’s transformers overloading them with current (transformers in the USA and the UK were also damaged by that solar storm). **The voltage fluctuations at Hydro-Quebec caused a domino effect resulting in the tripping of reactive power compensators** at the Albanel, Chibougamau, Nemiscau and la Verendrye substations. As noted by Marusek (2007), this led to a severe voltage drop, power lines from James Bay malfunctioned and the system collapsed causing a blackout that affected 6 million people. The eventual direct cost of the power blackout was over \$2 billion (Zurich 2010). The outage was in part due to the linked malfunction of over fifteen discrete protective-system operations. As noted by NASA (2010), the geomagnetically induced currents (GICs) that the solar storm of 1989 created caused the overloading of circuits, tripping of breakers, and (in severe cases) even melted the windings on heavy-duty transformers. *[Additionally, it has been shown that generators can be destroyed as a result of cyber attacks, as shown in footage of a previously classified US cyber war exercise (CNN 2007)].*

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

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

A utility firm placing a top priority order for the replacement of a damaged generator step-up transformer as a result of the 1989 event was told it would take almost 2 years to fulfill [at present there is a 3-year lead time for orders to be fulfilled (which could be greatly extended in future) if orders for replacements were high – comment by present author]. Luckily, a spare was available which was installed within 6 weeks (Marusek 2007). [It has yet to be factored in how many smart meters may be damaged by solar storms of similar (or greater) magnitude, and how long it would take to replace such units – present author's comment].

Within 25 months of the March 1989 storm, 12 Nuclear Plants had transformer incidents that were suspected as being delayed failures caused by that storm (Kappenman 2011). **The direct cost of the March 1989 solar storm was over \$2 billion** [£1.245 billion]. It was estimated in 2010 that the cost of protecting key areas of the US grid against EMP would be \$150 million [£94 million] (Riswadkar & Dobbins 2010). **Whilst Canada has already started taking measures to protect the grid, the introduction of smart technologies introduce a new layer of risk.** The costs could be substantially greater for smart grids as a result of their additional electronics introducing increased potential EMP vulnerabilities into grid systems (Radasky 2011). Measures to reduce risk are already being put in place by governments to secure their “critical electric infrastructures” (EIS 2011, 2010), but have yet to address smart meter vulnerability.

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

4.1.3.2 Other Canadian events due to solar storms (*partial listing*):

1940 - Temporary disruption of electrical services in Quebec and Ontario as a result of solar storm on March 24th (New England, New York, Pennsylvania and Minnesota in USA also affected) (NASA Education & Outreach 2012).

1958 - Solar storm caused a power transformer failure at the British Columbia Hydro and Power Authority on February 9th-10th (NASA Education & Outreach 2012).

1972 - On August 2nd a 230,000-volt transformer at the British Columbia Hydro and Power Authority in British Columbia explodes due to solar storm. Canada's Manitoba Hydro recorded power drops in the power it was supplying to Minnesota, from 164 to 44 megawatts, over a few minutes. (In the USA, the Bureau of Reclamation power station in Watertown, South Dakota experienced large swings in power line voltages up to 25,000 volts. Similar voltage swings reported by Madison Gas and Electric, Wisconsin Power and Light, and the Wisconsin Public Service Corporation (NASA Education & Outreach 2012).

1989 - The intense solar storm activity was reported to cause unexplained computer and disc drive crashes at the Toronto Stock Exchange in August 1989 (Zurich 2010).

4.1.4 Sensitivity to Geomagnetic Storms

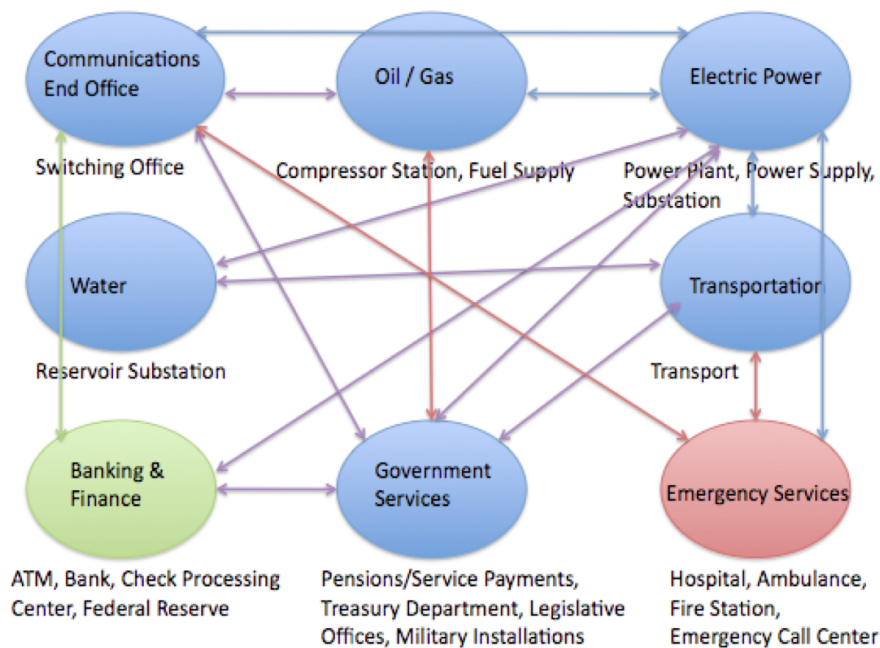


Figure 4.1 National economies are sensitive to geomagnetic storms due to a network of interdependencies. [Adapted from original graphic by US Department of Homeland Security] (Source: Jamieson 2011).

The US National Research Council (NRC 2008) states, “Because of the interconnectedness of critical infrastructures in modern society (Figure 4.1), the impacts of severe space weather events can go beyond disruption of existing technical systems and lead to short-term as well as to long-term collateral socioeconomic disruptions.” As noted by Arbutnot et al., (2010), *“There is limited time to upgrade national electric grids to avoid solar flare-induced, global scale burn out.”* It appears vital to ensure that AMI are properly designed to withstand such high risk. Unfortunately such time is quickly running out with much still remaining to be done. The consequences of such an event, or series of events, should they occur, could be dire as the effects could cascade through other systems dependent, either directly or indirectly on electricity. It is therefore vital that utility grids and meters are as robust as possible to try to withstand such potential threats.

Distribution of drinkable water could be greatly compromised by a severe solar storm, as could cooking and food refrigeration facilities, fuel supply, heating, lighting, Internet and telephone communications, sewage disposal and transport (fuel pumps require electricity to work). Banking, government, medical treatments and emergency services could also be affected to various degrees. **“The longer the outage, the more problematic, and uncertainty-fraught the recovery will be”** (Foster Jr. et al. 2004). The effects of solar super storms, as predicted for 2013-2015 (Lloyd’s 2010), could take many years to correct and severely damage national economies. There is no room for complacency.

4.1.5 Need for Robust Power Grid Solutions to Space Weather

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

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

As an example of a best practice initiative for power grids: "System operators in Canada have developed and implemented procedures to respond to these emergencies, thereby reducing potential damage... Since 1989, Hydro-Quebec has spent more than \$1.2 billion installing transmission line series capacitors ... [to] block [geomagnetically induced currents] GIC flow caused by severe solar storms in order to prevent them from causing damage to the system. ... Additional protective measures include ... desensitizing automatic control systems..." (Government of Canada 2002). Again the need to make smart meters robust enough to deal with such eventualities has yet to be addressed.

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

Shielding just 10% of critical infrastructure could reduce anticipated damage from EMP events considerably (The Sage Policy Group, 2007). The author of this present document suggests that, as it is possible that more than one solar super storm may inflict damage during this period, ideally protection levels for at least 10% of the grid should be 'As High As Reasonably Achievable' (AHARA). **Uncharted territory is being entered into where the intensity of a severe space weather event might even exceed that of the 1859 Carrington Event and lesser severe space weather events (in comparison) may also arise that may cause considerable damage and loss of life.** It is proposed by the present author that at the very minimum at least 10% of meters should have suitable resilience to EMP. Ideally they should all be EMP resistant, or have as high a level of resistance as the analog meters they may replace.

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

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

It appears more cost-effective to create robust EMP protected grids and electrical equipment now than to have to do so in retrospect. Solar events are not particularly rare (and the risk from manmade EMP, as discussed later in this document, is rising). Research now indicates that large GICs are also possible at low-latitudes as well as at high latitudes (Kappenman 2011).

It appears that utility grids will need to be protected against both solar EMP and manmade EMP to comply with the International Infrastructure Security Roadmap (EIS 2011, 2010). It is proposed that such matters should be urgently addressed as a matter of the highest priority.

4.2 Manmade EMP Events

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

4.2.1 High-Altitude Electromagnetic Pulse (HEMP)

As noted by the Commission to Assess the Threat to the United States from Electromagnetic Pulse Attack: "A determined adversary can achieve an EMP attack capability without having a high level of sophistication. EMP is one of a small number of threats that can hold our society at risk of catastrophic consequences. EMP will cover the wide geographic region within line of sight to the nuclear weapon. It has the capability to produce significant damage to critical infrastructures and thus to the very fabric of ... society, ...," (Foster Jr. et al. 2004). EMP can cause "temporary upset and even catastrophic failure to modern electronics and electrical systems over considerable geographic areas of the Earth" (NATO 2011).

The term HEMP is often used for EM signals created from a nuclear detonation interacting with the Earth's upper atmosphere. The characteristics of the different HEMP Types are given in Table 4.3.

Table 4.3 HEMP Components (Radasky, 2011)

HEMP Type	Intensity	Time to reach intensity
E1	50,000 V/m	< 10 nanoseconds
E2	100 V/m	1 microsecond - 1 second
E3	0.04 V/m	1 - several hundred seconds

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

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

4.2.2 Source Region Electromagnetic Pulse (SREMP)

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

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

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

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

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

4.2.4 Close Range EMP

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

Information is easily obtainable from the public domain detailing how to create close range EMP. For security reasons, further details are not given in this report.

4.2.5 Power Surges

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

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

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

4.3 Preventing Natural and Manmade EMP Catastrophes

Smart grids and AMI create more potential points of failure from EMP than traditional grids and analog meters. Ideally, protective measures should be considered early in the brief and applied before roll out. Cost effectiveness is essential (EMPrimus 2011, Koepke 2010), and should be assessed after taking in-depth reviews (which as part of their brief *realistically* factor in potential risk factors). It is possible through robust planning to prevent EMP catastrophes. Action is required sooner rather than later for protecting smart grids, smart meters and smart appliances, and could create numerous opportunities for investment and the development of new sustainable technologies.

Power grids, meter systems and related technologies should be designed where practical to prevent / reduce likely adverse effects from EMP (see Table 4.4).

Table 4.4 Preparation for EMP incidents

Recommendations (partial listing as related to EMP – various authors)
<ul style="list-style-type: none"> • Adhere to the Electric Infrastructure Security Council (EIS) International Infrastructure Security Roadmap (EIS 2011). • Determine grid and network level vulnerabilities & prioritise actions. • Improve forecasting ability for EMP events. • Protect important infrastructures and "high value"[†] assets through appropriate design measures - including hardening ([†]"High value" assets include essential government operations and those of other national institutions.) • Grid-level protection systems should be installed to protect against EMP threats to transformers. • Harden smart grid infrastructures and related technologies against EMP risk.* • Delay rollout of additional smart meters till after main period of solar risk if unhardened. Ideally also harden against risk of manmade EMP attacks and allow retention of analog meters. • Develop regional and national smart grid restoration plans and survival plans for populations. • Provide Government endorsement & tax incentives for required work. • Undertake "controlled" power cuts when necessary to protect grid. • Identify & address regulatory gaps that preclude effective mitigation. • Manufacture robust essential components for infrastructure, such as large transformers, within own country – this may greatly help shorten recovery periods and create extra jobs. • Ensure smart meters are robust.

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

"The technology to protect critical infrastructures from natural or malicious electromagnetic threats now exists. Implementation costs are estimated at less than 0.01% of GNP. ... "Since much of this cost would in any case be incurred for normal periodic upgrade and modernization, the net costs are even lower," Arbuthnot et al. (2010).

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

"If addressed, our reduced vulnerability helps deter attack, enhances infrastructure resilience and confers added protection against cyber threats and damaging geosolar storms." Commission to Assess the Threat from High Altitude EMP (Graham et al., 2011).

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

4.4 Cyber Security

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

It is recognised by the US Government Accountability Office (US GAO) and the US Department of Energy (US DOE) that the transition to smart grids is opening electric grids open to increased cybersecurity weaknesses that risk damaging their efficient operation (US DOE 2012, US GAO 2011, Mills & LaMonica 2010). **It has already been claimed that hackers from a major foreign country have reconnoitered the US electricity grid possibly seeking to discover exploitable systemic vulnerabilities such as those presented in present smart meter systems** (Anderson & Fuloria 2011). The Government of that same foreign country is also reported by a former Pentagon analyst to have "pervasive access" to around 80% of the World's communications, and is looking "to nail down" the remaining 20% (Protalinski 2012), creating a major security risk for other countries. **This security risk may be higher for Canada than some might envisage because it is responsible for a considerable part of US energy needs.** BC also supplies the USA with energy.

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

Grid shutdown: “In time of conflict, nation states often try to switch off an enemy’s electricity using air power if they have it; even better would be a remote computer exploit. This need not involve access to the keys used by utility to sign commands to its meters; **there are potentially many critical components, from software upgrade mechanisms to tariff setting and billing, that might be exploited in service-denial attacks.** Modern smart meters can support as many as 200 instructions, interactions between which may give rise to API [application programming interface] attacks. Meters may also run multiple applets, leading to software security issues. The transfer of cryptographic key material when a customer changes their electricity supplier may involve complex cryptographic protocols. **All such mechanisms have the potential to expose a nation to a ‘cyber-nuke’ that would reduce its population to destitution. Yet utilities have no experience of defending themselves against capable motivated cyber-adversaries”** (Anderson & Fuloria 2011).

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

In that same year (2009), “IOActive Inc., successfully reverse engineered a smart meter--known as Advanced Metering Infrastructure (AMI)--and demonstrated the ability to inject a worm into the grid that would grant a hacker full control over the grid devices. **The tests also revealed that the worm could spread like wildfire throughout the grid, potentially allowing the hackers to shut down massive portions of electricity to major cities, critical infrastructures and government agencies,”** Verton (2011).

In August 2012, the Department of Homeland Security issued a cyber-warning to Siemens subsidiary RuggedCom about a cyber security “flaw that could be used to decrypt RuggedCom’s data traffic between an end user and the router. ... From there, attackers could theoretically launch denial-of-service attacks, or infiltrate and potentially control networks that run power turbines, high-voltage grid gear and industrial plant across the world ...” (St. John 2012a).

4.4.1 Security controls for smart meters and critical infrastructures

False data injection attacks are used to exploit the configuration of power grids through introducing arbitrary errors into state variables whilst bypassing existing techniques used for bad measurement detection. Industry experts believe that the present generation of smart meters have poor security provisions against false data injection attacks. During a survey of 104 energy security professionals conducted in March 2012, when asked, “Do smart meter installations have sufficient security controls to protect against false data injection?” 61% of the industry experts said “No.” (Homeland Security News Wire 2012).

Elizabeth Ireland, vice president of marketing for nCircle, who undertook the survey with the US Department of Energy, remarked, **“A false data injection attack is an example of technology advancing faster than security controls. ... it’s a key reason for the significant cyber security risks we face across many facets of critical infrastructure. Installing technology without sufficient security controls presents serious risks to our power infrastructure and to every power user ...”** (Homeland Security News Wire 2012).

"Critical ... energy infrastructure continues to be penetrated and probed by a host of malicious actors operating in cyberspace, from organized criminal gangs to spies. It was ... reported that cyber-spies from [foreign countries] installed malware tools on the US electrical grid. Several years ago the California Independent System Operator reported that: "For at least 17 days at the height of the energy crisis, hackers mounted an attack on a computer system that is integral to the movement of electricity throughout California." According to a ... public report by a CIA analyst this is a global problem: criminals have launched cyber attacks against foreign power utilities with the goal of extorting money" (Gordes & Mylrea 2009). Additionally, as Canada supplies power to the USA, there appears a likelihood, however small, that its systems may have been, or will be, compromised in similar fashion, possibly primarily to inconvenience the USA. It would also appear likely those countries whose energy infrastructures are perceived as 'soft targets' will be sought by criminals.

It is already on record that the Canadian Cyber Incident Response Centre (CCIRC) has never operated 24 hours a day, 7 days a week (as had been originally intended) to monitor and analyze cyber threats. At the time of the Fall 2012 Audit Report by The Office of the Auditor General of Canada (2012), it was staffed to operate from 8:00 a.m. to 4:00 p.m. (Ottawa time), five days a week, with cyber threats or attacks being reported to CCIRC after operating hours being received by the Government Operations Centre which has a brief to page a CCIRC employee who is on call at the time. "As CCIRC is not operating around the clock, there is a risk that there will be a delay in the sharing of critical information linked to newly discovered vulnerabilities or active cyber events reported to CCIRC after operating hours. ... Public Safety Canada officials told us that the Department is now working to extend CCIRC's coverage to 7 days a week, from 6:00 a.m. until 9:00 p.m. (Ottawa time), although there are no plans to go to a 24-hour-a-day operation" (Office of the Auditor General of Canada 2012). This state of affairs may have already led to Canada's energy infrastructure being seen as a 'soft target' by rogue nations, criminals and terrorists.

Cyber attacks can take many forms. A declassified US Department of Homeland Security video (CNN 2007) which shows a staged cyber attack causing the self-destruction of an industrial power generator in Idaho can be viewed at: <http://edition.cnn.com/2007/US/09/26/power.at.risk/>. **CNN (2007) said sources familiar with that mock attack on a replica of a power plant's control system declared that the same attack scenario could be used against the large generators responsible for generating the nation's electricity; and that "Some experts fear bigger, coordinated attacks could cause widespread damage to electric infrastructure that could take months to fix." Industry experts also declared that the mock attack, which caused the generator to viscously vibrate and smoke before it destroyed itself, demonstrated that large electric systems are vulnerable in ways not previously predicted.**

Whilst some of the risk issues have been dealt to protect power-generating equipment, vulnerabilities still remain. This was further brought home when industrial control systems in Iran were taken out with the Stuxnet virus, which was unwittingly introduced into a computer at a secure facility by an unsuspecting technician who had been given it on a USB stick. "Once inside, the virus spread silently for months, searching for a computer that was connected to ... a programmable logic controller, a special-purpose collection of microelectronics that commonly controls the cogs of industry - valves, gears, motors and switches. When Stuxnet identified its prey, it slipped in, unnoticed, and seized control ... Under normal operating conditions, the centrifuges [that were targeted] spin so fast that their outer edges travel just below the speed of sound. Stuxnet bumped this speed up to nearly 1,000 miles per hour, past the point where the rotor would likely fly apart, ... At the same time, Stuxnet sent false signals to control systems indicating that everything was normal" (Nicol 2011).

A very serious real breach of the smart grid infrastructure took place in 2012. In September 2012, Telvent, the smart grid giant (which specializes in SCADA and related IT systems for energy utilities), reported hackers had breached its network, inserted malicious software and accessed project files for its OASyS SCADA system, which is used to control power grid, oil and gas pipeline, some water system networks, and industrial controls and to amalgamate them with new smart grid platforms (St John 2012, Zetter 2012).

Telvent refused to say whether the hackers had downloaded or altered project files that could be altered to sabotage systems. According to Dale Peterson, CEO of Digital Bond (a security firm specializing in industrial control system security), "Some project files contain the "recipe" for the operations of a customer, describing calculations and frequencies at which systems run or when they should be turned on or off ... **"If you're going to do a sophisticated attack, you get the project file and study it and decide how you want to modify the pieces of the operation. Then you modify the project file and load it, and they're not running what they think they're running"** (Zetter 2012). This is similar to the scenario created by Stuxnet virus in Iran (detailed above), and could permit malicious destruction of power generators and smart metering technology.

As noted by St John (2012a), "Stuxnet was aimed at Siemens' SCADA systems, and cybersecurity experts contend that the industrial giant hasn't fixed the underlying vulnerabilities in that system that the virus targeted. Since then, security firm Symantec has reported that a variant known as Duqu has been developed, apparently by the same shadowy group that created Stuxnet, with the aim of gathering information about SCADA systems for espionage or planning future attacks."

The potential financial cost of large areas losing energy power as a result of cyber attacks on the electrical power grid is astronomical. Scott Borg, Chief Economist at US Cyber Consequences Unit, which produces security-related data for the Federal Government, told CNN (2007) that if a third of the country lost power for three months, the economic price tag would be around \$700 billion, "equivalent to 40 to 50 large hurricanes striking all at once ... "It's greater economic damage than any modern economy ever suffered. ... It's greater than the Great Depression. It's greater than the damage we did with strategic bombing on Germany in World War II."

4.4.2 Blackout Attacks

As mentioned earlier, one of the gravest scenarios is that of "a 'cyber-nuke' [through the smart meters] that would reduce ... [a country's] population to destitution. *Recovery from such an attack would be painful* [loss of life may also be high – present author's comment]. *As a matter of national survival, the government would probably authorise any electrician or other competent person to short-circuit dead meters. Utility contractors might need to spend a year or more visiting every house to rekey or replace them*" (Anderson & Fuloria 2011). This risk is avoided with the use of analog meters.

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

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

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

Unnecessary National Security risks should be avoided/reduced wherever possible. The present installation of remote off-switches for smart meters further increases risk of blackouts - ideally smart meters should be designed to fail in the 'on' mode to reduce this risk.

4.5 Energy theft

Energy theft is becoming increasingly recognised that smart meter hacks which allow unscrupulous individuals to steal electricity are likely to spread. In the FBI alert on that issue it was noted that in one US utility alone it was estimated that around \$400 million was lost annually through smart meters being altered to under-report the amount of electricity used by consumers and businesses. The FBI expects this type of fraud to spread (KrebsOnSecurity 2010), which Part of their alert about smart meter hacks is shown in Figure .

In that alert it was noted that one US utility was estimated as losing around \$400 million annually through smart meters being altered to under-report the amount of electricity used by consumers and businesses. The FBI expects this type of fraud to spread.



FEDERAL BUREAU OF INVESTIGATION INTELLIGENCE BULLETIN Cyber Intelligence Section

27 May 2010

(U//FOUO) Smart Grid Electric Meters Altered to Steal Electricity

(U//FOUO) This intelligence bulletin satisfies requirements contained in the FBI's Cyber Intrusions against the US Standing Collection Requirements USA-CYBR-CYD-SR-0085-09, USA-CYBR-CYD-SR-0004-10, and USA-CYBR-CYD-SR-0061-10.

(U//FOUO) Smart Grid electric meters^a in Puerto Rico are being exploited to under-report the amount of electricity used by consumers and businesses, according to FBI case information.¹ The Puerto Rican utility estimates their losses could reach \$400,000,000 annually. This is the first report that criminals have compromised Smart Grid meters and the first time the FBI has investigated meter fraud.

UNCLASSIFIED

(U) Source Summary Statement

(U//FOUO) The information contained in this Intelligence Bulletin is derived from confidential sources with direct access who the FBI judges to be accurate, reliable, and credible, despite the fact that they have not reported previously. We would deem this reporting more reliable, if it could be independently verified.



(U//FOUO) The FBI assesses with medium confidence^b that as Smart Grid use continues to spread throughout the country, this type of fraud will also spread because of the ease of intrusion and the economic benefit to both the hacker and the electric customer.

(U) Smart Grid meters are intended to improve efficiency, reliability, and allow the electric authority to charge different rates for electricity at different times of the day. The Smart Grid also improves a utility's ability to remotely read meters to determine electric usage.²

(U//FOUO) Meters are being compromised in the following ways, according to a contact with good access

Source: KrebsOnSecurity (2010), <http://krebsonsecurity.com/tag/itron/>

Figure 4. Part of FBI alert about smart meter hacks.

According to KrebsOnSecurity (2010), "The FBI warns that insiders and individuals with only a moderate level of computer knowledge are likely able to compromise meters with low-cost tools and software readily available on the Internet."

"The FBI believes that miscreants hacked into the smart meters using an optical converter device — such as an infrared light — connected to a laptop that allows the smart meter to communicate with the computer. After making that connection, the thieves changed the settings for recording power consumption using software that can be downloaded from the Internet."

Excerpts from the FBI bulletin alert quoted by KrebsOnSecurity (2010) are shown below:

"The optical converter used in this scheme can be obtained on the Internet for about \$400, ... The optical port on each meter is intended to allow technicians to diagnose problems in the field. This method does not require removal, alteration, or disassembly of the meter, and leaves the meter physically intact."

"The bureau also said another method of attacking the meters involves placing a strong magnet on the devices, which causes it to stop measuring usage, while still providing electricity to the customer. This method is being used by some customers to disable the meter at night when air-conditioning units are operational. The magnets are removed during working hours when the customer is not home, and the meter might be inspected by a technician from the power company."

"Each method causes the smart meter to report less than the actual amount of electricity used. The altered meter typically reduces a customer's bill by 50 percent to 75 percent. Because the meter continues to report electricity usage, it appears be operating normally. **Since the meter is read remotely, detection of the fraud is very difficult.** A spot check of meters conducted by the utility found that approximately 10 percent of meters had been altered."

"... this type of fraud will also spread because of the ease of intrusion and the economic benefit to both the hacker and the electric customer," the agency said in its bulletin.

Comment: It appears likely that the introduction of FortisBC's presently proposed new metering may actually increase energy theft. The loss of meter-readers *physically* reading meters could further increase the temptation of people to short change the utility company as meters are less likely to be regularly checked.

Conclusion – the design of power grids, meter systems and electrical appliances needs to be rapidly rethought to deal with the real life issues that have been raised.

Appendix A - References

Copies of studies published in scientific journals cannot be distributed due to copyright restrictions.

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B.1 Health Promotion – Making things better

"The concept of health promotion is positive, dynamic and empowering which makes it rhetorically useful and politically attractive. ... Further developmental work is clearly required ..."WHO (2009) / HPI (1986).

There are a number of health promotion initiatives that have been instigated by the World Health Organization (WHO) to provide incentives to achieve the target of 'Health For All' through improved health promotion and the creation and adoption of healthier technologies and environments.

B.1.1 Ottawa Charter for Health Promotion

First International Conference on Health Promotion Ottawa, 21 November 1986 - WHO/HPR/HEP/95.1

This Charter is an international agreement signed in 1986 at the First International Conference on Health Promotion in Ottawa, Canada, which was organised by the World Health Organization (WHO 1986). It has acted, and continues to act, as a catalyst for a wide range of beneficial actions which encourage improved health promotion measures worldwide.

Extracts from the Ottawa Charter are given below:

Health Promotion

"Health promotion is the process of enabling people to increase control over, and to improve, their health. To reach a state of complete physical, mental and social well-being, an individual or group must be able to identify and to realize aspirations, to satisfy needs, and to change or cope with the environment. ..."

The creation of healthier electromagnetic environments can greatly contribute to the realisation of this objective.

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

Enable: *"Health promotion focuses on achieving equity in health. Health promotion action aims at reducing differences in current health status and ensuring equal opportunities and resources to enable all people to achieve their fullest health potential. This includes a secure foundation in a supportive environment, access to information, life skills and opportunities for making healthy choices."*

From the anecdotal evidence received from the roll outs of wireless smart meters elsewhere (EMFSN 2011), it appears that the adoption of some types of smart meters may actually increase differences in current health status and reduce equality.

"People cannot achieve their fullest health potential unless they are able to take control of those things which determine their health. ..."

It is suggested by the present author that people should be allowed to opt out of smart metering if they wish to. Proposed mandatory installations of such meters have already been legally overturned in the US (SKT&A 2011, SmartGridNews.com 2011). It appears that adhering to a policy of mandatory installation may lose FortisBC a great deal of public good will.

B.1.2 Health Promotion Action Means:

B.1.2.1 Build Healthy Public Policy

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

It is proposed by the present author that the costs of creating more 'biologically friendly' (wired) metering systems may be substantially less than the costs of the health consequences of adopting a wireless AML system.

"... It is coordinated action that leads to health, income and social policies that foster greater equity. Joint action contributes to ensuring safer and healthier goods and services, healthier public services, and cleaner, more enjoyable environments."

"Health promotion policy requires the identification of obstacles to the adoption of healthy public policies in non-health sectors, and ways of removing them. The aim must be to make the healthier choice the easier choice for policy makers as well."

It is intended that this present submission will help contribute to this aim.

B.1.2.2 Create Supportive Environments

"Our societies are complex and interrelated. Health cannot be separated from other goals."

"Systematic assessment of the health impact of a rapidly changing environment - particularly in areas of technology, work, energy production and urbanization - is essential and must be followed by action to ensure positive benefit to the health of the public. The protection of the natural and built environments and the conservation of natural resources must be addressed in any health promotion strategy."

B.1.2.3 Strengthen Community Actions

"Health promotion works through concrete and effective community action in setting priorities, making decisions, planning strategies and implementing them to achieve better health."

"At the heart of this process is the empowerment of communities - their ownership and control of their own endeavours and destinies."

"... This requires full and continuous access to information, learning opportunities for health, as well as funding support."

B.1.2.4 Moving into the Future

"Health is created and lived by people within the settings of their everyday life; ... Health is created by caring for oneself and others, by being able to take decisions and have control over one's life circumstances, and by ensuring that the society one lives in creates conditions that allow the attainment of health by all its members."

B.1.2.5 Commitment to Health Promotion

"The participants in this Conference pledge:

- *to move into the arena of healthy public policy, and to advocate a clear political commitment to health and equity in all sectors;*
- *to counteract the pressures towards harmful products, resource depletion, unhealthy living conditions and environments ...; and to focus attention on public health issues such as pollution, occupational hazards, housing and settlements;*
- *"to acknowledge people as the main health resource; to support and enable them to keep themselves, their families and friends healthy ... and to accept the community as the essential voice in matters of its health, living conditions and well-being;"*
- *"to recognize health and its maintenance as a major social investment and challenge; and to address the overall ecological issue of our ways of living."*

B.1.3 Adelaide Recommendations on Healthy Public Policy

Second International Conference on Health Promotion, Adelaide, South Australia, 5-9 April 1988

Excerpts:

B.1.3.1 Healthy Public Policy

"Healthy public policy is characterized by an explicit concern for health and equity in all areas of policy and by an accountability for health impact. The main aim of health public policy is to create a supportive environment to enable people to lead healthy lives."

"Such a policy makes ... social and physical environments health-enhancing. In the pursuit of healthy public policy, government sectors concerned with agriculture, trade, education, industry, and communications need to take into account health as an essential factor when formulating policy."

"These sectors should be accountable for the health consequences of their policy decisions. They should pay as much attention to health as to economic considerations."

Whilst no figures appear available for BC, it is indicated from the results of studies abroad (Blettner et al. 2009, Schreier et al. 2006, Rööslä et al. 2004, Levallois et al. 2002, Miljöhälsorapport 2001), that it is likely that at least 2.5% of its citizens may be EHS. It also appears from the review undertaken for this present commentary that many other health ailments may be negatively impacted by increased exposures to manmade electromagnetic fields, and that increased exposures are likely to increase incidence of EHS.

Adopting the precautionary practices with regard to electromagnetic field exposures, as shown in countries such as Austria (Oberfeld 2003), may prove prudent.

B.1.3.2 The value of health

"Health is both a fundamental human right and a sound social investment. Governments need to invest resources in healthy public policy and health promotion in order to raise the health status of all their citizens. A basic principle of social justice is to ensure that people have access to the essentials for a healthy and satisfying life."

"... this raises overall societal productivity in both social and economic terms. Healthy public policy in the short term will lead to long-term economic benefits as shown by the case studies ..."

"New efforts must be made to link economic, social, and health policies into integrated action."

Adopting precautionary 'best practice' 'electromagnetic hygiene' measures in the design of FortisBC's AMI system, and addressing the other issues raised in this present document, may prove a sound social and financial investment.

B.1.3.3 Accountability for Health

"Public accountability for health is an essential nutrient for the growth of healthy public policy. Governments and all other controllers of resources are ultimately accountable to their people for the health consequences of their policies, or lack of policies."

"A commitment to healthy public policy means that governments must measure and report the health impact of their policies in language that all groups in society readily understand. ..."

B.1.3.4 Partners in the policy process

"Government plays an important role in health, but health is also influenced greatly by corporate and business interests, nongovernmental bodies and community organizations. Their potential for preserving and promoting people's health should be encouraged."

B.1.3.5 Future Challenges

"Health for All will be achieved only if the creation and preservation of healthy living and working conditions become a central concern in all public policy decisions."

"The most fundamental challenge for individual nations and international agencies in achieving healthy public policy is to encourage collaboration (or developing partnerships) in peace, human rights and social justice, ecology, and sustainable development around the globe."

Addressing the challenges that exist can make FortisBC a key player in "Health for All" for the citizens of British Columbia.

B.1.4 Jakarta Declaration on Leading Health Promotion into the 21st Century

This Declaration is also discussed elsewhere in the present document as related to the 'Precautionary Principle.'

"... The Fourth International Conference on Health Promotion is the first to ... involve the private sector in supporting health promotion. It has provided an opportunity to reflect on what has been learned about effective health promotion, to re-examine the determinants of health, and to identify the directions and strategies that must be adopted to address the challenges of promoting health in the 21st century. The participants in the Jakarta Conference hereby present this Declaration on action for health promotion into the next century."

B.1.4.1 Health promotion is a key investment

"Health is a basic human right and is essential for social and economic development. Increasingly, health promotion is being recognized as an essential element of health development. It is a process of enabling people to increase control over, and to improve, their health. ..."

B.1.4.2 Health promotion makes a difference

"Research and case studies from around the world provide convincing evidence that health promotion is effective. Health promotion strategies can develop and change lifestyles, and have an impact on the social, economic and environmental conditions that determine health. Health promotion is a practical approach to achieving greater equity in health. ..."

B.1.4.3 New responses are needed

"To address emerging threats to health, new forms of action are needed. ... There is a clear need to break through traditional boundaries within government sectors, between governmental and nongovernmental organizations, and between the public and private sectors."

"Cooperation is essential; this requires the creation of new partnerships for health, on an equal footing, between the different sectors at all levels of governance in societies."

B.1.5 Priorities for health promotion in the 21st Century

1. Promote social responsibility for health

"Decision-makers must be firmly committed to social responsibility. Both the public and private sectors should promote health by pursuing policies and practices that:

- *avoid harming the health of individuals*
- *protect the environment ...*
- *include equity-focused health impact assessments as an integral part of policy development."*

Under the Jakarta Declaration both the public and private sectors are expected to be committed to social responsibility. Unless the needs of those individuals classified as being EHS are addressed, along with others with health conditions that may be initiated and/or worsened by increased exposures to radiofrequency and microwave radiation, it may be claimed that this commitment is not being met in BC.

It would appear that ensuring that the specification of meters is fit for purpose in operational terms, as related to severe terrestrial and space weather, health and other human rights issues and cyber security, is also covered by this requirement for social responsibility.

2. Increase investments for health development

"In many countries, current investment in health is inadequate and often ineffective. Increasing investment for health development requires a truly multisectoral approach ... Greater investment for health and reorientation of existing investments ... has the potential to achieve significant advances in human development, health and quality of life."

"Investments for health should reflect the needs of particular groups such as women, children, older people, and indigenous, poor and marginalized populations."

It is proposed by the present author that BC's investments for health should also include the needs of those who may have have their health detrimentally affected by electromagnetic fields.

3. Consolidate and expand partnerships for health

"Health promotion requires partnerships for health and social development between the different sectors at all levels of governance and society. Existing partnerships need to be strengthened and the potential for new partnerships must be explored."

It is proposed by the present author that FortisBC might wish to become more involved in this initiative through delivering a service that enhances health?

"Partnerships offer mutual benefit for health through the sharing of expertise, skills and resources. Each partnership must be transparent and accountable and be based on agreed ethical principles, mutual understanding and respect. ..."

There are a number of experts who could be contacted to help bring such an initiative, as outlined above, into reality.

4. Increase community capacity and empower the individual

"Health promotion is carried out by and with people, not on or to people. It improves both the ability of individuals to take action, and the capacity of groups, organizations or communities to influence the determinants of health."

Allowing individuals the choice of accepting or refusing a smart meter can empower the health choices they may wish to take.

5. Secure an infrastructure for health promotion

"... All countries should develop the appropriate political, legal, educational, social and economic environments required to support health promotion."

Call for action

"...In order to speed progress towards global health promotion, the participants endorse the formation of a global health promotion alliance ... to advance the priorities for action in health promotion set out in this Declaration."

Priorities for the alliance include:

- *raising awareness of the changing determinants of health*
- *supporting the development of collaboration and networks for health development*
- *mobilizing resources for health promotion*
- *accumulating knowledge on best practice ...*
- *fostering transparency and public accountability in health promotion"*

"National governments are called on to take the initiative in fostering and sponsoring networks for health promotion both within and among their countries."

"The participants call on WHO to take the lead in building such a global health promotion alliance and enabling its Member States to implement the outcomes of the Conference. A key part of this role is for WHO to engage governments, nongovernmental organizations, development banks, organizations of the United Nations system, interregional bodies, bilateral agencies, the labour movement and cooperatives, as well as the private sector, in advancing the priorities for action in health promotion."

B.1.6 Mexico Ministerial Statement for the Promotion of Health: from Ideas to Action

Excerpts:

"Gathered in Mexico City on the occasion of the Fifth Global Conference on Health Promotion, the Ministers of Health who sign this Statement:

- *Recognize that the attainment of the highest possible standard of health is a positive asset for the enjoyment of life and necessary for social and economic development and equity. ...*

- Conclude that health promotion must be a fundamental component of public policies and programmes in all countries in the pursuit of equity and better health for all.
- Realize that there is ample evidence that good health promotion strategies of promoting health are effective."

"Considering the above, we subscribe to the following:

Actions

To position the promotion of health as a fundamental priority in local, regional, national and international policies and programmes."

"... To take the leading role in ensuring the active participation of all sectors and civil society, in the implementation of health promoting actions which strengthen and expand partnerships for health. ..."

"The support of research which advances knowledge on selected priorities. ... To establish or strengthen national and international networks which promote health."

"To advocate that UN agencies be accountable for the health impact of their development agenda. ..."

This Ministerial Statement was signed by the following countries:

Algeria, Angola, Argentina, Australia, Austria, Bangladesh, Belize, Bhutan, Bolivia, Brazil, Bulgaria, Cameroon, Canada, China, Colombia, Costa Rica, Cuba, Czech Republic, Denmark, Dominican Republic, Ecuador, El Salvador, Finland, France, Gabon, Germany, Guatemala, Hungary, India, Indonesia, Iran, Israel, Jamaica, Korea, Kuwait, Lao PDR, Lebanon, Madagascar, Malaysia, Maldives, Malta, Morocco, Myanmar, Nepal, Netherlands, New Zealand, Nicaragua, Niger, Pakistan, Panama, Paraguay, Poland, Portugal, Puerto Rico, Russian Federation, Saint Kitts and Nevis, Saint Lucia, Samoa, Slovakia, Slovenia, Spain, Swaziland, Sweden, Switzerland, Turkey, United Kingdom, United States, Uruguay, Vanuatu, Venezuela, Yugoslavia, Zambia."

Canada recognises that "health promotion must be a fundamental component of public policies and programmes ... in the pursuit of equity and better health for all."

This indicates that the needs of EHS individuals, and other members of the BC community whose health may be adversely affected by increased proliferation of manmade electromagnetic fields, need to be taken into account to a greater degree in policy decisions related to FortisBC's proposed AMI system programme. **Low field alternatives to the system that FortisBC currently propose are currently available and would be in keeping with this requirement for health promotion.**

B.1.7 The Bangkok Charter for Health Promotion in a Globalized World (WHO 2005).

Excerpts:

"The Bangkok Charter identifies actions, commitments and pledges required to address the determinants of health in a globalized world through health promotion. ... [It] affirms that policies and partnerships ... to improve health and health equality, should be at the centre of global and national development."

"The Bangkok Charter complements and builds upon the values, principles and action strategies of health promotion established by the 'Ottawa Charter for Health Promotion' and the recommendations of the subsequent global health promotion conferences which have been confirmed by Member States through the World Health Assembly."

"The Bangkok Charter reaches out to people, groups and organizations that are critical to the achievement of health, including:

- *governments and politicians at all levels*
- *civil society*
- *the private sector*
- *international organizations, and*

- the public health community.”

“The United Nations recognizes that the enjoyment of the highest attainable standard of health is one of the fundamental rights of every human being without discrimination.”

“Health promotion is based on this critical human right and offers a positive and inclusive concept of health as a determinant of the quality of life and encompassing mental and spiritual well-being.”

“Health promotion is the process of enabling people to increase control over their health and its determinants, and thereby improve their health. It is a core function of public health and contributes to the work of tackling communicable and noncommunicable diseases and other threats to health. ...”

It is already recognised by many that the roll out of smart meters in other areas has reduced the quality of life of many individuals. This is contrary to the basic human right outlined above. As noted in FortisBC’s response to Question 16, “Whatever its cause, EHS can be a disabling problem for the affected individual,” individuals should be able to increase control over their health and its determinants. One of these determinants appears to be the amount of electromagnetic exposure they receive.

B.1.7.1 Strategies for health promotion in a globalized world

Effective interventions

“Progress towards a healthier world requires strong political action, broad participation and sustained advocacy.

Health promotion has an established repertoire of proven effective strategies which need to be fully utilized.”

Required actions

“To make further advances in implementing these strategies, all sectors and settings must act to:

- *advocate for health based on human rights and solidarity*
- *invest in sustainable policies, actions and infrastructure to address the determinants of health*
- *build capacity for policy development, leadership, health promotion practice, knowledge transfer and research, and health literacy*
- *regulate and legislate to ensure a high level of protection from harm and enable equal opportunity for health and well-being for all people*
- *partner and build alliances with public, private, nongovernmental and international organizations and civil society to create sustainable actions.”*

Key commitments

1. **Make the promotion of health central to the global development agenda**

“Health promotion must become an integral part of domestic and foreign policy and international relations, ...

This requires actions to promote dialogue and cooperation among nation states, civil society, and the private sector. ...”

2. **Make the promotion of health a core responsibility for all of government**

“... health is a major determinant of socioeconomic and political development.

Local, regional and national governments must:

- **give priority to investments in health, within and outside the health sector**
- **provide sustainable financing for health promotion.”**

“To ensure this, all levels of government should make the health consequences of policies and legislation explicit, using tools such as equity-focused health impact assessment.”

3. **Make the promotion of health a key focus of communities and civil society**

“Communities and civil society often lead in initiating, shaping and undertaking health promotion. They need to have the rights, resources and opportunities to enable their contributions to be amplified and sustained. ...”

"Civil society needs to exercise its power in the marketplace by giving preference to the goods, services and shares of companies that exemplify corporate social responsibility."

"Health professional associations have a special contribution to make."

4. Make the promotion of health a requirement for good corporate practice

"The corporate sector has a direct impact on the health of people and on the determinants of health ..."

"The private sector, like other employers and the informal sector, has a responsibility to ensure health and safety ..."

"The private sector can also contribute to lessening wider global health impacts, ... by complying with local national and international regulations and agreements that promote and protect health. ..."

A global pledge to make it happen

All for health

"Meeting these commitments requires better application of proven strategies, as well as the use of new entry points and innovative responses."

"Partnerships, alliances, networks and collaborations provide exciting and rewarding ways of bringing people and organizations together around common goals and joint actions to improve the health of populations."

"Each sector – intergovernmental, government, civil society and private – has a unique role and responsibility."

