Improvements to the Smart Meter Program of Hydro-Québec

prepared for

Regroupement des organismes environnementaux en énergie (ROEÉ)

regarding

Régie de l'énergie hearing R-3770-2011

Projet Lecture à Distance of Hydro-Québec (Phase 1)

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Table of Contents

Executive Summary

This document contains the evidential material of Mr. Ludo Bertsch for the first phase of the Smart Meter project application of Hydro-Québec in the regulatory process of the Régie de l'énergie. The primary intention is to better inform the Régie on how to address the complex and rapidly changing technical issues.

Hydro-Québec plans to replace 3.75 million electrical meters in three phases. The first phase (corresponding to the application in question) is to replace the meters of 1.7 million customers with smart meters to automate the meter reading process, and to use remotely control the cut-off and restoration services.

Background material is provided on Smart Meters and the Smart Grid, including a discussion of the challenges of the many competing interests associated with introducing such a revolutionary technology.

A comparative study of overall costs and features to the BC Hydro SMI project is presented. BC Hydro is another utility in Canada presently upgrading all of its 1.8 million customers with Smart Meters throughout the province of BC.

I will show that the approach of Hydro-Québec to focus its first phase only on the immediate needs and with limited functionality, without regard to future features, should be re-visited. An early integrated architectural system design stage can help alleviate problems later on, and it is recommended that Hydro-Québec implement such a stage, no matter what features are planned to be incorporated into its first phase.

I will show how other jurisdictions such as BC Hydro are moving forward with their Smart Meter programs with a full slate of Smart Grid features designed from the beginning and having fully allocated the benefits accordingly.

The following Smart Grid features will be discussed:

- Conservation tools (e.g. in-home displays)
- Theft of electricity
- Tamper detection
- Time-of-use and other rate structures
- Opt-out
- Net metering

I will show how neglecting to consider each feature above in the initial system design stage could cause issues later on, including increased costs – again supporting the concept of an early system design stage considering all future features.

1. Regulatory Context

On June 30, 2011, Hydro-Québec submitted an application for a "*Projet Lecture à Distance – Phase 1*"[1] to the Régie de l'énergie. The project description is: "*a remote reading project (the LAD project) aims to replace 3.75 million meters with new generation meters and implement information technology (IT) to create an Advanced Measurement Infrastructure (AMI).*"[2]

The role of the Régie is defined in the "*Act Respecting the Régie de l'énergie*"[3]. The Hydro-Québec "LAD project" was initiated within the framework of Section 73 of the Act and under the "*Regulation respecting the conditions and cases where authorization is required from the Régie de l'énergie*"[4].

In response to Hydro-Québec's application, the Régie issued Decision D-2011-124[5] on August 18, 2011, which among other things, clarified the framework for stakeholders in their analysis of the project. More specifically the Régie included a list of relevant questions:

- "*Quels sont les objectifs visés par le Projet?*
- *Ces objectifs sont-ils utiles ou nécessaires à la prestation du service de distribution d'électricité?*
- *Le Projet est-il justifié en relation avec les objectifs visés?*
- *Les coûts associés au Projet sont-ils justifiés et raisonnables?*
- *Les études de faisabilité et les analyses de sensibilité sont-elles satisfaisantes?*
- *Quel est l'impact des coûts du Projet sur les tarifs de distribution d'électricité?*
- *Quel est l'impact du Projet sur la qualité de prestation du service de distribution d'électricité?*
- *Est-ce que d'autres solutions ont été envisagées par le Distributeur pour atteindre les objectifs qu'il vise?* "[6]

[1] B-0001 to B-0006, July 11, 2011
[2] C-GRAME-0025, Section 1.1, Page 7 of 58
[3] An Act Respecting the Régie de l'énergie; http://www.regie-energie.qc.ca/regie/Loi/Loi_RegieEnergie_ENG.pdf
[4] Regulation respecting the conditions and cases where authorization is required from the Régie de l'énergie; *http://www2.publicationsduquebec.gouv.qc.ca/dynamicSearch/telecharge.php?type=3&file=/R_6_01/R6_01R2_A.HTM*
[5] A-0003
[6] A-0003, Item 29, Page 9

In its application, Hydro-Québec defined the objectives (goals) of the LAD project:

"There are three levels of LAD project goals:

- *Durability of the embedded meter*
- *Improving efficiency through automated reading of consumption and remote cut-off and restoration of service*
- *Possibility of technological development that will allow us to offer new services to clients in the future, and implementing grid management measures* "[7]

2. Expert Mandate and Direction

I (Mr. Ludo Bertsch, P.Eng) am the founder and president of Horizon Technologies, a BC company specializing in automation, data communications, system integration, control technologies and energy/environmental sustainability. I have experience as a lead Intervener in BCUC regulatory hearings of BC Hydro, FortisBC and BC Transmission Corporation. I have also designed hardware and firmware, and developed system integration for a range of data communications, home automation and networking products.

I am chair of the Canadian Advisory Committee for ISO/IEC Joint Technical Committee 1 SC25 (Interconnection of Information Technologies) committee and a working expert in the Home Electronic systems working group. I am an actively participating member of the Standards Council of Canada, Canadian National Committee of the IEC Task Force on Smart Grid Technology and Standards. In that task force I am a key contributor to the working group focused on developing the direction for Canada's Smart Grid as it relates to Smart Meters and inside the home aspects. I also represent Continental Automated Buildings Association (CABA) in Smart Grid Canada, an organization to promote a more modern and efficient electricity grid.

On October 14, 2011, the Regroupement des Organismes Environnementaux en Énergie (ROEÉ)[8], an Intervener in the LAD project application[9], applied to the Régie for me to be recognized as an expert witness[10].

In response, the Régie granted expert status for me in the area of "*hardware and firmware design development in data communications, networking, home*

[7] C-GRAME-0025, Section 1.1, Page 7 of 58, Lines 12 to 18
[8] C-ROEÉ-0002
[9] A-0003, Item 50, Page 15
[10] C- ROEÉ-0012

automation and system integration"[11]. In granting this status, the Régie reiterated in respect to my mandate:

> *"[47] La Régie croit plus pertinent d'obtenir l'opinion de l'expert ... sur les choix du Distributeur en regard des objectifs qu'il poursuit et surtout, sur la question de savoir si les coûts du Projet sont raisonnables. Pour savoir si les coûts du Projet sont raisonnables, il peut être utile de les comparer avec ce qui se fait ailleurs.*
>
> *. . .*
>
> *[77] À cet égard, l'apport utile de l'expert tient à son expérience sur ce qui s'est fait (et se fait) ailleurs au Canada et en Amérique du Nord. Ainsi, son opinion sur les sujets de la justification du Projet en regard de ses objectifs, la pertinence de ces objectifs par rapport à ce qui se fait ailleurs, les choix technologiques du Distributeur, les coûts du Projet par rapport à l'expérience qu'il a vécue ailleurs et les risques de ce type de projet sera susceptible d'éclairer la Régie.*"[12]

In order to help provide a common basis of understanding, I will provide background material on Smart Meters and the Smart Grid, including the challenges of implementing such a technology.

In support of the guidelines above, I will identify and justify an appropriate jurisdiction elsewhere in North American, particularly in Canada. I will then use this jurisdiction for comparative purposes to the Quebec proposal. This approach will allow me to describe features and costs of Smart Metering systems without access to the confidential tender documents. The resultant document that I have produced herein will provide a platform for the Régie, which together with their access to the confidential information, will generate the ability to make appropriate determinations and to direct Hydro-Québec accordingly.

I submit that I will be providing enough new background information in this submission, to justify that further questions to be asked of Hydro-Québec, and for suggested directions provided to them. However, my involvement can only go so far into the design stages. I recognize Hydro-Québec will need to do the fully developed system design themselves, to develop a well-rounded complete solution and take all considerations into account. In addition, Hydro-Québec has full access to the confidential tender documents and related discussions with suppliers that will also be needed for the final solution.

[11] A-0020 (D-2011-168)
[12] A-0020, Item 52, Page 14

3. History and Overview of AMI and Smart Grid Technology

The technology behind electrical meters has remained essentially the same for over 100 years, using magnetic forces to drive a rotating disc. In order to bill the customer, each individual meter had to be visited by a meter reader, usually monthly or bimonthly. As the electromechanical devices age, they may slow down and they are susceptible to a wide range of tampering techniques reducing the revenue for the utility, ultimately costing all customers.

The role of electronics in meters increased as there was increased demand for new features, such as replacing the rotating dials, hourly readings, tamper detection, etc. Advancements in meters were seen as ways to address environmental concerns and became a significant driver for more energy efficiency and conservation improvements. Utilities around North America initiated installations and pilots of advanced meters throughout the 2000's. The advanced/Smart Meter industry got its biggest endorsement and influx of investments, when President Obama announced $4.5 billion of investments matched with $5.5 billion in public and private stakeholders in Smart Grid projects around the US through the *Recovery Act*[13].

3.1. Smart Grid

There are many definitions of the Smart Grid, but generally "*it enables integration, effective cooperation, and two-way communication among the many interconnected elements of the electric power grid.*"[14]

As seen in the diagram below, the Smart Grid involves many areas of the electrical grid – including generation, transmission, and distribution. Portions of the Smart Grid can even reside right in the home. Overall, the Smart Grid, if done properly, can provide for a more efficient, reliable and cost-effective electrical infrastructure.

[13] The White House, A Policy Framework for the 21st Century Grid: Enabling Our Secure Energy Future, Chapter 2, Page 9; http://www.whitehouse.gov/sites/default/files/microsites/ostp/nstc-smart-grid-june2011.pdf

[14] NIST, Smart Grid, website; http://www.nist.gov/smartgrid/nistandsmartgrid.cfm

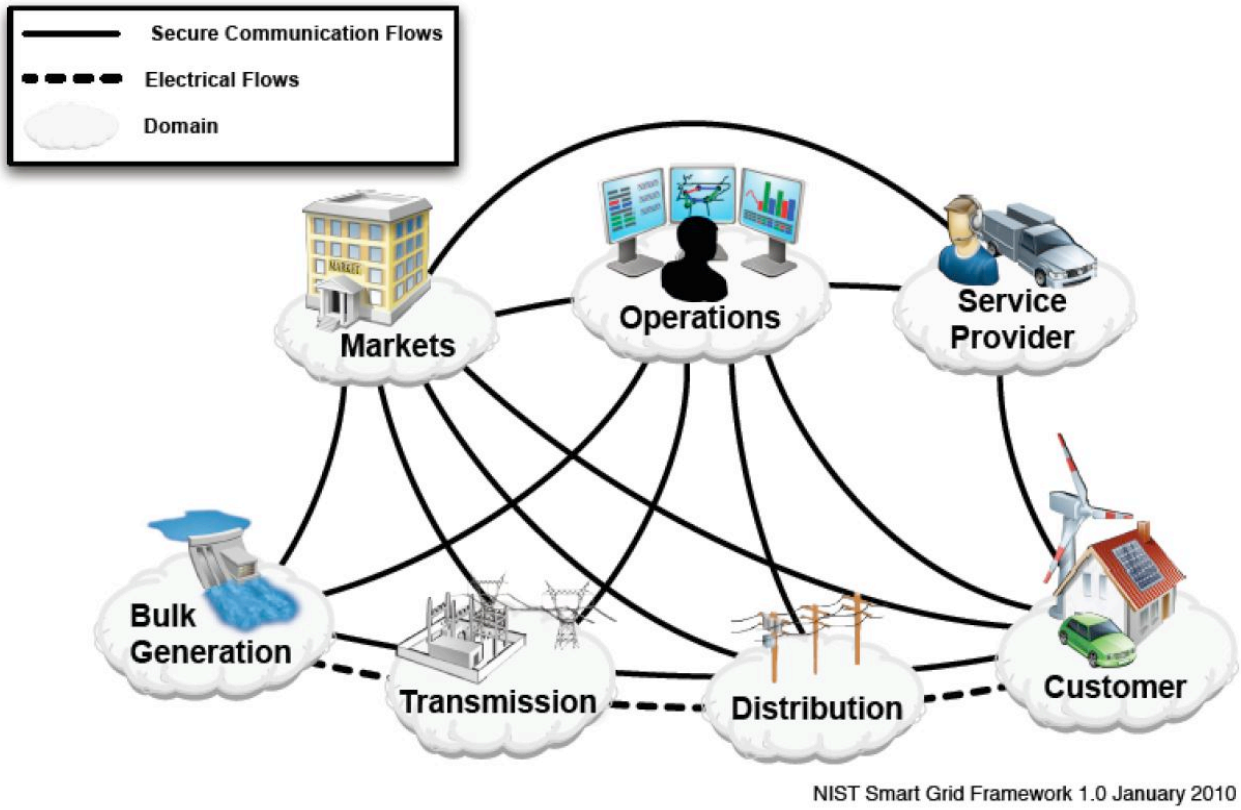

Figure 3-1 Interaction of actors in different Smart Grid Domains through Secure Communication Flows and Electrical Flows.

Figure 1 - Smart Grid Framework *[NIST Smart Grid Framework]*

A part of the Smart Grid involves replacing manually-read electrical meters with communicating electrical meters that send their data to the utility through some form of communications. For example, Hydro-Québec's AMI project[15] describes a system where the meters send their data signals wirelessly to local routers on power poles. The routers then relay the information to centrally located collectors, which send the data via cellular or satellite communications onwards to the utility.

[15] C-GRAME-0025, Section 3.1, Figure 5, Page 19 of 58

Figure 5: Advanced Measurement Infrastructure (AMI)

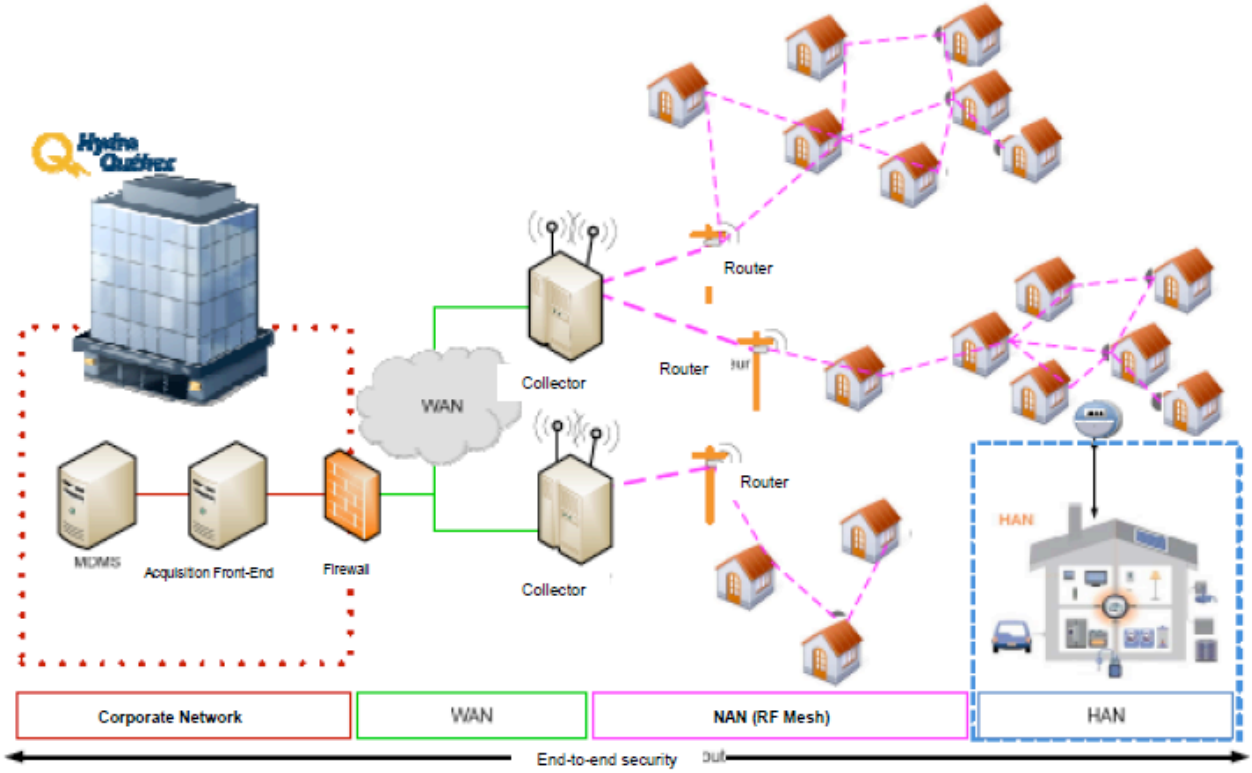

Figure 2 - Hydro Quebec AMI *[C-GRAME-0025, Page 19 of 58]*

Because the meter reading data is sent through electronic communication, the meter read timing can be more consistent. It can be timed to occur precisely when people move in or out and more consistently throughout the month, removing the need for estimated bills.

With the elimination of meter readers, the associated travel requirements are essentially eliminated which help address environmental concerns with greenhouse gas emissions.

To help service more customers with the same infrastructure, higher rates for peak time usage can reduce peak demand through advanced metering based on time-of-day.

Using sophisticated monitoring techniques to reduce the theft of electricity can help reduce the costs for everyone.

Intermittent “green” power sources such as wind and solar in large quantities using net metering or “feed-in tariffs” can cause stability issues for the grid – a Smart Grid helps stabilize the grid so higher levels of renewables can be accommodated.

A Smart Grid is also used to improve the efficiency of the electrical distribution system by using devices at strategic places in the system to optimize its voltage levels which result in lower operating costs.

3.2. In Home Display – Home Area Network

Residents typically reduce their energy usage when they can see their energy consumption soon after usage, instead of weeks later on their bills. This "near" real-time energy information appears on a range of display units inside the home, often called In-Home Displays. Simple versions show consumption levels by colored lights – e.g. green for low consumption, red for consumption above a certain threshold. Other units are small LCD displays that show consumption levels or prices, but may have limited use after the initial exposure - one example shown by BC Hydro below[16].

Optional in-home feedback tools will provide customers with more choices and control.

Figure 3 - In Home Display [BC Hydro SMI Business Case, Page 7]

More sophisticated dedicated units are more expensive but show graphs and some have touch screens.

The information for the display units either comes directly from the Smart Meter (with minimal delay) or through the utility on a personalized web page (typically with longer delays of up to 24 hours).

The Home Area Network (HAN) is a communications system in the home to support information transfer among devices. One use of the HAN is to support the metering information to be transferred from the Smart Meter to the In-Home Display. This communication is separate from the meter to the utility

[16] BC Hydro, Smart Metering & Infrastructure Program Business Case, January 18, 2011, Page 7; http://www.bchydro.com/etc/medialib/internet/documents/smi/smi_business_case.Par.0001.File.smi_business_case.pdf

communications and there are typically gateways between the two systems to provide isolation.

Other purposes of the HAN are to support smart appliances such as thermostats, lights or even major appliances (e.g. Smart Home or home automation). With permission from the resident and through special programs with the utility, there are also "demand response" programs in which appliances are directly or indirectly controlled by the utility in order to assist them in managing their overall system (e.g. reducing peak demand) often in return for financial incentives.

The latest trend is to not only have software applications on smart phones, tablets and computers to view energy consumption, but also to control smart appliances both from inside and outside the premises; see concept diagram below from BC Hydro's web page[17].

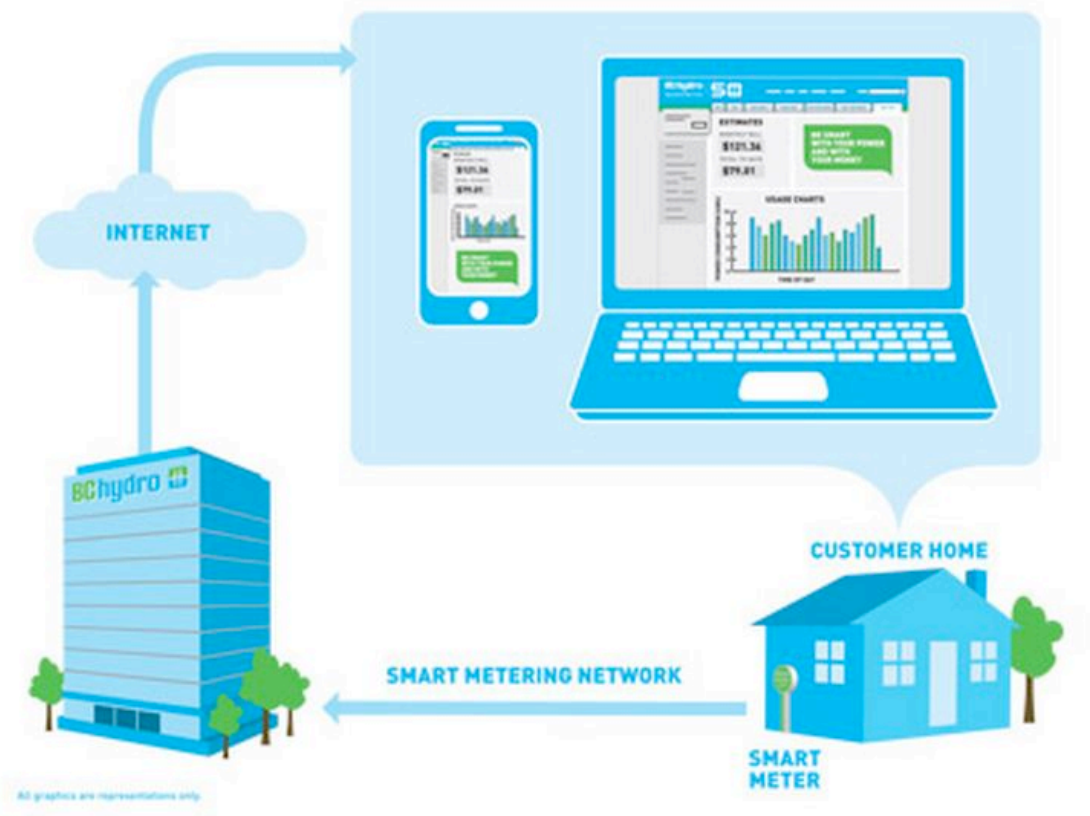

Figure 4 - Smart Phone/Computer Display [BC Hydro SMI web page]

[17] BC Hydro, SMI web page; http://www.bchydro.com/energy_in_bc/projects/smart_metering_infrastructure_program/smart_meter_and_grid_technology/future_with_smart_meters.html

3.3. Overview of Smart Meter Hardware and Software

The main portions of a typical Smart Meter include:

- Radio transceiver to communicate to utility (outside premise)
- Radio transceiver to communicate to HAN (inside premise)
- Power measurement and other sensing measurements (if supported)
- Memory to store data until transmitted
- Microcontroller to run product
- Local LCD Display for manual meter reading
- Power Supply
- Connect/Disconnect circuitry (if supported)
- Firmware (software that runs the hardware)

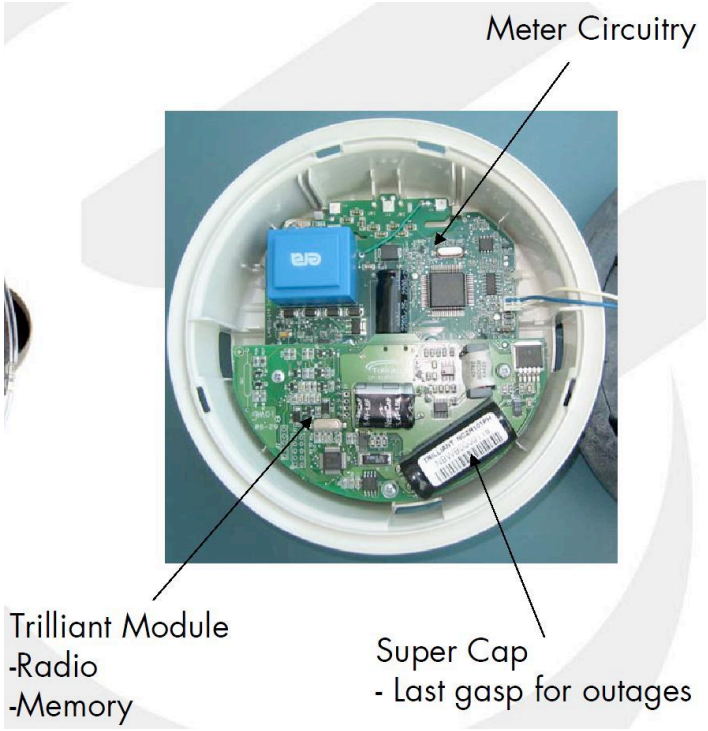

Figure 5 – Main Portions of a Smart Meter[18]

To select the most appropriate Smart Meter for a utility's wide scale implementation program, not only should the mix of firmware and hardware

[18] Hydro One Networks, Connectivity: the Key to the Smart Network, Presentation to the IESO Smart Grid Forum, Aug 19, 2008, Page 19; http://www.ieso.ca/imoweb/pubs/smart_grid/HydroOne-Connectivity.pdf

features and options be chosen for its primary purpose, but I suggest also consideration should be given for its use in future Smart Grid applications.

While some of the features may be downloaded in future as needed, other features will need supporting hardware in the meters, or otherwise would risk expensive upgrades in the field. Even if the firmware is downloaded, there may be issues (such as not having enough memory) in handling the new features.

Some Smart Meter systems have included the ability to provide information to the utilities on the location of meters that have lost power. If the Smart Meter system is designed with this capability, Smart Meters typically have a "last gasp" ability to send out a final message[19], even after the grid power has failed. This is accomplished with special hardware, a built-in capacitor in the Smart Meter. Therefore, the consideration of this feature would need to be decided on before the meters are deployed, or risk large investments afterward.

And this is only one of many examples, where the hardware consideration is related to the overall Smart Meter system design and feature set.

4. Challenges in the North American Context

As Smart Metering programs proliferate throughout North America replacing century-old technology at a revolutionary pace, there are numerous challenges to overcome.

4.1. Balance of Interests at Stake

One challenge for regulators dealing with Smart Meter applications is the need to balance the interests of Interveners, utilities and users, all with opposing positions and views. In addition, there is a wide range of understanding among the participants in Smart Meters, Smart Grid and Home Area Networks programs.

Because of the complexity and rapidly changing technology of Smart Meters and the Smart Grid, it is my experience that utilities are tending to rely too much on suppliers for determining their needs. This contrasts with the way it should be. Utilities should develop their own requirements, based upon their particular market and regulatory characteristics to primarily drive the system design. This approach would ensure that the resultant system meets their needs and would be cost effective. Suppliers do have an important role to play in the evaluation

[19] BC Hydro, Smart Meter website;
http://www.bchydro.com/energy_in_bc/projects/smart_metering_infrastructure_program/smart_meter_and_grid_technology/smart_meters_smart.html

of the state of the technology, and their survival depends on business profitability, but overall the decisions should be driven by the needs of the utility and the public interest as determined through the regulatory process.

Ultimately, one cannot forget that the customers or clients of the utility are the residents or energy users themselves – the homeowners, the shop keepers etc. at the end of the powerline. They want low cost yet reliable power, and in many cases, environmentally responsible solutions.

In Canada, many of the electrical utilities are run as Crown Corporations, representing citizens, the shareholders.

To ensure accountability, the utilities have overseeing regulatory bodies, the Régie in the case of Hydro-Québec, with input from a wide range of interveners.

Balancing all the demands from the various stakeholders is a challenge in the best of circumstances, but is further complicated when the pace of technology is so revolutionary and so complex, and in addition, when the implementation is so widespread it ultimately affects all the residents of the jurisdiction.

For a successful Smart Meter project, the goals of the utility have to be understood and articulated including how its customers will be serviced, while working together with the suppliers to define the most appropriate technology. In addition, the project should follow the guidelines of the regulatory process and direction from the political processes. And ultimately, it is up to the Régie to orchestrate, including ensuring the environmental concerns[20] are appropriately considered.

4.2. Technological Challenges and Standards

Another challenge is the handling of the significant technological step change in Smart Meters from their analog-type processors. As the limitations of the old spinning disk technology are removed by use of electronics and communications, a host of new features and capabilities explode onto the marketplace, while introducing a new set of challenges. Meter readers are no longer needed, being replaced by the energy reading communication. This in turn results in new privacy and security issues that need to be addressed.

In order to reduce costs and increase interoperability, the role of standards is crucial: *"In the absence of standards, there is a risk that the diverse Smart Grid technologies that are the objects of these mounting investments will become prematurely obsolete or, worse, be implemented without adequate security measures."*[21]

[20] Act Regie (see footnote 3), Section 73 (4)
[21] NIST, Draft NIST Framework and Roadmap for Smart Grid Interoperability Standards, Release 2.0,

Major Standards activities in the industry, primarily based in the U.S. at the National Institute for Standards and Technology (NIST) are aimed at the development of interoperable standards as the rollout of a Smart Grid accelerates[22], boosted by the large U.S. Smart Grid stimulus investments.

Although slower to start, Canada initiated a task force focused on promoting Smart Grid standardization in Canada. Coordinated through the Standards Council of Canada and the National Committee of the International Electrotechnical Committee[23], the group (of which I am a member) will produce a Smart Grid road map with recommendations in early 2012. Canada participates in a number of International Standards[24] to help align and affect its developments around the world, particularly in the USA and Europe.

5. Canadian Experiences

I will now examine how these challenges are being addressed in other Canadian jurisdictions and indicate where comparisons may inform the analysis and decision making of the Régie with respect to Hydro-Québec's application.

5.1. Ontario: Early Introduction has its Challenges

Ontario started its Smart Metering program in 2004 with a request from the Minister of Energy for 800,000 Smart Meters installed by Dec 31, 2007 and remaining customers by Dec 31, 2010[25].

A key function of the Ontario system is the ability to charge time of use rates[26]. The original plans (even back in 2004/2005) envisioned "*smart thermostats, voltage monitoring, earlier payment, load limiting and remote cut-off*" [27].

Since that time much has changed in the industry. As documented by Hydro-Québec, the price of Smart Meters has dropped significantly, from $295 in 2005 to $100 in 2009[28]. In 2009, Obama's administration gave a big push in the US on

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October 2011; http://collaborate.nist.gov/twiki-sggrid/pub/SmartGrid/IKBFramework/Draft_NIST_Framework_Release_2-0_10-17-2011.pdf
[22] NIST, Smart Grid, website; http://www.nist.gov/smartgrid/
[23] Canmet Energy, Natural Resources Canada; http://canmetenergy-canmetenergie.nrcan-rncan.gc.ca/eng/renewables/integration_der/success_stories/collaboration_canada_council.html
[24] Mr. Bertsch is chair of the Canadian Advisory Committee of ISO/IEC JTC1 SC25, Interconnection of Information Technology Equipment, which includes Home Electronic Systems
[25] Ontario Hydro, Smart Meter Implementation Plan, Report of the Board to the Minister, Page i; http://sites.energetics.com/MADRI/toolbox/pdfs/ontario/plan.pdf
[26] Ontario Hydro, Smart Meter Plan (see footnote 25), Page v
[27] Ontario Hydro, Smart Meter Plan (see footnote 25), Page ii
[28] C-GRAME-0025, Section 2.1, Page 13 of 58

Smart Grid[29]. Smart meters now regularly have remote disconnect/connects and Home Area Networks, so Ontario will have to catch up on those features and there is a concern with stranded assets.

Almost all of its 4.7 million customers now have Smart Meters[30], but many customers are missing its main objective, Time-of-Use rates[31].

"*By 2030, the OPA forecasts smart meters and TOU pricing will contribute 409 MW of peak demand savings, although this is dependent on the price differentials and time periods for peak and off-peak TOU rates.*"[32] This "*can reduce the need for future peaker plants*" [33] and subsequently reduce the impact on rates.

However, the Environmental Commissioner of Ontario is "*disappointed that the Ontario Energy Board (OEB) is just beginning to collect and analyze the data in order to track the actual reduction in peak demand due to TOU pricing*"[34].

5.2. Alberta: Smart Grid Inquiry

Most industrial and large commercial customers in Alberta have Smart Meters. Some utilities such as FortisAlberta have significant residential installations, while other utilities in Alberta do not. FortisAlberta, ATCO Electric and the City of Lethbridge deployed remote metering systems to reduce meter reading costs[35]. SAREA deployed smart meters with multi-period usage information, but does not use that feature[36].

The province initiated a Smart Grid inquiry and published a report, Alberta Smart Grid Inquiry, on January 31, 2011[37]. The inquiry was set up "*so that it can consider implementing policies supporting the deployment of smart grid technology*"[38].

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[29] See Section 3 of this document
[30] Environmental Commissioner of Ontario, Gord Miller, Annual Energy Conservation Progress Report - 2010 (Volume Two), Dec 2011, Section 2.3.3, Table 9, Page 25; http://www.eco.on.ca/uploads/Reports-Energy-Conservation/2011-v2/2010-Energy-Conservation-Annual-Report-volume-2.pdf
[31] Environmental Commission of Ontario, Progress Report (see footnote 30), Section 2.3.3, Page 25
[32] Environmental Commission of Ontario, Progress Report (see footnote 30), Section 2.3.3, Page 26
[33] Environmental Commission of Ontario, Progress Report (see footnote 30), Section 2.3.3, Page 25
[34] Environmental Commission of Ontario, Progress Report (see footnote 30), Executive Summary, Page 3
[35] Alberta Utilities Commission, Alberta Smart Grid Inquiry, Jan 31, 2011, Current smart meter deployment in Alberta, Page 31; http://www.energy.alberta.ca/Electricity/pdfs/SmartGrid.pdf
[36] Alberta Utilities Commission, Inquiry (see footnote 35), Page 31 http://www.energy.alberta.ca/Electricity/pdfs/SmartGrid.pdf
[37] Alberta Utilities Commission, Inquiry (see footnote 35)
[38] Alberta Utilities Commission, Inquiry (see footnote 35), Introduction, Page 1

EPCOR applied for a Smart Meter program in 2010, and was denied in part because of "*the absence of a provincial smart meter policy*"[39].

5.3. British Columbia : A Suitable Comparison

I suggest that the recent Smart Metering & Infrastructure Program (SMI) of BC Hydro[40] is suitable for comparison to the Hydro-Québec Smart Metering program for several reasons.

First of all, both BC and Quebec programs are in Canada and therefore provide a common platform for federal considerations, including common requirements such as those from Measurement Canada[41].

BC and Quebec both have energy rates that relatively low for North America, and both have significant hydroelectric generation.

The BC Hydro program with nearly 1.8 million installations[42] is very close to the same size of the Phase 1 of the Hydro-Québec Smart Meter program of 1.7 million[43] customers. This provides a useful comparison including on technological solutions, scaling and costs.

The appropriate timing of a comparative Smart Meter program helps in determining its suitability. If the comparative program was initiated too far in the past then there may be too many changes in technology advancements and customary market procedures. For example, the suitability of Ontario smart meter program from a timing point of view may not be ideal since its Smart Meter installations began in 2005[44], and since that time the Smart Meter market has changed significantly.

If the comparative program was too recent, then it may only have overall requirements and concepts, and the utility may have not had to deal with complex system designs nor had to overcome procurement issues.

I believe that the BC Hydro SMI program lies within these two extremes, and aligns quite appropriately for comparison purposes to Hydro-Québec.

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[39] Alberta Utilities Commission, Inquiry (see footnote 35), Page 31
[40] BC Hydro, Smart Meters webpage;
http://www.bchydro.com/energy_in_bc/projects/smart_metering_infrastructure_program.html
[41] Measurement Canada, About Us webpage; http://www.ic.gc.ca/eic/site/mc-mc.nsf/eng/h_lm00013.html
[42] BC Hydro, SMI Program Business Plan, December 23, 2010, Section 1.2, Page 7;
http://www.bchydro.com/etc/medialib/internet/documents/smi/smi_business_plan.Par.0001.File.smi_business_plan.pdf
[43] C-GRAME-0025, Item #1.1, Table 2, Page 9 of 58 and Table 1, Page 7 of 58
[44] Ontario Energy Board, Monitoring Report; Smart Meter Investment - September 2010, March 3, 2011;
http://www.oeb.gov.on.ca/OEB/_Documents/SMdeployment/SM_Cost_Report_September2010.pdf

Because the BC Hydro SMI program has just started meter installations in July 2011[45], it is recent enough to have incorporated the latest advancements in both technology and latest market customary practices. Yet, it is mature enough in that it has released its business plan[46], business case[47], and finalized its procurement of meters[48]. It has therefore has already gone through the full system design and has had to deal with challenging procurement issues.

Another advantage for using the BC Hydro SMI Program for comparison is that it does have some reasonable public documentation to draw upon – namely the previously mentioned business plan[49] and business case[50].

However, I recognize that BC Hydro's SMI program has been exempted from the BC Utility Commission (BCUC) regulatory process through the 2010 Clean Energy Act[51] (Bill 17) and therefore, the SMI program has had limited external scrutiny and corresponding documentation (except for a government panel review[52] completed in June 2011).

In summary, I suggest that the BC Hydro SMI program is appropriate and suitable for comparative purposes as suggested by the Régie.

6. BC Hydro vs Hydro-Québec : Comparative Analysis

The ongoing F2012 to F2014 BC Hydro Revenue Requirements Application[53] includes the SMI Business Case[54] and SMI Business Plan[55] as part of its evidence record. It remains to be seen whether or not further discovery of information relating to these documents will be explored in the BC Hydro F2012-F2014 RRA proceedings. Should further relevant information be revealed in the BC proceedings, it may be appropriate to provide an update of my expert report to the Régie.

[45] BC Hydro, SMI Business Plan (see footnote 42), Section 1.2, Page 7
[46] BC Hydro, SMI Business Plan (see footnote 42)
[47] BC Hydro, SMI Business Case (see footnote 16)
[48] BC Hydro, Press Announcement, April 11, 2011;
http://www.bchydro.com/news/articles/press_releases/2011/itron_selected_smart_meters.html
[49] BC Hydro, SMI Business Plan (see footnote 42)
[50] BC Hydro, SMI Business Case (see footnote 16)
[51] BC Legislature, Bill 17, Clean Energy Act, Section 7(1) (j), Section 7(2), Section 7(3);
http://leg.bc.ca/39th2nd/3rd_read/gov17-3.htm;
[52] Government of BC, Review of BC Hydro, June 2011;
http://www.newsroom.gov.bc.ca/downloads/bchydroreview.pdf
[53] BC Hydro, F2012-F2014 Revenue Requirements Application;
http://www.bcuc.com/ApplicationView.aspx?ApplicationId=298
[54] BC Hydro, SMI Business Case (see footnote 16)
[55] BC Hydro, RRA (see footnote 53), Exhibit A2-3

6.1. BC Hydro SMI Program History

In its 2005/2006 to 2007/2008 Service Plan, BC Hydro recognized the potential advantages of *"'smart grid' technology . . . for energy efficiency, conservation and optimizing the output of existing equipment"*[56] and which "*. . . can be enhanced in combination with solutions such as rate designs . . .*"[57].

In its 2006/2007 to 2008/2009 Service Plan BC Hydro introduced the "*Advanced Metering Infrastructure (AMI)*"[58] as a contemplated project "*to install smart meters that have multi-functions and are capable of two-communication between BC Hydro and its customers.*"[59]. The program had a preliminary estimate of completion in 2012 and total cost preliminary estimate of $350 million[60]. In the next service plan (2007/2008 to 2009/2010) the program total cost estimate had increased to $480 to $530 million[61].

During the time period of 2006 to 2008, BC Hydro implemented the Conservation Research Initiative (CRI) pilot project of appropriately 2000 customers in Greater Vancouver, Campbell River and Fort St. John using smart meters with time-of-use and critical peak pricing, plus direct load control[62].

On June 3, 2010, the BC government passed the BC Clean Energy Act[63] which mandated installation of the smart meters by the end of 2012 for BC Hydro's 1.8 million residential and commercial customers and exempted them from the regulatory process of the BC Utilities Commission[64].

On December 23, 2010, BC Hydro released its Business Plan[65] for the Smart Metering and Infrastructure (SMI) Program and on January 18, 2011 released the Business Case[66] for the program. On April 11, 2011, BC Hydro announced that Itron was chosen to provide all the smart meters for its program[67].

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[56] BC Hydro 2005/2006 to 2007/2008 Service Plan, Page 24, "Technology Developments";
http://www.bchydro.com/etc/medialib/internet/documents/info/pdf/info_service_plan_2005.Par.0001.File.info_service_plan_2005.pdf
[57] BC Hydro, 2005-2008 Service Plan (see footnote 56), Page 24
[58] BC Hydro's 2006/2007 to 2008/2009 Service Plan, Page 47, Advanced Metering Infrastructure (AMI);
http://www.bchydro.com/etc/medialib/internet/documents/info/pdf/info_service_plan_2006_2007_to_2008_2009.Par.0001.File.info_service_plan_2006_2007_to_2008_2009.pdf
[59] BC Hydro, 2006-2009 Service Plan (see footnote 58), Page 47
[60] BC Hydro, 2006-2009 Service Plan (see footnote 58), Page 47
[61] BC Hydro, 2007/2008 to 2009/2010 Service Plan, Page 48;
http://www.bchydro.com/etc/medialib/internet/documents/info/pdf/info_bc_hydro_service_plan_2007_08_to_2009_10.Par.0001.File.info_bc_hydro_service_plan_2007_08_to_2009_10.pdf
[62] BC Hydro, Conservation Research Initiative, Presentation, May 26, 2010, Slide 11;
http://www.vaasaett.com/wp-content/uploads/2010/05/BC-Hydro-Conservation-Initiative.pdf
[63] BC Legislature, Bill 17, Clean Energy Act; http://leg.bc.ca/39th2nd/3rd_read/gov17-3.htm;
[64] Clean Energy Act (see footnote 63), Section 7(1) (j), Section 7(2), Section 7(3)
[65] BC Hydro, SMI Business Plan (see footnote 42)
[66] BC Hydro, SMI Business Case (see footnote 16)
[67] BC Hydro, Itron Announcement (see footnote 48)

The above historical references are included to assist the Régie in understanding the context and background of the BC Hydro SMI program.

6.2. Complete Cost and Benefits

This section will review the complete cost and benefits of the BC Hydro and Hydro-Québec SMI systems, discuss the overall benefits as describe by the BC Hydro and Hydro-Québec systems and then provide a comparative analysis.

6.2.1. BC Hydro Complete Cost/Benefits

The full BC Hydro Smart Metering Infrastructure program is budgeted at $930 million[68] with the following breakdown:

BC HYDRO COMPLETE COSTS	
Stage Description	**$ millions**
Initial phases	49.1
Smart Metering System	391.1
Solution Integration (Information Technology)	60.9
Theft Detection	110.5
Conservation Tools	62.8
Grid Modernization	54.2
Program Delivery Activities	37.0
Interest	14.4
Contingency	60.0
Reserve	90.0
TOTAL	**930.0**

[68] BC Hydro, SMI Business Case (see footnote 16), Page 10

The quantified benefits expected by BC Hydro are estimated at $1.6 billion[69] as shown below:

BC HYDRO BENEFITS	
Benefit Description	**$ millions**
Operational Efficiencies, Avoided Capital	
Metering Reading Automation	222
Meter Sampling	61
Remote Re-connect Automation	47
Distribution Asset Optimization	15
Outage Management Efficiencies	10
Continuous Optimization and Load Research	6
Call Center & Billing	[2]
Energy Savings – Commercial and Distribution System	208
Revenue Protection – Theft Detection	732
Capacity Savings – Voluntary Time-of-use rates	110
Energy Savings – Conservation Tools	220
TOTAL	**1,629**

The complete net present value for the BC Hydro program is calculated at approximately $520 million[70].

6.2.2. Hydro-Québec Phase 1 Cost/Benefits

Since the present Hydro-Québec application is for only Phase 1 of the LAD project, only the costs dealing with Phase 1 will be used in this comparison.

[69] BC Hydro, SMI Business Case (see footnote 16), Page 9
[70] BC Hydro, SMI Business Case (see footnote 16), Page 2

The cost of Phase 1 for Hydro-Québec is expected to be $440 million[71]:

HYDRO-QUÉBEC PHASE 1	
Stage Description	**$ millions**
Capital Investments	
Meter purchase and installation	245.3
Telecommunications equipment	46.2
Information technology	72.1
Office	18.5
Borrowing costs	2.3
Other	11.8
Operating Expenses	
Relocation	7.1
Information Technology	19.4
Telecommunications	2.9
Miscellaneous	14.8
TOTAL	**440.5**

The financial benefits of the Hydro-Québec project are not calculated using the benefits of new features, but are calculated by comparing the Smart Meter Scenario to a Reference Scenario (continuing with the standard process). For all phases the added benefits of Smart Meters is estimated at almost $290 million[72]:

HYDRO-QUÉBEC BENEFITS			
$ millions	**Smart Meters**	**Reference Scenario**	**Difference**
Capital Investments	720.1	500.4	219.7
Operating Expenses	365.3	871.8	(506.5)
Taxes and Residuals	(84.1)	(81.2)	(2.9)
Total	**1,001.3**	**1,291.0**	**(289.7)**

Using a benefit calculation of $73.70 per meter[73], it is estimated that installed the costs of the telecommunications infrastructure will be compensated after 1.2 million smart meters are installed (third quarter of 2013 in Phase 1)[74].

[71] C-GRAME-0025, Page 46 of 58, Section 10.2, Table 11
[72] C-GRAME-0025, Page 38 of 58, Section 7, Lines 1 and 2
[73] C-GRAME-0025, Page 40 of 58, Section 7.2, Lines 21 to 23
[74] C-GRAME-0025, Page 40 of 58, Section 7.2, Lines 23 to 25

6.2.3. Comparison of BC Hydro and Hydro-Québec Cost/Benefits

Since the systems are so different, with different geographical (BC having more mountainous territory to cover, for example) and infrastructure systems (Hydro-Québec having more indoor meters than BC Hydro), a direct comparison between the systems is only useful from a very broad, general point of view. The calculation categories are different and feature sets of the meters themselves vary significantly. In addition, BC Hydro has slightly more meters to install.

In addition, in order to do any comparison of overall costs, the additional features of the BC Hydro would have to be compensated for.

However, with those caveats, it is still possible to draw useful comparisons. One way to provide at least a very rough common platform is to remove the costs of the BC Hydro system features that are not in the Hydro-Québec system so that each are compared using roughly the same feature set. The resultant comparison can provide an overall gauge of whether or not the Hydro-Québec system is priced within the general market place, but should not be considered an accurate comparison, and it is understood that further refinements may be appropriate.

BC HYDRO COSTS – Reduced feature set (similar to Hydro-Québec)	
	$ Millions
Initial phases	49.1
Smart Metering System	391.1
Solution Integration (Information Technology)	60.9
TOTAL	**501.1**

HYDRO-QUÉBEC COSTS	
	$ Millions
TOTAL	**440.5**

Therefore, the systems are within approximately 10% of each other. Given the very rough comparison being made, the result shows that Hydro-Québec costs are not out of line with those of BC Hydro, especially considering that BC Hydro's system design is slightly larger and has incorporated a full expansion to the other features, and therefore is expected to cost more.

6.3. Overall Benefits

Hydro-Québec was asked through Information Request process:

> "*Please explain how the Distributor can make the AMI solution economically attractive solely with remote meter reading and whether other companies are in the same situation.*"[75]

Hydro-Québec responded with:

> *"Most electricity distribution companies that were planning on implementing an AMI had previously implemented AMR technology. These companies justified their project through the benefits offered by other functions because the benefits associated with the meter reading function were smaller."*[76]

In answering the question about how Hydro-Québec can make its solution economically attractive solely on remote meter reading for its AMI, Hydro-Québec focused on its assumption that most electricity distribution companies had already previously implemented AMR. In the case of BC Hydro, I submit that BC Hydro is not one of those distribution companies, yet has justified its project with other functions.

In other words, the question remains unanswered: how can Hydro-Québec makes its AMI attractive, if BC Hydro, for example, having not previously implemented AMR technology, has justified its project through benefits offered by other functions?

6.3.1. BC Hydro SMI Overall Benefits – An Integrated Approach

The benefits of the BC Hydro SMI program are prominently discussed throughout the Business Case. In fact, after a short introduction in the executive summary, BC Hydro immediately presents the "*substantial benefits to customers*"[77]:

- *"Improve safety and reliability*
- *Enhance customer service*
- *Reduce electricity theft*
- *Improve operational efficiency and reduce wasted electricity*
- *Support greater customer choice and control*
- *Help modernize British Columbia's electricity system"*

These benefits are further detailed later in the Business Case, along with quantified financial allocations.

[75] C-GRAME-0037, Item 3.2, Page 7 of 17
[76] C-GRAME-0037, Item 3.2, Page 7 of 17
[77] BC Hydro, SMI Business Case (see footnote 16), Page 1

The BC Hydro Smart Meter project developed a series of 7 "Releases"[78], each release dealing with different functionalities[79]. From the "*SMI Program Framework*" diagram, it is evident that Release 0, "*Architectures & Frameworks (Foundational)*", provides a foundation for all the other Releases 1 to 6[80]. This shows an integrated approach where each of the Releases 1 through 6 draw upon the "Foundational" Release 0. By developing a full architectural design in this manner, the system can be more efficient, cost effective, and fewer unexpected issues will arise.

Figure 1 SMI Program Framework

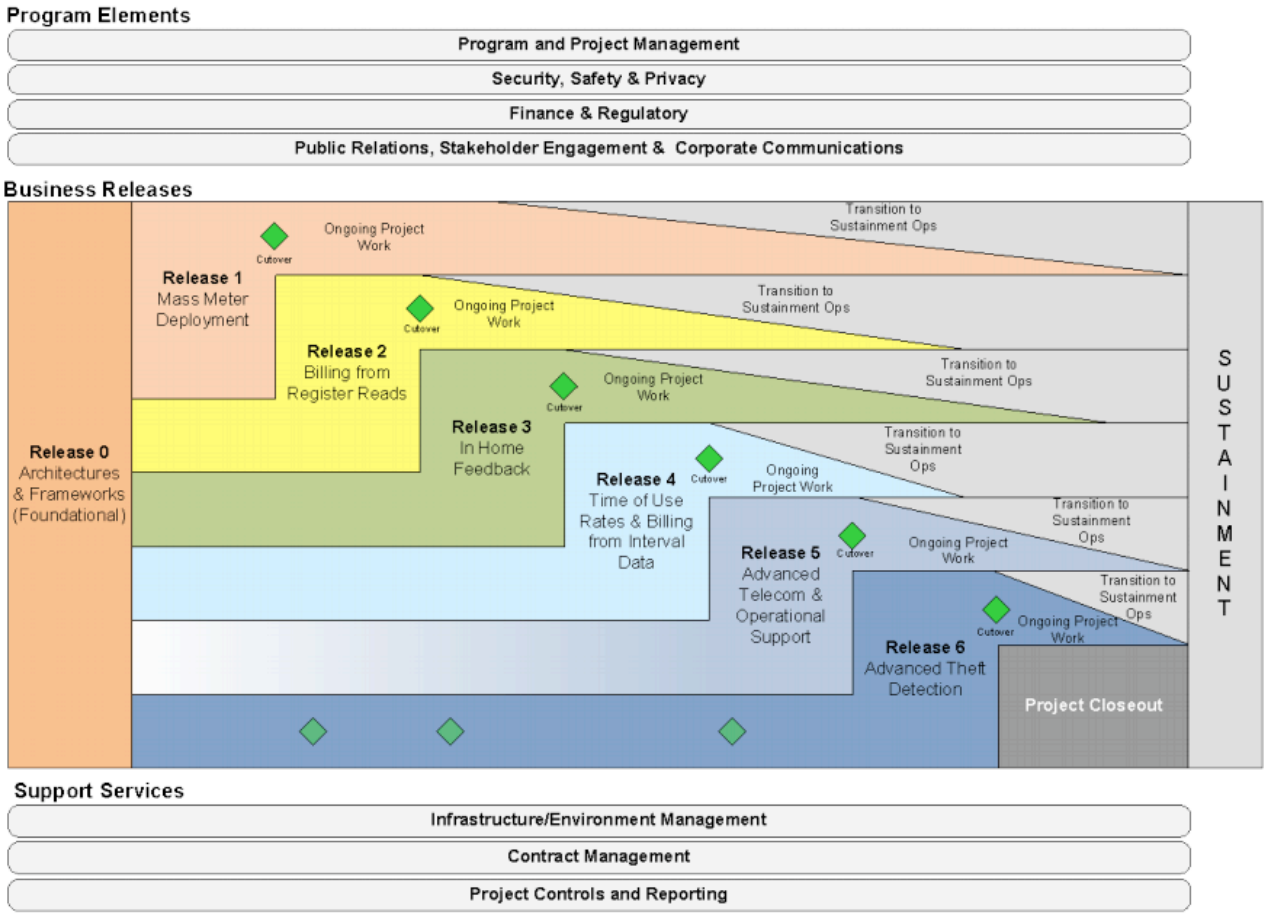

Figure 6 - SMI Program Framework [BC Hydro SMI Business Case, Page 15]

[78] BC Hydro, SMI Business Plan (see footnote 42), Pages 14 and 15
[79] BC Hydro, SMI Business Plan (see footnote 42), Pages 16 to 18
[80] BC Hydro, SMI Business Plan (see footnote 42), Figure 1, Page 15

6.3.2. Hydro-Québec LAD Overall Benefits – A Fragmented Approach

On the other hand, Hydro-Québec by not considering the many other benefits available, as discussed above in its Information Request answer[81], has not provided any indication that a fully integrated system design has been developed nor of the compromises or additional costs that may be incurred for adding extra benefits at a later time.

Hydro-Québec in its application included a chart of functions used by "*electricity distribution companies*" and states:

> "*Every new function that addresses an actual need by the Distributor or its clients will be the subject of a specific examination. This examination will focus on determining the benefits of the function and an analysis of implementation cost will also be performed.*"[82]

Hydro-Québec by only examining a function which "*addresses an actual need*", yet not articulating those needs falls short of clarifying Hydro-Québec's intentions for these functions.

In answering an Information Request regarding these functions, Hydro-Québec states:

> *"Ces nouvelles fonctionnalités n'ayant pas fait l'objet d'analyses approfondies, le Distributeur ne peut fournir plus d'informations sur les coûts qui seront liés à leur mise en application. Il n'est pas non plus en mesure d'indiquer lesquelles seront développées et selon quel échéancier de réalisation.*
>
> *Dans la phase 1 du projet LAD, le Distributeur a choisi de limiter le périmètre du projet à la mise en place des TI de l'IMA, au remplacement des compteurs de nouvelle génération, à l'automatisation de la relève et à l'interruption et la remise en service à distance notamment des clients en recouvrement."*[83]

By not subjecting the new features to thorough analysis and by limiting the project scope "*au remplacement des compteurs de nouvelle génération, à l'automatisation de la relève et à l'interruption et la remise en service à distance notamment des clients en recouvrement* " Hydro-Québec has re-emphasized its position for developing a limited system.

[81] See questions relating to footnotes 75 and 76
[82] C-GRAME-0025, Section 2.2.4, Page 18 of 58, Lines 6 to 7
[83] B-0040, Question 1, Page 4 of 21

Even if Hydro-Québec is not anticipating carrying through with a system incorporating all the potential benefits at this time, executing an overall system design and requirements definition stage could consider all the aspects anticipated for a full system. Hydro-Québec could then move only on the stages that Hydro-Québec wishes to start with, to full implementation.

6.3.3. Comparison of BC Hydro and Hydro-Québec Overall Benefits

The approach of Hydro-Québec is significantly different than that of BC Hydro. BC Hydro described a full slate of benefits[84], while Hydro-Québec described only a limited number of benefits[85].

By having so many specific, detailed, quantified and wide-spread benefits, the BC Hydro SMI program can continue to be justified even in the face of significant changes. Also, it forms a stronger support base in the midst of the inevitable Smart Meter challenges seen throughout North America. Although BC Hydro could have justified its system through only a small number of key benefits, it built up its business case of a larger itemized list of benefits and exposed it at the initial release of the Business Case.

In my opinion, a Smart Metering system with so few benefits as described by Hydro-Québec would not be the best use of funds.

Take an example, where Hydro-Québec would have been running their Smart Metering system for some time. For whatever reason (further analysis, or changing market conditions), assume Hydro-Québec then decides to add theft detection features. They may find that their meters are missing a crucial feature (such as one of the tamper detection methods) because they did not do the initial integrated architectural system step, and therefore expensive field upgrades may be necessary.

In BC's case, BC Hydro has already incorporated an initial integrated architectural system design, and so their installed meters should have taken those considerations into account already.

[84] BC Hydro, SMI Business Case (see footnote 16), Page 1
[85] B-0006, Page 7 of 58, Section 1.1, Lines 12 to 19

7. Technological Compatibility Issues – Challenges of the Feature Implementation

In trying to determine the "Smart Grid" features, the Régie asked:

> "*Please indicate the additional costs associated with the requirement that the new generation meters support setting up new "Smart Grid" type functions."*[86]

Hydro-Québec responses:

> "*The acquisition cost of the new generation meters routinely includes the items necessary so they can implement a "Smart Grid" type intelligent network without additional cost.*
>
> *All the functions likely to be required for the deployment of a "Smart Grid" type network are present in the meters acquired by the Distributor. The Distributor will not need to perform any physical action on the new generation meters installed on client locations. The additional costs required for their activation of these functions will be supported by an analysis of the needs, costs and benefits and presented to the Régie if required."*
>
> *"Every new function that addresses an actual need by the Distributor or its client . . . ."*[87]

What level of "Smart Grid" support is Hydro-Québec committing to? In answering the question, Hydro-Québec does not indicate the specific Smart Grid features that are present in the meters, but only refers to those "likely" to be required and only those with an "actual need" by the Distributor or its client. Throughout the LAD proceeding, I have not seen any "actual" need expressed from Hydro-Québec for any of the Smart Grid functions, except for the remote disconnect and service restoration.

Therefore, in my opinion, I suggest the following are important features that Hydro-Québec should incorporate into its system design.

[86] C-GRAME-0026, Question 2.1, Page 9 of 38
[87] C-GRAME-0026, Answer 2.1, Page 10 of 38

7.1. Conservation Tools

BC Hydro has prominently included in-home displays as part of Conservation Tools as a key benefit of its Smart Metering Infrastructure program. BC Hydro notes in its benefits to customers as expressed in its executive summary:

> "*Support greater customer choice and control by offering optional in-home feedback tools that provide direct and timely information to customers about their electricity consumption.*"[88]

BC Hydro has allocated $220 million as benefits to Conservation Tools which include in-home display units[89]. This is essentially tied in second place for quantified benefits with Meter Reading Automation at $222 million[90].

BC Hydro estimates that display tools for their customers "*can help reduce their energy use by up to 15 per cent*"[91].

It should be noted that BC Hydro has already decided how the display units will be distributed in the marketplace:

> "*Take-up of such in-home display devices will be by customer choice, with a variety of options expected to be available in the market. BC Hydro will provide financial incentives to enable customers to acquire a basic market available in-home display device from their local retailer*" [92].

BC Hydro is considering advanced demand side management techniques such as demand response in its system design:

> "*As customers, especially industrial and commercial customers, become more interested in direct load control, they can use demand response capabilities included in the Smart Metering Program to configure, manage, monitor and settle various load programs.*"[93]

BC Hydro is a participant in a number of Standards Groups[94], including the Zigbee Alliance which "*defines data communications standards for smart meters and in-home devices over a Home Area Network*" [95]. BC Hydro not only monitors the activities, but also contributes – for example, BC Hydro is specifically

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[88] BC Hydro, SMI Business Case (see footnote 16), Page 1
[89] BC Hydro, SMI Business Case (see footnote 16), Page 28
[90] BC Hydro, SMI Business Case (see footnote 16), Page 9
[91] BC Hydro website, "Smart meters have arrived: The straight facts", Fact 5; http://www.bchydro.com/news/press_centre/media_updates/smart_meter_facts.html
[92] BC Hydro, SMI Business Plan (see footnote 42), Page 9
[93] BC Hydro, SMI Business Case (see footnote 16), Appendix 2, Page 21
[94] For a list of the standards group, see BC Hydro, SMI Business Case (see footnote 16), Appendix 10, Page 38
[95] BC Hydro, SMI Business Case (see footnote 16), Appendix 10, Page 38

mentioned for its work in the development of the Smart Energy Profile requirements document[96] and OpenHAN document back in 2008[97].

This intimate involvement in standards from BC Hydro itself will become particularly important when issues arise such as regarding the use of Zigbee 1.1 or Zigbee 2.0[98]. BC Hydro will be able to make its own determination on weighing the risks of technology obsolescence versus delivery schedule rather than relying on the supplier's determination.

The HAN not only involves the In-Home display, but will potentially expand to other products, so it will be important to "get it right" from the beginning.

The Hydro-Québec Smart Meter proposal document contrast sharply to that of BC Hydro. The only mention of the In-Home Displays by Hydro-Québec is a table showing them being used in 56% of cases[99] by electricity distribution companies. However, this table did not relate to Hydro-Québec's own Smart Metering system nor does Hydro-Québec commit to include this feature[100].

The only other section of the Smart Meter document of Hydro-Québec which relates to the In-Home Display is in the discussion of the Home Area Network - HAN[101], but for which no information regarding In-Home Displays is provided.

Hydro-Québec does not list their standards involvement and are not listed in the standards documents cited above. Consequently, it seems that Hydro-Québec relies on the supplier's advice for their direction moving forward, which may or may not align with the needs of Hydro-Québec. It does not appear that Hydro-Québec has their own independent evaluation of the technology requirements.

A number of questions arise: How will the "pairing" between the meter and In-Home Display occur? Who owns the In-Home Display? Will information come from the HAN and Internet? How will gateways play a role? To what extent will open standards be used to connect to the Meter? What are the privacy and security considerations?

In my opinion, the Régie should require Hydro-Québec to consider the development of a strategy for supporting In-Home Displays and the related Home Area Network in its LAD project.

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[96] HomePlug, ZigBee Alliance, Smart Energy Profile Marketing Requirements Document (MRD), March 11, 2009, Section 0.9, Page 2 of 310; https://www.homeplug.org/tech/ZBHP_SE_MRD_090624.pdf
[97] Utility AMI, Utility AMI 2008 Home Area Network System Requirements Specificationi, August 19, 2008, Page 3 of 102; http://www.utilityami.org/docs/UtilityAMI%20HAN%20SRS%20-%20v1.04%20-%20080819-1.pdf
[98] C-ROEE-0008 and C-ROEE-0011, Question 5.6
[99] C-GRAME-0025, Section 2.2.4, Page 18 of 58, Figure 4
[100] C-GRAME-0037, Section 3.2, Page 7 of 17
[101] C-GRAME-0025, Section 3.1, Page 20 of 58, Lines 15 to 19, and Line 24

In addition, Hydro-Québec should demonstrate participation in standards organizations, so that it knows firsthand the direction of the technology, and does not rely on its suppliers. I suggest that Hydro-Québec be required to have an independent evaluation of the technology choices for the Home Area Network.

7.2. Theft of Electricity

BC Hydro in its business case for Smart Meters, placed "theft of electricity" as the top benefit, with an estimated benefit of $732 million[102]. Almost the entire BC Hydro SMI project could be cost justified on this feature alone.

On the other hand, the Ontario Energy Board in January 2005 suggested no value be placed on theft detection:

> "*In Ontario, the more common mode of theft is by meter bypass and that is not detectable by smart meter systems.*"[103]
>
> "*It is possible to detect theft if the supply transformer has its own meter which can then be compared to the totalized readings of customer meters supplied by it and in that case remote reading capability is a definite advantage. However, there are technical and cost hurdles to be overcome with this idea and any utility considering it would probably be better off just installing all customer meters at the transformer secondaries and eliminate the possibility of bypass altogether.*
>
> *Overall, the cost group doubts that any real benefit will accrue from smart metering in the area of theft detection and so has attached* ***no value to it****."*[104] *[****emphasis added****]*

This vast difference in benefit evaluation (from $0 to $732 million) illustrates an important point. Besides the variation in time frames; Ontario in 2005 and BC in 2011; which may have some bearing on the differences as technology has progressed since 2005, the design of the overall AMI system design can have a significant effect on whether the system supports certain features or not.

As noted by BC Hydro (in dealing with meter bypass):

> "*New distribution system meters (different from those to be installed at customer homes or businesses) located at key points on BC Hydro's system will measure electricity supplied to specific areas. Combined with software tools to enable electricity balancing analysis, distribution system meters will*

[102] BC Hydro, SMI Business Case (see footnote 16), Page 27
[103] Ontario Hydro, Smart Meter Plan (see footnote 25), Appendix C, Page 110
[104] Ontario Hydro, Smart Meter Plan (see footnote 25), Appendix C, Pages 111 to 112

help BC Hydro identify electricity theft more accurately and address it more quickly."[105]

In BC Hydro's case, the feature of theft detection could be realized because the appropriate distribution system meters and software tools were added. This was planned from the beginning in BC Hydro's system design. This compares to the Hydro-Québec system, where there is no indication of any of these features being incorporated or designed into the system.

Another point that is illustrated by the differences in BC and Ontario theft detection evaluation is that there are wide variations in the Smart Metering systems around North America, and one should not assume important features are incorporated without an analysis of each system.

In the case of Quebec, Hydro-Québec has reported that theft of electricity is between $40 to $110 million per year[106]. Given that Hydro-Québec has such large losses for the theft of electricity and that BC Hydro has placed such an emphasis on using smart meters to deal with this issue, it is noteworthy that Hydro-Québec placed such low value and focus on theft of electricity in its Smart Meter application.

The Hydro-Québec main objectives did not specially include theft of electricity[107]. Even when possible there was the opportunity to discuss new features and services of the Smart Meter program through an Information Request response, theft of electricity was not specifically named[108] (as only failure detection and demand management were mentioned).

Hydro-Québec does mention "Theft Detection" as a feature used by electricity distribution companies in 57% of cases[109], but the list of features does not relate to any of the features, including having Theft Detection in its own Smart Metering system. In addition, Hydro-Québec does not commit to use this feature[110].

It is recognized that Hydro-Québec has discussed the "*possibility of technological development that will allow us to offer new services to clients in the future . . .*"[111]. However, if Hydro-Québec does not develop its full system design with consideration for a feature such as theft detection at the beginning of the program, there is the increased risk that extra unnecessary costs may be incurred in the future, or technological decisions made may prohibit such features.

[105] BC Hydro, SMI Business Case (see footnote 16), Page 6
[106] R-3677-2008, HQD-16, Document 9, Option Consommateurs, Answer 8.1, Page 64 of 71
[107] C-GRAME-0025, Section 1.1, Page 7 of 58, Lines 12 to 18
[108] C-GRAME-0025, Section 1.1, Page 8 of 58, Lines 5 to 7
[109] C-GRAME-0025, Section 2.2.4, Page 18 of 58, Figure 4
[110] C-GRAME-0037, Section 3.2, Page 7 of 17
[111] C-GRAME-0025, Section 1.1, Page 7 of 58, Lines 17 to 18

I suggest that the benefits of a full theft detection program (e.g. adding the distribution system meters and software) can be justified for their Smart Meter program at the initial stages.

It is suggested that the work of BC Hydro be considered in this analysis. BC Hydro has shown that the payback for such features can be very short with a $732 million benefit[112] using an additional $110.5 million expenditure[113].

Whatever features of theft detection are utilized in the Hydro-Québec system, I recommend that all the appropriate financial benefits (planned and potential) be documented accordingly to help describe the advantages of the system, similar to what BC Hydro has done in its business case. If Hydro-Québec prepares such documentation it encourages the discussion and the system design process within Hydro-Québec.

Whether or not, a full scale theft detection process is envisioned by Hydro-Québec now or in the future, I encourage serious consideration all Smart Meters should contain the necessary hardware and software support in order to enable the feature of working in concert with distribution system meters to detect theft.

By including those features now it would reduce the need for mass volume field upgrades later. I suggest that Hydro-Québec do the full system design now to allow for the feature. Then, they would decide what portions of the system are necessary to implement in the initial stages. For example, the smart meters may need certain features or messaging capability, but the distribution meters may not be needed at the beginning.

7.3. Tamper Detection

BC Hydro notes that its "*smart meters have a tamper detection feature that automatically notifies BC Hydro if they have been removed from the wall or otherwise manipulated*"[114].

The specifications of the Itron meters that BC Hydro uses show that the meters provide tamper detection for inversion, removal and reverse power flow[115].

It is important to note that this type of feature is included in the Smart Meters themselves (versus the infrastructure), and therefore needs to be included in the initial purchase of meters, and cannot easily be added later.

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[112] BC Hydro, SMI Business Case (see footnote 47), Page 27
[113] BC Hydro, SMI Business Case (see footnote 47), Page 10
[114] BC Hydro, Smart Meter News, May 3, 2011;
http://www.bchydro.com/news/articles/conservation/2011/smart_meters_energy_theft.html
[115] Itron, OpenWay Centron Meter specification, Page 2;
https://itron.com/PublishedContent/OpenWay%20CENTRON%20Meter.pdf

While Hydro-Québec has noted that their meters will have real-time alarms, namely failure or reverse rotation alarms[116], they have indicated they do not intend to operate those features in the first years. Even after that, they have not committed to using those features at all and it is not clear if the messaging/software support will be provided. It is not clear if the failure alarms cover the cases of meter inversion and meter removal.

It is noted that the 2nd smart meter supplier for Hydro-Québec, Elster[117], describes theft of electricity in a white paper[118]. Elster describes the use of tilt warnings and *"host-based intrusion detection logging*", and that it is "nearly impossible to pierce an Elster meter" [119].

It is not clear if Hydro-Québec will be using the particular model of Elster's that includes these features. Even if it is included in the meter, it is not clear if the system will support the feature. It is also not clear, if the Landis & Gyr meters also include the same feature set.

Why should the Hydro-Québec system be compromised without a full slate of tamper detection features for all of its Phase 1 meters from both suppliers?

Not only should the meters have the hardware (e.g. in the meters) to support this, but it is also recommended that the infrastructure (messaging and alerting operations) also be developed to handle the tampering situations accordingly. BC Hydro has shown that such features can be realistically incorporated without adding exorbitant costs, and that the benefits outweigh the costs.

7.4. Time of Use, Other Rate Structures

A fundamental use and often a main reason for Smart Meters is for the support of innovative rate structures. BC Hydro estimates a benefit of $110 million[120] for voluntary time-of-use rates:

> "*Reducing peak period demand for electricity can reduce the amount of capacity BC Hydro needs in the system, thus potentially deferring the need to build more generation, transmission, and distribution assets.*"[121]

BC Hydro has learned from issues created when "*utilities have chosen to implement time-of-rates at the same time as smart meter installation, resulting in*

[116] C-GRAME-0025, Page 20 of 58, Lines 22 to 23
[117] C-GRAME-0025, Section 4.2.2, Page 27 of 58, Lines 4 to 6
[118] Elster, Jeff McCullough, "Deterrent and detection of smart grid meter tampering and theft of electricity, water or gas"; http://www.energyaxis.com/pdf/WP42-1010A.pdf
[119] Elster, Jeff McCullough, Deterrent (see Footnote 118), Page 2, Column 2
[120] BC Hydro, SMI Business Case (see footnote 16), Page 9
[121] BC Hydro, SMI Business Case (see footnote 16), Page 27

higher bills for customers"[122] and therefore BC Hydro has decided to "*maintain existing rate structures at the same time as meter installation*"[123].

In answer to many questions from the public on the subject, "*Are you introducing time-of-use rates?*"[124] - BC Hydro clearly states that it:

> "*will be maintaining the existing rate structure throughout the implementation period. Any future consideration of new time-of-use rate structures will include transparent public consultation, extensive research on whether there is any long-term need for time-of-use in British Columbia, and the independent regulatory review of the BC Utilities Commission."*

BC Hydro has also clarified in its SMI Business Case that "*any new rate structures will be subject to public consultation and review by the independent British Columbia Utilities Commission*"[125]; this contrasts to the BCUC exemption status of the overall SMI program.

New rate structures can cover a whole host of new structures including time-of-use and critical peak pricing, which were tested in the Conservation Research Initiative – Residential Time-of-Use (CRI-RTOU) pilot project mentioned previously[126]. "*The goal of the Conservation Research Initiative was to examine how individual British Columbians could make a difference and help meet the growing demand for electricity in BC by conserving electricity in their homes."*[127]

The 2006/2008 BCUC-approved pilot involved approximately 2000 customers with smart meters using time-of-use[128] and expanded to include critical peak pricing plus direct load control[129]. BC Hydro reported that the peak consumption was reduced by 11.5% in year one, and 11.1% in year two[130]. The overall consumption was reduced by 7.9% in year one and 5.5% in year two[131].

I was part of the CRI Working Group[132] advising BC Hydro on this program. BC Hydro also gathered advice for the program from the Rates Working Group (of which I was also a member of). The mandate of the Rates Working Group:

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[122] BC Hydro, SMI Business Case (see footnote 16), Page 12
[123] BC Hydro, SMI Business Case (see footnote 16), Page 12
[124] BC Hydro, Smart Meters, Frequently Asked Questions, Question #4; http://www.bchydro.com/energy_in_bc/projects/smart_metering_infrastructure_program/faqs/general_program_faqs.html#4
[125] BC Hydro, SMI Business Case (see footnote 16), Page 1
[126] For more information on CRI (see footnote 62)
[127] BC Hydro, SMI Business Case (see footnote 16), Appendix 3, Page 22
[128] BC Hydro, Conservation Research Initiative – Residential Time-Of-Use Application, Aug 28, 2006; http://www.bcuc.com/Documents/Proceedings/2006/DOC_12451_B-1_Residential-TOU-Application.pdf
[129] BC Hydro, Conservation Research Initiative – Residential Time-Of-Use Application, Second Year, Aug 22, 2006; "2007_08_22_cri_cri tou application-1.pdf" (attached)
[130] BC Hydro, CRI (see footnote 62), Slide 17
[131] BC Hydro, CRI (see footnote 62), Slide 17
[132] BC Hydro, CRI – 2nd year (see footnote 129), Page C-3

"*The over-arching mandate of the Rates Working Group is that given the growing gap between electricity supply and demand in B.C., the group will provide input and advice on how BC Hydro can design and implement rates that provide a price signal to encourage economically efficient and cost effective conservation, and efficient use of electricity, while ensuring that rates are fair and simple to understand.*" [133]

Hydro-Québec does not seem to plan on using Time-of-Use for its full Smart Meter program rollout, even though it already tested rate structures[134] in its "Time it Right" rate project[135] (a similar situation to other features mentioned previously). It is noted that Hydro-Québec states in regard to time-of-use rates in the "Time It Right Project that "*the project showed there is no real interest in those types of rates here in Quebec at the moment*"[136].

I suggest that Hydro-Québec develop an innovative rate structure strategy, but as BC Hydro has done, keep the same rate structure during the installation of the Smart Meters. It is also suggested that Hydro-Québec set up an advisory group similar to the Rates Working Group or CRI Working Group to allow Hydro-Québec the ability to gather detailed "project-specific" customer input on innovative rate structures. It will allow for further investigation into the feasibility of such rates.

7.5. Opt-Out

The California Public Utilities Commission (CPUC), the regulatory body for Pacific Gas & Electric (PG&E), is holding hearings regarding the "opt-out" of customers who do not wish to have smart meters (e.g. for customer concerns with emission levels). PG&E has reported that if its Smart Meter radio was turned off, the meter it uses would not be able to collect interval energy consumption data (e.g. for time-of-use)[137]. The proposed CPUC ruling dated Nov 22, 2011 directs PG&E to enable "opt-out" with either radios-off or radios-out, but must still be able to collect interval energy consumption data[138].

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[133] BC Hydro 2008 LTAP, B-1-1, Appendix K, Page 47 of 213; Pages 79-88 of 213; http://www.bchydro.com/etc/medialib/internet/documents/info/pdf/2008_ltap_appendix_k.Par.0001.File.2008_ltap_appendix_k.pdf

[134] Hydro Quebec, Application R-3644-2007, HQD-12, Doc 5; http://www.regie-energie.qc.ca/audiences/3644-07/Traduction/C-8-15_OC_VA-HQD-12Doc5_3644_21sept07.pdf

[135] Hydro Quebec, Time it Right rate project; http://www.hydroquebec.com/residential/tarif-residentiel.html#heure-juste

[136] Hydro Quebec, Installation of Next-Generation Meters, Frequently Asked Questions, Question #26; http://www.hydroquebec.com/residential/nouveau-compteur/faq.html

[137] California Public Utilities Commission (CPUC), 11-03-014, Nov 22, 2011, Section 4.2, Page 20; http://docs.cpuc.ca.gov/efile/PD/153864.pdf

[138] CPUC, Nov 22, 2011 (see footnote 137), Order 2(a), Page 43

This is hardware functionality not present in some smart meters, and which PG&E is directed to have by Jan 2014[139]. Should the CPUC ruling pass, PG&E will need to exchange its Smart Meters already installed in the field with new Smart Meters that can collect the data with the radio turned off.

It remains to be seen if the same functionality will be required for Hydro-Québec. In any case, I recommend that Hydro-Québec investigate and if not too expensive to ensure that its smart meters can continue to collect interval energy consumption data while radios are off.

7.6. Self-Production – Net Metering

Self-Production encourages local renewable electricity generation, in most cases consisting of a solar panel array or wind turbine to offset the electricity draw from the grid to customer's premise. At times when the local generation is greater than the consumption, the electricity is supplied back into the grid, thereby making the "meter dial go backwards". Hydro-Québec uses a system called Net Metering to reduce a customer's electricity bill with the energy that the customer feeds back into the grid[140].

While one may assume that Smart Meters would naturally handle Net Metering, there have been cases where installed Smart Meters had to be removed and reverted back to analog meters to handle net metering[141]. Southern California Edison states in regards to its Net Energy Metering (NEM) program:

> "*The current version of the Smart Meter, however, is not NEM-compatible . . .*"[142]

In addition, there will need to be some coordination between the tamper detection techniques and Net Metering, as one of the tamper detection alarms is reverse power flow – which is the effect that can occur during Net Metering.

Another consideration is the ability to do Net Metering while operating with Time-of-Use rates; FortisBC, for example, allows for Time-of-Use with its Net Metering program.

There are also considerations for ensuring that Net Metering is supported in the billing system.

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[139] CPUC, Nov 22, 2011 (see footnote 137), Order 2(a), Page 43
[140] Hydro Quebec, Net Metering Rate Option for Self-Generators, Page 5; http://www.hydroquebec.com/self-generation/docs/depliant-mesurage-net.pdf
[141] North County Times, Smart meters and solar panels don't mix, May 28, 2010; http://www.nctimes.com/business/article_560be00e-f979-5516-bf44-873527a9ea96.html
[142] Southern California Edison, Net Energy Metering FAQs, Question #5; http://www.sce.com/customergeneration/net-energy-faqs/net-energy-metering-faqs.htm#Q6

I recommend that the Régie require Hydro-Québec ensure that their Smart Meter system can easily handle Net Metering, and that the Net Metering can be combined with Time of Use and other rate structures.

8. Recommendations and Conclusions

The material on Smart Meters, Smart Grid and Home Area Networks presented in this document provides a useful background for Interveners and the Régie, and allows for a common platform and terminology for discussions with Hydro-Québec.

Smart Meter systems and the Smart Grid can provide great benefits, but also can present significant challenges that need to be overcome.

In my opinion, BC Hydro's SMI program is an appropriate comparison case for Hydro-Québec. I note that the BC Hydro and Hydro-Québec SMI programs are within 10% cost of each other, but BC Hydro's system is slightly larger and has incorporated a full expansion to the other features.

A summary of my suggestions that would be appropriate and reasonable for Hydro-Québec to execute under guidance of the Régie (find full text of suggestions within this document):

- The technical direction of Hydro-Québec should be guided from its own requirements rather than its suppliers,
- Hydro-Québec should articulate its goals,
- Hydro-Québec should demonstrate participation in standards organizations,
- There is not enough information provided by Hydro-Québec on their Smart Metering system plans to fully assess what is being proposed; Hydro Quebec should provide more information,
- Hydro-Québec should fully document all of the benefits (including financial allocations) of its system (planned and potential),
- Hydro-Québec should be required to have an independent evaluation of the technology choices for the Home Area Network,
- Hydro-Québec should setup an advisory group to assist in its innovate rate structure strategy,
- Hydro-Québec should execute a well thought-out initial integrated architectural system step no matter what features are implemented in the first phase, and

- Hydro-Québec should consider the following aspects in the system design of its Smart Meter program:
    - Conservation Tools
    - Theft of Electricity
    - Tamper Detection
    - Time of Use/Other Rate Structures
    - Opt-Out
    - Self-Production – Net Metering.