Considerations for Powerline Communicating Systems

prepared for

Regroupement des organismes environnementaux en énergie (ROEÉ)

regarding

Régie de l'énergie hearing R-3788-2012

Demande de modifications des tarifs et conditions de distribution d'électricité relative à une option d'installation d'un compteur n'émettant pas de radiofréquences

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1.0 Hydro-Quebec's "Opt Out" solution

As stated by Hydro-Quebec in its application for "Opt Out" smart meters: "*Toutefois, le Distributeur est sensible au fait qu'une faible minorité de ses clients peut craindre l'exposition aux radiofréquences*"[1].

Hydro-Quebec chose a non-communicating electronic meter[2] from three options[3] to address the fear, that some of its customers have about exposure to radio frequencies from the smart meters (although it is recognized that no particular reason needs to be provided for opting out).

As confirmed by Hydro-Quebec, for this option, there is no communications capacity either to the utility or to the Home Area Network (e.g. to the In-Home Display)[4].

This particular solution for "opt out" as chosen by Hydro-Quebec presents some issues.

1.1 Issues – General

Some of the general issues raised by the opt-out program proposed by Hydro-Quebec include the continuing need for access to indoor meters and having to maintain staff for meter reading (but spread out over a larger area, thereby increasing costs).

There will not be the benefits that smart meters have such as energy efficiency gains through the in-home display and home area network.

Homes will have to be constantly switched between the two types of meters depending on the preference to the resident at any particular time.

For customers, they will be requested to pay more, yet receive a lower level of service – not generally seen as a fair principle.

1.2 Issue – Multi-meter rooms

While the fears of a resident of a single family house with a smart meter on the side of their house may be addressed with the replacement of their own meter with a non-communicating electronic meter, the issue of a person living next to a

[1] Exhibit B-0006, Page 5 of 21, Lines 14 to 16
[2] Exhibit B-0029, IR #3.2.3 Response, Page 6 of 14
[3] Exhibit B-0029, IR #3.2.1 Response, Page 6 of 14
[4] Exhibit B-0029, IR #3.2.15 Response, Page 10 of 14

meter room full of meters was raised in the oral hearing of the Hydro-Quebec R-3770-2011 project[5].

It is noted by Hydro-Quebec that 562,500 meters are located in multi-meter rooms[6] (presumably in Phase 1; this needs to be confirmed).

In my view, there has been no satisfactory solution provided for these customers using Hydro-Quebec's proposed solution for the "Opt Out" meter.

If the single smart meter is replaced with a non-communicating electronic smart meter, there will still be many other wireless smart meters in the room. In fact, the smart meter of that customer may not even be the closest to the resident's living space.

It is also likely that a higher percentage of customers living next to such rooms may express fears of RF given the overwhelming impression of a room full of wireless smart meters.

If all the meters in a meter room are replaced with non-communicating electronic smart meters to address this customer, then all the customers in the building would need their meters manually read, and will lose the benefits of extra features (e.g. provided by the Home Area Network such as in-home displays). This could cause so much friction (between residents within such buildings that want the extra features of the smart meters and those that want the "opt out") that mass "Opt Out" meter replacement probably would not be an appropriate solution.

This then comes back to replacing just the customer's meter itself, and as mentioned previously, this does not address the customer issues (of their fear of RF), nor address the principles of the Hydro-Quebec "Opt Out" program (to address this fear).

So, the only conclusion is that a reasonable portion of Hydro-Quebec's customer base (those living next to meter rooms) would not be able to effectively participate in the "Opt Out" program – this seems a detriment to the program.

Assuming that Hydro-Quebec's estimates for the overall percentage of "opt out" customers are appropriate in the order of 1% - 2%, the chances that at least one customer of a multi-meter room will want an "opt out" rises substantially as the number of meters per room increase. Therefore, the number of customers not addressed in these types of buildings rise significantly higher than the 1% - 2%.

[5] Transcript March 20, 2012, page 66 to 70
[6] Exhibit B-0029, IR #3.2.3 Response, Page 7 of 14

1.4 Issue – Meters in kitchens

In addition, it is conceivable that a higher percentage of customers with multiple meters in their kitchen could be consider "Opt Out" meters, especially given the higher visibility of such meters. We know that approximately 57,500 meters are located in or near a kitchen[7], but do not know how many of those have multiple meters.

1.5 Issue – Rate structures

The meter readings for the "opt out" meters will have to be done manually. This presents the obvious extra administration challenges and costs for Hydro-Quebec.

But, potentially an even bigger issue is related to limitations of the type of rate structures that these "opt out" customers will be able to obtain in the future. This opens up a myriad of ramifications.

How will future rate structures be developed? If the rate structures require features in the smart meters, that will mean that two different rate structures will need to be developed – one for smart meters and another for the "opt out" customers.

Will it mean rate structures are limited to the "lowest common denominator" – the manually read meter? If so, does that not reduce one of the significant benefits of the smart meters?

Some customers may switch to "opt out" versus smart meters because of the rate structures. There will be an ongoing challenge in balancing the fairness of two rate structure designs in the future.

Future rate structure design may be hampered because of having to deal with the two types of meters and the potential for customers switching back and forth. There is a potential negative impact on the conservation levels that can be obtained through innovative rate structures if there are different meters.

It is understood that some of the features could be programmed into the "opt out" meters, but even with that ability, the features may be limiting, or may require field updates. This sets the stage for two quite different processes with far-reaching ramifications.

All of these issues would arise because there would be no communications from the meter back to the utility.

[7] Exhibit B-0029, IR #3.2.17.9 Response, Page 14 of 14

2.0 Fear of Radio Frequency

As stated in section 1, Hydro-Quebec's "Opt Out" application is to address the fear that some of its customers have concerning exposure to radio frequencies from the smart meters. To help understand this fear, another Canadian jurisdiction in which the introduction of Smart Meters is more advanced, is examined below and may be a reasonable indicator for the Quebec situation.

BC Hydro is well over halfway through its 1.8 million Smart Meter provincial-wide installation[8]. A wide range of concerns with Smart Meters have been expressed, including reactions from municipalities and the union representing the municipalities in the province, Union of BC Municipalities (UBCM).

The first municipality to formally express concern was the city of Colwood, through a request for a moratorium on smart meters. It then presented the following resolution to the UBCM[9], which was subsequently passed by the UBCM on September 30, 2011:

> *WHEREAS significant and serious health, privacy and other concerns have been identified regarding the installation of **wireless** smart meters in British Columbia; AND WHEREAS BC Hydro is proceeding with its program to install wireless smart meters in British Columbia although it recognizes there is active discussion and ongoing research into the possible health and environmental effects related to radio frequency signals and it is aware the World Health Organization has called for further investigation on this matter in its press release issued on May 31,2011:*
>
> *THEREFORE BE IT RESOLVED that a moratorium be placed on the mandatory installation of **wireless** smart meters until the major issues and problems identified regarding **wireless** smart meters are independently assessed and acceptable alternatives can be made available at no added cost to the consumer.*
>
> *(**emphasis added**)*

It is important to note the use of "**wireless**" each time smart meters is discussed. This is an indicator that it is the wireless communicating aspect of the smart meters that is of main concern.

[8] R-3770-2011, Exhibit C-ROEE-0043
[9] UBCM Resolution B174, September 30, 2011
http://www.ubcm.ca/assets/Library/Convention/Convention~2011/2011%20UBCM%20Minutes.pdf

Dozens of other municipalities throughout the province continued with their own resolutions.

On May 2, 2012, Adriane Carr, a Vancouver councilor, introduced a motion on Smart Meters which provided further details[10]. The motion stated in part:

> *. . .*
>
> *7. Smart meters and smart grids can be installed using non-wireless technology, including phone lines, fiber optics, or the **Echelon power line** technology as used in many European countries.*
>
> *THEREFORE BE IT RESOLVED*
>
> *A. THAT the City of Vancouver request that BC Hydro offer opt out options to Vancouver residents, whether or not a smart meter has already been installed in their home, at no extra costs to the consumers, which options would include analogue meter or smart meter and smart grid technologies which do not emit radio frequency emissions such as used in **Italy and other European countries**.*
>
> *(**emphasis added**)*
>
> *. . .*

It is observed that the Vancouver motion specifically recognizes power line technology, called “Echelon”, as well as recognition of its use in Italy and other European countries[11].

There are electric utilities, such as Idaho Power, that specifically are targeting their powerline solutions to overcome issues with wireless[12]:

> *“11. Are smart meters safe?*
>
> *Yes, The smart meter technology we are deploying at Idaho Power utilizes the low frequency 60 hertz (hz) power line signal as the carrier for our communications. The system we are deploying uses only wired infrastructure to communicate to and from our smart meters.*

[10] Vancouver City Council, May 2, 2012;
http://vancouver.ca/ctyclerk/cclerk/20120502/documents/ptec20120502min.pdf
[11] Echelon Announces New, Long-Term Relationship with Enel S.p.A., Oct 25, 2006;
http://www.echelon.com/company/news-room/2006/pressPDFs/ltr_enel.pdf
[12] Idaho Power, Meter Exchange Frequently Asked Questions, Item #11;
http://www.idahopower.com/ServiceBilling/Residential/Billing/AMRfaqs.cfm

We are aware some smart meter deployments in other states have raised questions about potential hazards related to wireless transmissions from AMI meters. The technology we are deploying in Idaho is fundamentally different from the technologies in question. The smart meters being deployed in Idaho Power's service territory do not transmit wirelessly; they use the 60 Hz power line to communicate."

Another example is Washington Electric Cooperative (WEC) which use:

"meters that use the electrical wires to send data instead of radio frequency transmissions, which are still the source of controversy among some members of the public because of concerns over perceived health risks."[13]

These are all clear indications that the fear of a reasonable segment of the population is related to the use of smart meters which use radio frequency (or wireless), but that fear does not extend to other communicating techniques such as powerline – in some areas, the use of powerline is promoted.

3.0 Powerline communications

Over the last several decades there has been a wide range of systems which use the powerline itself as a communications method. For example, historically power utilities have used the powerline communication (PLC) for telemetry purposes[14]. Some utilities today still believe PLC systems are slow because of another "historical" system, called "Turtle"[15].

Today, PLC systems are "*the number one technology for smart metering in Europe*"[16] with a range of modern technologies. Echelon claims 81% share of installed base of smart meters in Europe in 2010[17] and that *" . . .the latest generation of Power Line technology which is vastly superior to early-technology PLC . . ."*[18]

[13] http://www.smartmeters.com/the-news/3283-vermont-to-get-more-smart-meters.html
[14] Landis & Gyr, "Introducing the power of PLC", page 3; http://www.nrs.eskom.co.za/nrs/Specifications/The%20Power%20of%20PLC%20-%20LandisGyr%20White%20Paper.pdf
[15] Echelon Smart Meter Model Status Quo in Europe, Exception in U.S., Feb 3, 2011; http://www.pikeresearch.com/blog/articles/echelon-smart-meter-model-status-quo-in-europe-exception-in-u-s
[16] Ibid., page 4
[17] Market Share Leadership, Energy & Power Systems Industry – Europe, 2011, page 3; http://www.zirode.com/Downloads/Frost-Sullivan_Market_Share_Leadership_Award2011.pdf
[18] Ibid., page 5

So, the obvious question - would a powerline communicating meter be an appropriate solution to resolve some of the issues raised in the sections above?

3.1 Meters per transformer

An interesting question is asked: "*why have the U.S. and Europe taken such divergent paths . . .?*"[19] A significant part of the answer (why Europe has focused more on power line communications than the US):

> *"Each transformer in Europe serves 50 to 60 customers. In the U.S., the numbers are more like three or four customers. The Echelon technology, deployed at the transformer, is more cost effective there because if can gather more data at each site than it can in the U.S."*

However, if we look at the urban areas of Quebec, such as Montreal, we see an interesting trend in the number of clients per transformer which resembles Europe.

Overall Quebec[20]

Number of clients per transformer	Number of transformers	Percentage (calculated)
Less than 10	362,579	79.7%
From 11 to 50	89,078	19.6%
Between 51 and 100	3,045	0.7%
More than 100	332	0.07%
TOTAL	**454,734**	**100%**

Montreal[21]

Number of clients per transformer	Number of transformers	Percentage (calculated)
Less than 10	6,081	23.0%
From 11 to 50	17,905	67.6%
Between 51 and 100	2,223	8.4%
More than 100	270	1%
TOTAL	**26,479**	**100%**

[19] Echelon Smart Meter Model Status Quo in Europe, Exception in U.S., Feb 3, 2011; http://www.pikeresearch.com/blog/articles/echelon-smart-meter-model-status-quo-in-europe-exception-in-u-s

[20] Exhibit B-0029, IR #3.2.17.6 Response, Page 12 of 14
[21] Exhibit B-0029, IR #3.2.17.7 Response, Page 12 of 14

While almost 80% of transformers in Quebec have less than 10 clients per transformer, there are only 23% of these in Montreal. Over two thirds (67.6%) of the transformers in Montreal have from 11 to 50 clients per transformer compared to less than 20% throughout Quebec.

The percentage is more than 10 times as high in Montreal for transformers with more than 50 customers (9.4% versus 0.77%).

Almost all the transformers with more than 100 customers are in Montreal (270 out of 332), in spite of the fact that Montreal has only 6% of the transformers[22].

Looking at just the area of Montreal, its characteristics seem to resemble those of Europe and the advantages of powerline systems such as Echelon's may then be more cost effective.

3.2 Hydro-Quebec comments

Back to the question - would a powerline communicating meter be an appropriate solution for the "opt out" program of Hydro-Quebec?

This Information Request was asked by ROEE:

> *"Veuillez indiquer si Hydro-Québec a considéré une option de retrait telle que celle décrite à la page 46 de la pièce C-ROEÉ-0082 du dossier R- 3770-2011 (compteur communiquant par lignes de tension). Si non, veuillez expliquer pourquoi Hydro-Québec ne l'a pas fait."*[23]

The response of Hydro-Quebec:

> *"Les compteurs communiquant par courant porteur ne sont pas la solution technologique retenue et proposée par le Distributeur pour l'option de retrait.* Les contraintes et limitations techniques, de même que *la nécessité de mettre en place une infrastructure technologique spécifique pour un petit nombre de clients dont la répartition géographique variera au fil du temps ont poussé le Distributeur à rejeter cette option."*

Complément de réponse :

> *La solution des compteurs communiquant par courant porteur n'a pas été retenue, notamment, à cause des limites et contraintes techniques suivantes :*

[22] 26,479 transformers in Montreal / 454,734 transformers in Quebec = 6%
[23] Exhibit B-0040, IR #3.2.17, Page 5 of 7

-une bande passante très étroite limitant la performance exigée du Distributeur pour relever les compteurs ou pour effectuer des opérations de base telles que la relève ad hoc, le débranchement / rebranchement à distance ou la notification de panne ;
- un délai de communication très lent (temps de latence élevé) ;
- l'impossibilité d'appliquer la sécurité avancée exigée par le Distributeur ;
- le potentiel d'interférences avec des appareils électriques ou électroniques des clients.

Le Distributeur réitère que l'installation de compteurs communiquant par courant porteur chez les clients adhérant à l'option de retrait requerrait la mise en place d'une seconde infrastructure technologique à l'échelle de la province afin de répondre aux demandes provenant de toutes les régions."[24]

If the "opt out" solution consisted of installing powerline communicating meters targeted to all installations with large number of clients per transformer, such as Montreal or for multi-meter rooms, then the powerline smart meter costs may come in line with those of Hydro-Quebec's standard wireless smart meter.

As discussed above in Section 3.0, the bandwidth of some PLC systems are indeed small (such as the Turtle), but modern systems have higher performance. I suggest that it may be premature to suggest high latency times without a full understanding or description of the entire communication system.

Although some PLC systems may be lacking in security, it is suggested that the security levels on the Echelon data Concentrator be considered:

"CHAP, MS-CHAP, PAP and 160-bit application-level authentication for WAN; 96-bit authentication on the power line network; 128-bit RC4 encryption for WAN and power line communication; Password protection for optical communication"[25]

Similarly, although Hydro-Quebec's concerns for interference with electrical appliances or customers may exist for certain powerline systems (especially given that there is such a broad range of powerline systems), it is suggested that such a broad statement would not be applicable to all powerline systems. Such concerns should take into account the specifics of the particular powerline system being considered.

While a second technology infrastructure would need to be taken into account, dependent on the specific technology selection, it could be compatible at certain levels. For example, a supplier like Landis & Gyr could supply a hybrid solution with both the Gridstream PLC and Gridstream RF solutions, as described by

[24] Exhibit B-0040, IR #3.2.17 Response, Page 5 to 6 of 7
[25] DC-1000/SL Data Concentrator; Page 2, Data Security;
http://www.ubitronix.com/fileadmin/documents/datasheets/echelon/DC1000-SL.pdf

Poudre Valley Rural Electric Association[26]. Such a system could even be more efficient than the challenges of dealing with a partial manual and partial automated reading system, as highlighted in the above Section 1.5.

3.3 Interior meters

It has been noted by Landis & Gyr:

> *"Unlike other continents, in Europe most buildings are solid concrete constructions with meters typically installed in basements. This makes the installation of low power RF devices a great challenge: Antennas must be placed outside of buildings. This leads to high installation costs. Furthermore, the RF communication ranges are greatly limited by solid building construction and permitted low power transmission levels.*
>
> *These factors have prevented the widespread use of RF mesh technology in Europe to date. We believe that, going forward, RF mesh technology will not overcome small pilot / island installation."*[27]

It is noted that 70% of meters in Montreal (638,624 meters)[28] are located inside, while 35% of meters (1,339,794 meters)[29] throughout Quebec are located inside. So again, Montreal could be seen as being similar to Europe, and therefore having potentially favorable characteristics for powerline communications.

3.4 Other installations

While most North American smart meter system use wireless communications, a few powerline systems have already been mentioned in this report. Other North American powerline projects include Duke Energy[30] and FortisAlberta[31].

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[26] Leading the way in building a "smart grid", Poudre Valley Rural Electric Association, Page 1; http://www.pvrea.com/members/newsletters/2009/CCL%20Aug%2009.pdf
[27] Landis & Gyr, "Introducing the power of PLC", page 9; http://www.nrs.eskom.co.za/nrs/Specifications/The%20Power%20of%20PLC%20-%20LandisGyr%20White%20Paper.pdf
[28] R-3770-2011, Exhibit B-0157, Slide 21; 29% + 41% = 70%; 259,888 + 378,736 = 638,624
[29] R-3770-2011, Exhibit B-0157, Slide 21; 16% + 19% = 35%; 628,842 + 710,952 = 1,339,794
[30] Duke Energy Takes Steps to Further Advance Its Smart Grid Communications Architecture; http://www.duke-energy.com/news/releases/2010090201.asp
[31] FortisAlberta Receives Award for Customer Engagement at Metering America; http://www.landisgyr.com/en/pub/media/press_releases.cfm?news_ID=7712

3.5 Pacific Gas and Electric "Opt Out"

While considering the various alternatives to consider when evaluating potential "Opt Out" programs for Pacific Gas and Electric, the following alternative was considered:

> *"Wired smart meter – Under this option, interval energy consumption data would be transmitted to the utility through a traditional telephone line, fiber optic, a **power line carrier** or other wired technologies. Since this option would allow the meter to communicate with the utility, the meters would not need to be read manually every month."*[32]

(***emphasis added***)

4.0 Costs

It is recognized that pricing of the smart meters, whether they be wireless or powerline, will need to be finalized through procurement processes, so such details are difficult to discuss. In addition, consideration of overall system and infrastructure requirements vary from system to system, and are challenging to compare. The costs will also vary dependent on the specific configurations (e.g. number of meters per concentrator or router).

On the other hand, there are public documents, although somewhat dated, that do provide some guidance on comparison pricing for powerline and wireless smart meters.

The "Benefit-Cost Analysis for Advanced Metering and Time-Based Pricing"[33] document prepared for the Vermont Department of Public Service.

For the Washington Electric Cooperative:

> *"the large number of concentrators (36) and repeaters (almost 1,000) needed to cover the sparsely populated service territory for WEC drove the mesh network costs about the PLC costs, which required only 8 of the more expensive PLC concentrators."*[34]

For Green Mountain Power:

> *"As with CVPS, the difference in the two technologies is not large. For the mesh system, the cost of the initial AMI investment equals $11.1 million, or about $118 per meter."*[35]

[32] R-3770-2011, Exhibit C-ROEE-0137, Page 8
[33] "Benefit-Cost" Analysis for Advanced Metering and Time-Base Pricing, Final Report, March 26, 2008
[34] Ibid., Page 78
[35] Ibid., Page 69

For Central Vermont Public Service:

"The difference between the two estimates is not large and is probably within the error bound of the estimates, given the uncertainty in the required number of concentrators, repeaters and other system components. A detailed propagation study and firm cost estimates from vendors could easily produce a result indicating that PLC or some combination of mesh, star and PLC networks would be the optimal configuration."

Idaho Power estimates installed a new smart meter to be approximately $130 per meter[36].

5.0 Recommendations

Hydro-Quebec's "Opt Out" program as presently described raises a number of unresolved issues that could be resolved with powerline communicating systems.

There are examples of powerline communicating systems not only in Europe but also in North America, in addition to "hybrid" (PL and RF) from the same manufacturer as proposed by Hydro-Quebec.

It is my opinion and recommendation to the Régie that:

1) ***There is enough relevant information and material in this document to justify the consideration of powerline communicating smart meters for Hydro-Quebec's Smart Meter "Opt Out" program, and that it would be in the best interests of its customers to consider such technologies.***

2) ***Hydro-Quebec should develop a Requirements Document for its program to be clearly articulated in such a manner as to allow for full evaluation of the technical, cost and rate implications of such technology for their "Opt Out" program. Notably, this would include addressing specific topic areas as multi-meter rooms, meters in kitchens, urbanized areas, interior areas, rate structures, and HANs.***

3) ***Hydro-Quebec should fully evaluate the latest powerline technologies both in Europe and North America.***

4) ***Hydro-Quebec should then be required, using its Requirements Document and its powerline technology evaluation, to perform a full analysis of the potential of using powerline communicating smart meters for its "Opt Out" program.***

[36] Idaho Power, Meter Exchange Frequently Asked Questions, Item #9; http://www.idahopower.com/ServiceBilling/Residential/Billing/AMRfaqs.cfm

5) ***The "Opt Out " program and application as proposed by Hydro-Quebec fails to account for a number of important considerations that may mean that it is sub-optimal, notably in terms of its costs, implications for rates and rate structures, impacts on the ability of the utility to deliver innovative rate options to all of its customers, and adverse effects on fairness, costs of service, reduction of energy consumption, energy efficiency and overall environmental impact of electrical energy services for Quebec.***

6) For all of these reasons, it is my opinion that the Régie should not accept Hydro-Quebec's application as filed and should rather require that it be reconsidered after the completion of the necessary studies and evidence as set out above.