BEFORE THE CANADIAN RADIO-TELEVISION AND TELECOMMUNICATIONS COMMISSION

IN THE MATTER OF

AN APPLICATION BY CANADIAN ELECTRICITY ASSOCIATION (APPLICANT)

PURSUANT TO PART I OF THE *CANADIAN RADIO-TELEVISION AND TELECOMMUNICATIONS COMMISSION RULES OF PRACTICE AND PROCEDURE* AND SECTIONS 24, 25(1), 32, 35(1), 46.1, 46.2, 47, AND 55 OF THE *TELECOMMUNICATIONS ACT*

TO GRANT CANADIAN ELECTRICITY ASSOCIATION A SHARED MOBILE NETWORK CODE AND OTHER ASSOCIATED RELIEF

30 OCTOBER 2018

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Executive Summary

ES-1. As Canadian Electrical Utilities (“CEUs”) increasingly rely on wireless communications for a myriad of services essential to the continued reliable function of Canadian electrical transmission and distribution grids, it is essential for the CEUs to be able to access public wireless communications networks in the most reliable and cost-effective manner possible.

ES-2. CEA is submitting this application (“Application”) pursuant to Part 1 of the *Canadian Radio-Television and Telecommunications Commission Rules of Practice and Procedure* and sections 24, 25(1), 32, 35(1), 46.1, 46.2, 47, and 55 of the *Telecommunications Act*[1] (“the *Act*”).

ES-3. CEA is requesting the following relief from the Commission:

a. An order from the Commission directing that the CRTC Interconnection Steering Committee (CISC) Canadian Steering Committee on Numbering (“CSCN”) revise the Canadian International Mobile Subscriber Identity Guideline (“IMSI Guideline”) such that CEA may be granted a two-digit Mobile Network Code (“MNC”) to be shared amongst its CEU members;

b. The recognition by the Commission of a new type of Mobile Virtual Network Operator (“MVNO”) namely a Private Mobile Virtual Network Operator (“PVNO”), which, while similar in most respects to a Full MVNO, would not offer telecommunications services to the general public, coupled with recognition that CEUs meet this definition.

ES-4. Canada’s electrical grid has been identified by the federal government as constituting critical infrastructure. Electricity is necessary for the proper function of many other critical services, including, but not limited to, Health, Food, Finance, Water, Information and Communication Technology, Safety, Manufacturing, Government and Transportation. The failure of the electricity supply could result in loss of life, adverse economic effects, and a loss of public confidence in the integrity of Canada’s electrical grid.

ES-5. Canada’s electrical grid is also undergoing constant evolution to meet societal needs and take advantage of new technological developments. For example, electricity is increasingly being generated, stored, and distributed closer to end customers, partly as a result of the accelerating

1 SC 1993, c 38 [“*Telecommunications Act*”].

adoption of renewable energy sources and new storage technologies. The electrical grid is also becoming increasingly digitized as CEUs and customers rely upon so-called “smart devices” to control, where, when, and how electricity is being used.

ES-6. In order to ensure the “always on” reliability required of Canada’s electrical grid in the twenty-first century, CEUs are increasingly leveraging wireless communications in their operations. Some of the key ways in which wireless communications are being used include:

a. Real-time information sharing between field crews (typically for intra-utility, but also for inter-utility mutual aid including cross-border operations during emergencies);
b. Remote monitoring and control of crucial components of the distribution and transmission grids (including smart meters, fault detectors and substation management);
c. Remote monitoring of sensors in key elements of power generation (including seismic, slide, slope, flood, and other sensors);
d. Tracking of workers and assets for planning as well as optimization of incident response efforts;
e. Backup for fixed wireless microwave and wireline fibre optic telecommunications systems also used as described in items a through d.

ES-7. This new digitized electrical grid that leverages wireless communications is also known as the “smart grid”. The smart grid allows CEUs to deliver energy more reliably, by deploying a smarter, more distributed grid. It also provides the tools for CEUs to create innovative new business models, such as enabling customers to optimize their use of electricity, as well as achieving operational and cost efficiencies, all while meeting demand securely and reliably.

ES-8. With emerging technologies and applications, the smart grid requires more and more devices integrated to the home. Without being exhaustive, according to CEA, a smart grid includes components such as smart meters, Intelligent Electronic Devices, plus two-way communications and power flow functionalities to:

- Quickly detect outages, so as to minimize the impact on the rest of system;
- Allow power to be distributed more efficiently and reliably (including peak load shaving);
- Integrate highly variable renewable energy sources, like wind and solar;

- Manage electricity generation flow from centralized power generating stations out to consumers, or from consumers and businesses back into the grid; and
- Facilitate the integration of electric vehicles.

ES-9. Smart grid technology is the necessary future of electricity generation, distribution, and transmission in Canada. Absent the deployment of smart technology, it will be very difficult for CEUs: (a) to ensure the 'always on' availability of electricity throughout the country that is so vital to the twenty-first century economy; and (b) integrate the renewable and user-generated energy sources necessary for Canada to meet its emissions reduction targets.

ES-10. Smart grid technology is also consumer friendly in that it better allows customers to control their electricity costs.

ES-11. There is a significant public safety element to the smart grid as disruptions in the electricity supply can put lives at risk. For example, the 2003 blackout in eastern Canada and the United States led to the deaths of at least 11 people. A subsequent review determined that smart technology would have largely prevented that blackout. A reliable electrical supply is also becoming increasingly important for protecting the sick and elderly who rely upon medical devices powered by electricity. Finally, smart grid technology enhances public safety by allowing the easier detection and thus deterrence of the increasingly common, but very dangerous, practice of electricity theft.

ES-12. Smart grid technology also enhances the safety of utility workers by allowing CEUs to better detect instances of 'islanding', where portions of the grid can remain electrified from local generators during blackouts despite appearing to not be electrified.

ES-13. A truly smart grid also greatly benefits the economy by reducing the frequency and duration of power outages that can result in billions of dollars of losses each year.

ES-14. For Canada's current electrical grid to evolve into a smart grid, CEUs need to be able to communicate effectively with the millions of smart devices that will be deployed into the smart grid. CEA conservatively estimates that within the next 10 to 15 years, CEUs will deploy more than 25 million wireless data devices and over 50,000 voice devices to support the management of the electric supply.

ES-15. Realistically, given the vastness of Canada's electrical grid and the already significant overlap of the grid with the mobile wireless networks of Canada's Mobile Network Operators ("MNOs"), CEUs need to use these wireless networks in order to be able to communicate with the smart devices that they are deploying throughout the electrical grid. Given the immense costs of deploying mobile wireless networks, it simply is not feasible for even the largest CEUs to deploy their own ubiquitous mobile wireless networks. Indeed, many smart devices being used by CEUs today are built to contain SIM cards and are already connected to the mobile wireless networks of MNOs.

ES-16. Unfortunately, while leveraging mobile wireless networks is the best path forward for facilitating the development of the smart grid in Canada, CEUs are experiencing a number of problems under the current regulatory environment that are hampering the deployment of the smart grid in Canada.

ES-17. A significant problem is the phenomenon of SIM card lock-in. As noted above, a smart grid consists of tens of millions of smart devices deployed throughout Canada's electrical grid. Many of these smart devices rely upon SIM cards and mobile wireless connectivity to ensure two-way communications with the CEU and the smart device. However, these SIM cards are only programmed to connect to the mobile wireless network of the MNO that provided the SIM cards that is to say, they are locked into that network.

ES-18. This can be extremely problematic for CEUs. It effectively prevents CEUs from switching mobile wireless providers as switching would require truck rolls to each smart device, which could number in the hundreds of thousands or millions for large CEUs, to manually swap out SIM cards. The cost of these truck rolls is a serious competitive constraint that makes it prohibitively costly for CEUs to switch to a different MNO, even if a different MNO can provide better terms and conditions for providing mobile wireless connectivity to that CEU's smart devices.

ES-19. The high cost of switching and the resulting inability of CEUs to negotiate the best deals possible for providing mobile wireless connectivity for smart devices drives up the cost of deploying smart devices and slows down the development of the smart grid in Canada.

ES-20. SIM card lock-in also limits redundancy in the smart grid. Currently, smart devices subject to SIM card lock-in will not automatically switch communications to the mobile wireless network of an alternative MNO if the primary MNO's network ceases to function for any reason. When these outages in mobile wireless networks occur, CEUs are unable to communicate with their smart devices and effectively lose all visibility into the grid, thus preventing the proper functioning of the smart grid and immediately transforming a smart grid into a legacy grid.

ES-21. Aside from the competitive and redundancy issues associated with SIM card lock-in, CEUs have issues with extending mobile wireless network coverage in rural, and remote areas not served by MNOs in which the CEUs may have electrical infrastructure.

ES-22. In places where MNOs do not offer cellular coverage, CEUs could deploy their own private wireless networks. However, numbering resources are required to do so using 3GPP technology and CEUs must be able to interconnect with the existing networks of MNOs in order to ensure that CEUs can communicate with these smart devices located in rural and remote areas. The relief requested by CEA in this Application will enable this interconnection to occur.

ES-23. Furthermore, there are significant privacy and security concerns inherent in the development of the smart grid as each smart device is potentially a gateway for a cyber-attack by a malicious actor. Currently, CEUs do not have any control over key aspects of the security of their smart devices, including control of the SIM card credentials and subscription database, which are controlled by the MNOs providing mobile wireless connectivity to the smart device. This is unacceptable to CEUs and the relief requested in this Application will allow CEUs to apply utility-grade security standards to these potential vulnerabilities.

ES-24. In order to solve the problems noted above that are hindering the timely development of Canada's smart grid, CEA is proposing that CEUs be permitted to share a unique two-digit MNC that will be administered by the CEA. With a unique two-digit MNC, CEUs will be able to provision their own SIM cards, implement the appropriate systems/networks under their own control, and negotiate corresponding parallel commercial agreements with MNOs.

ES-25. Having their own MNC will allow CEUs to let smart devices select the proper mobile network automatically and switch to another network when quality of service is inadequate or in case of major network failures. Crucially, if CEUs have their own MNC, this switching functionality will be able to be done remotely and will not require truck rolls to each and every one of the tens of millions of smart devices being deployed throughout Canada’s electrical grid.

ES-26. Thus, at a stroke, the problem of SIM card lock-in will be solved, thereby addressing the competitive and redundancy shortcomings described above.

ES-27. Access to a unique two-digit MNC will also allow CEUs to interconnect their private wireless networks in rural and remote areas with the mobile wireless networks of MNOs, thus ensuring that CEUs have a path to communicate with these particular smart devices.

ES-28. With a unique two-digit MNC CEUs will be in a position to have their own core networks, which will be under their own control, thereby addressing the security concerns described above.

ES-29. In order for CEUs to be granted a shared two-digit MNC, regulatory change is required as the current ISMI Guideline, which governs the allocation of MNCs in Canada, does not envision the CEA being able to apply for a shared two-digit MNC for CEUs for the purpose of facilitating the deployment of the smart grid in Canada.

ES-30. CEA is thus proposing the following amendments to the IMSI Guideline, which would allow it to apply for a two-digit MNC to be shared amongst its CEU members:

a. Subsection 7.1 amended to add a new paragraph (d) that reads: “An Electric Utility related association, some of whose members operate as PVNOs, may also be an applicant for a two-digit MNC to be shared amongst its members who operate as PVNOs.”

b. Subsection 7.3(a) amended to read: "The ability of a terminal to access telecommunication services from mobile wireless networks, regardless of whether the terminal itself is in motion or not, and the capability of the network to identify and locate that terminal."

c. Section 15.0, the Glossary, amended to add a new definition of PVNO as follows: "Private Virtual Network Operator (PVNO): is a full MVNO that only provides telecommunication services to itself and not to consumers, operates core network hardware (e.g., switches, routers) separate from all WSPs and has a service profile management system (e.g. Home Location Register [HLR], Home Authentication, Authorization, and Accounting [AAA], or Home Subscriber System [HSS]) for devices owned and/or operated by the PVNO that can access WSP networks in Canada."

ES-31. CEA is proposing that the Commission recognize a new category of wireless service provider, namely PVNOs. A PVNO would be the same, technically, as a full MVNO. However, it would not provide mobile wireless services to consumers, but only to itself (namely for private enterprise needs and internal telecommunication purposes). As such, there should be no requirements for PVNOs to adhere to any of the consumer-centric obligations imposed on MVNOs or wireless carriers such as wireless number portability. CEUs would be recognized as PVNOs.

ES-32. CEA notes that its proposal is not radical or unprecedented. The solution proposed by the CEA to facilitate the deployment of millions of SIM-card enabled smart devices throughout Canada's electrical grid has actually been implemented by the national telecommunications regulator in The Netherlands. Furthermore, both Belgium and Germany are also considering following the Dutch model and assigning MNCs to electrical utilities.

ES-33. The relief requested by CEA advances a number of policy objectives contained in section 7 of the *Act*, by buttressing the Canadian economy, enhancing competition, stimulating innovation, and protecting the privacy and security of customers of CEUs. The relief requested by the CEA is also consistent with the Policy Direction as by addressing the problem of SIM card lock-in, which effectively prevents competition in the provision of mobile wireless services to smart devices, it enhances reliance on market forces. The requested relief is efficient and proportionate as it only requires minor changes to the IMSI Guideline and the recognition of PVNOs. The requested relief is competitively neutral.

1.0 Introduction and request for relief

1. Founded in 1891, the Canadian Electricity Association ("CEA") is the national forum and voice of the evolving electricity business in Canada. CEA contributes to the regional, national, and international success of its members. CEA is governed by a Board of Directors comprised of senior executives from its Corporate Utility Members. CEA's mission is to be the national voice for safe, secure, and sustainable electricity for all Canadians.

2. CEA members generate, transmit, and distribute electrical energy to industrial, commercial, residential, and institutional customers across Canada. Members include integrated electric utilities, independent power producers, transmission and distribution companies, power marketers, manufacturers and the suppliers of materials, technology, and services that keep the industry running smoothly. CEA's strategic goal, on behalf of its membership, is to provide a comprehensive roadmap to address the industry's most pressing issues, including: infrastructure renewal, environmental protection, innovation and technology, Indigenous and North American partnerships, and regulation and security. CEA strives to deliver a coherent and convincing industry viewpoint to decisionmakers on critical policy and regulatory issues. CEA members involved in the generation, transmission, and distribution of electrical energy are collectively referred to as Canadian Electrical Utilities or "CEUs" in this Application.

3. CEA submits this application ("Application") pursuant to Part 1 of the *Canadian Radio-Television and Telecommunications Commission Rules of Practice and Procedure* ("Rules") and sections 24, 25(1), 32, 35(1), 46.1, 46.2, 47, and 55 of the *Act*.

4. As set out more fully below, CEA is requesting the following relief from the Commission:

a. An order from the Commission directing that the CRTC Interconnection Steering Committee (CISC) Canadian Steering Committee on Numbering ("CSCN") revise the Canadian International Mobile Subscriber Identity Guideline ("IMSI

Guideline”) such that CEA may be granted a two-digit Mobile Network Code (“MNC”) to be shared amongst its CEU members;

b. The recognition by the Commission of a new type of Mobile Virtual Network Operator (“MVNO”) namely a Private Mobile Virtual Network Operator (“PVNO”), which, while similar in most respects to a Full MVNO, would not offer telecommunications services to the general public, coupled with recognition that CEUs meet this definition.

2.0 <u>The electrical grid is critical infrastructure and is undergoing significant changes that require the increased and flexible use of mobile wireless networks by CEUs</u>

2.1 The electrical grid constitutes critical infrastructure

5. The electric grid is a key element of the Canada’s critical infrastructure. Public Safety Canada[2] defines “critical infrastructure” as “the processes, systems, facilities, technologies, networks, assets and services essential to the health, safety, security or economic well-being of Canadians and the effective functioning of government. Critical infrastructure can be stand-alone or interconnected and interdependent within and across provinces, territories and national borders.”

6. Disruptions of critical infrastructure could result in catastrophic loss of life, adverse economic effects and significant harm to public confidence.

7. Critical infrastructure is supported by a wide range of stakeholders and entities and it is not straightforward to paint a complete picture of all processes and services, but electricity underpins the proper functioning of many of the other critical services, notably Health, Food, Finance, Water, Information and Communication Technology, Safety, Manufacturing, Government and Transportation.

2 https://www.publicsafety.gc.ca/cnt/ntnl-scrt/crtcl-nfrstrctr/index-en.aspx.

2.2 The electrical grid is evolving rapidly to meet societal needs and take advantage of new technological developments

8. The electrical grid is also under constant evolution. It is becoming increasingly decentralized with energy generated, stored and distributed closer to end customers. This is in part driven by the acceleration of renewable (e.g., wind, solar) and storage technologies. At the same time, the grid is becoming increasingly digitized. The digitization of the electrical grid allows electricity system operators and customers to control where, when, and how electricity is being used. This is critical to allow for efficient capacity planning and capital allocation.

9. Finally, the electrification of Canada is accelerating. Transportation (rail, automotive, aerospace) are gradually becoming integrated into the electrical grid. These use cases further emphasize the need for a reliable electrical grid.

10. Ubiquitous communication is essential to securing that reliability.

2.3 Efficient and effective wireless data communications constitute an increasingly important element of the electrical grid

11. There are five (5) key drivers for the use of wireless communications in electrical operations:

a. Real-time information sharing between field crews (typically for intra-utility, but also for inter-utility mutual aid including cross-border operations during emergencies);
b. Remote monitoring and control of crucial components of the distribution and transmission grids (including smart meters, fault detectors and substation management);
c. Remote monitoring of sensors in key elements of power generation (including seismic, slide, slope, flood, and other sensors);
d. Tracking of workers and assets for planning as well as optimization of incident response efforts;
e. Backup for fixed wireless microwave and wireline fibre optic telecommunications systems also used as described in items a through d.

12. Historically the electrical grid had few dependencies on public wireless communication networks. Most of its connectivity was, out of necessity, provided through separate dedicated purpose-built fixed and mobile wireless networks.[3] .

13. However, it is becoming increasingly less cost-efficient to build out dedicated wireless networks. Spectrum is a scarce resource, the build out of a physical network infrastructure is cost-intensive, and the operational cost is high. Furthermore, cellular technology has become more capable and general public network capabilities have improved to the point that it makes economic sense to explore the enterprise-wide adoption of commercial network technology for utility operations. Thanks to the standardization of LTE and 5G through the 3GPP[4] organization, cellular technology has the critical mass required to attract innovation, making it cost-efficient and ensuring that a broad device ecosystem is available. Specifically, innovation targeted for emerging public safety networks is well suited to electricity operational needs.

14. CEU field crews increasingly rely on public networks for backup communications and high-speed data transfer. Access to public networks is important for inter-utility assistance (including international support) and mutual aid assistance.

2.4 The smart grid requires extensive connectivity services that are best provided by using Canadian mobile wireless networks

15. In addition to all of the factors driving the need for connectivity that have been discussed, the most important such driver, particularly of wireless connectivity, is the evolution of electrical grids into the smart grid.

16. CEUs have deployed their electric system infrastructure over many decades. As Canadians increasingly rely on electricity for their quality of life and economic prosperity, CEUs are investing in new digital protection, automation, monitoring, and control technologies. Many of these new technologies require telecommunications to be deployed deeper and deeper into Canada's electrical grids. This new more connected grid is referred to as the "smart grid."

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3 These alternatives include Private Microwave, WiMAX, and SCADA Radio for grid operations; P25, TETRA for Land Mobile Radio (LMR) or Mesh networks for Smart Metering have been the dominant technologies.

4 3rd Generation Partnership Project. See http://www.3gpp.org/.

17. The smart grid allows CEUs to deliver energy more reliably, and implement a smarter, more distributed grid. It also provides the tools for CEUs to deliver the best customer experience, as well as achieve operational and cost efficiencies, all while meeting demand securely, and reliably.

18. With emerging technologies and applications, the smart grid requires more and more devices integrated to the home. Without being exhaustive, according to CEA, a smart grid includes components such as smart meters, Intelligent Electronic Devices,[5] plus two-way communications and power flow functionalities to:

- Quickly detect outages, so as to minimize the impact on the rest of system;
- Allow power to be distributed more efficiently and reliably (including peak load shaving);
- Integrate highly variable renewable energy sources, like wind and solar;
- Manage electricity generation flow from centralized power generating stations out to consumers, or from consumers and businesses back into the grid; and
- Facilitate the integration of electric vehicles.[6]

19. CEA has attached a background paper ("CEA Smart Grid Paper") further explaining the components of the smart grid and its benefits as Appendix A to this Application.[7]

20. Smart grid technology is the necessary future of electricity generation, distribution, and transmission in Canada. Absent the deployment of smart technology, it will be very difficult for CEUs: (a) to ensure the 'always on' availability of electricity throughout the country that is so vital to the twenty-first century economy; and (b) to integrate the renewable and user-generated energy sources necessary for Canada to meet its emissions reduction targets.

21. Smart grid technology is consumer-friendly technology that, in an age of increasing costs for electricity stemming from a variety of factors, will be particularly beneficial to low and middle-income consumers by enhancing their ability to control their usage of electricity and thus the

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5 An Intelligent Electronic Device is a term used in the electric power industry to describe microprocessor-based controllers of power system equipment, such as circuit breakers, transformers and capacitor banks.

6 Canadian Electricity Association, "The Smart Grid: A Pragmatic Approach", 2010. ["CEA Smart Grid Paper"].

7 *Ibid*.

amount they are ultimately charged. For example, consumers will be able to monitor their electricity usage via an application on their smartphones and reduce their consumption during peak hours. Smart grid technology also reduces the costs of delivering power, by allowing utilities to monitor usage remotely as opposed to sending workers out to customer premises to physically check meters.

22. There is also a significant public safety element to the smart grid. As explained in the CEA Smart Grid Paper, when the power grid goes down, lives are at risk. The infamous 2003 blackout in eastern Canada and the United States caused the loss of at least eleven lives.[8] A review of the root causes of the blackout determined that the entire incident was caused by tree branches in Ohio brushing against power lines and the failure of an alarm to go off subsequently at the local utility.[9] Had smart technology been deployed throughout the grid in 2003, the voltage disruptions caused by the tree branches brushing up against the power lines would have been detected well in advance, thereby enabling the relevant utilities to dispatch workers to remove the branches before the disruptions cascaded throughout eight US states and Ontario.[10] Even if the power lines had been knocked down, smart grid technology would have allowed utilities throughout Canada and the United States to identify the source of the problem correctly, isolate the affected area to prevent the adverse consequences from cascading throughout the grid, and reroute power through other networks in order to minimize the size of the blackout.[11]

23. The smart grid has an important role to play in protecting the sick and elderly, who often use medical devices that require electrical power to operate correctly and are therefore vulnerable to disruptions in the electrical power supply.

24. Smart grid technology also enhances the safety of utility workers. During blackouts, a frequent risk to worker safety is the possibility of "islanding" where portions of the grid remain electrified by power from local generators.[12] Presently, these islands of electricity can be

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[8] *Id.* at pg 10.
[9] *Ibid.*
[10] *Ibid.*
[11] *Ibid.*
[12] *Id.* at pgs 6, 8, 10.

incredibly difficult to detect and pose a constant risk to utility workers seeking to restore power to areas that otherwise appear to be completely devoid of electricity.[13] However, with smart grid technology deployed throughout the grid, utilities will be able to monitor instances of islanding in real-time actively, advise workers to take extra precautions, and shut down generators in the affected areas remotely until workers have fully restored service.[14]

25. By allowing the monitoring of power-flow, smart grid technology also enhances public safety by deterring the very dangerous, but unfortunately increasingly common, practice of electricity theft. For example, BC Hydro has had to deal with over 1,500 instances of electricity theft over three years, all associated with illegal marijuana growing operations.[15]

26. Finally, smart grid technology, by reducing the frequency and duration of outages, will dramatically benefit the economy. A 2004 study found that power interruptions cost the economy of the United States $80 billion per year and other estimates indicate that the loss was as high as $150 billion per year.[16] While the amounts in Canada would be lower due to the smaller size of Canada's economy, the negative impact is still no doubt measured in the billions of dollars per year.

27. Overall, it is vital for economic, public safety, and environmental reasons that CEUs can deploy smart grid technology throughout their grids and have access to the resources necessary to do so in the most cost-effective and reliable way possible.

28. One of the most important aspects of the evolution of the smart grid is the need for CEUs to be able to communicate with the very numerous individual devices that comprise it. CEA expects that within the next 10 to 15 years, more than 25 million wireless data devices and over 50,000 voice devices will be deployed to support the management of the electric supply by CEUs. Considering the current pace of technological evolution and rapid adoption of the Internet of Things ("IoT"), these estimates could be conservative.

13 *Id.* at pg 8.
14 *Ibid.*
15 *Id.* at pg 12.
16 *Id.* at pg 5.

29. Clearly, the availability of ubiquitous, reliable and secure wireless communications technology is essential to the development and operation of the smart grid.

30. Since there is a high degree of overlap of coverage between the aggregate footprints of the mobile wireless networks of Canada's Mobile Network Operators ("MNOs")[17] and CEU electrical grids, it is efficient for CEUs to have their wireless data communications needs met by the MNOs. While it is possible to connect smart devices in the grid via fibre in some cases, realistically, the only way to cover the vastness of Canada's electrical grid, particularly in more rural and remote areas, is to leverage existing mobile wireless networks. Thus, many smart devices being used by CEUs today are built to contain subscriber identification module ("SIM") cards and are connected to existing mobile wireless networks of the MNOs.

3.0 <u>The relief sought by CEA will greatly improve the management of the electrical grid</u>

31. Leveraging commercial mobile networks can bring significant benefits to CEUs. The Commission has estimated that between 2012 and 2016 Canadian telecom providers have spent $8.7B in wireless plant and equipment and $8.9B on spectrum (AWS-3, 700MHz, and 2,500MHz).[18]

32. Clearly, CEUs do not have the capabilities to invest similar amounts of capital in mobile communication network deployments, nor is the diversion of such resources consistent with their core mandate. From an economic and societal perspective, it makes sense to maximize the use of existing assets as opposed to driving additional network deployments (unless that is necessary for specific coverage, security, reliability or capacity requirements).

33. While existing mobile wireless networks constitute a promising method of telecommunications for CEUs to develop the Canadian smart grid, unfortunately CEUs have been experiencing a number of problems under the current mobile wireless regulatory environment that

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17 Those are the entities listed as Wireless Carriers on the Commission's List of Telecommunications Service Providers. See https://applications.crtc.gc.ca/telecom/eng/registration-list?_ga=2.114163207.1818544366.1539969706-670211790.1509399832.

18 https://crtc.gc.ca/eng/publications/reports/policymonitoring/2017/cmr5.htm.

are hindering the deployment of the smart grid in Canada. These problems are discussed below, where we also demonstrate how the relief sought by CEA will solve them.

3.1 SIM card lock-in is hampering the development of Smart Grid in Canada

34. MNOs are fostering vendor lock-in. They do this through a practice known as “SIM card lock-in”. The practice ensures that SIM cards placed in devices will only connect to the mobile wireless network of the MNO that provided the SIM cards. CEUs are subjected to this practice when they obtain SIM cards from MNOs for deployment in smart grid devices.

35. This situation can be extremely problematic if the entity deploying the smart devices later decides that it wishes to switch MNOs. In such a case, the deployer of the smart devices has to physically attend, at every smart device, in order to manually remove each SIM card programmed by the previous MNO, so that it can be replaced with the SIM card programmed to connect to the network of the new MNO. The ‘truck rolls’ necessary for completing this task entail significant cost, which increases exponentially in the case of a comprehensive changeover. Further, there is also a risk of interruption of electricity during these activities.

36. CEUs operate millions of smart devices, including in many rural and remote areas. The cost of sending utility workers to swap out the SIM cards on smart devices in rural and remote areas, for example, could be thousands of dollars per swap. Even in dense urban areas, the sheer number of smart meters and other smart devices involved would make the cost of switching providers prohibitive for any CEU.

37. The problem of SIM card lock-in is a serious competitive constraint which makes it prohibitively costly for CEUs to consider switching MNOs for their smart devices, even if another can provide the CEU with more favourable financial or other terms than the CEU’s current provider.

38. The high cost of switching SIM cards and MNOs is a variable that CEUs must factor into their business cases when deploying smart devices. Consequently, it slows down the deployment of smart devices in Canada and is an impediment to potential new innovative services that will improve control of the electric grid. If a CEU had the ability to switch MNOs so as to obtain service

from the MNO that provides the best financial and other terms, including the best quality of service, as other businesses and consumers can do, the costs of deploying and operating smart devices in Canada's power grid would be lowered and the pace of innovation and deployment could be correspondingly increased.

39. This problem is not unique to the smart devices of CEUs and has been identified by the Organization for Economic Co-operation and Development as a serious challenge to overcome to enable the widespread deployment of IoT devices (which include IoT smart devices that form part of the smart grid).[19]

40. It is imperative for CEUs to have access to a more competitive market for the provision of mobile wireless services. The relief sought in this Application would reduce the cost of switching service providers significantly, thereby giving CEUs more negotiating power when dealing with MNOs . The net result would be increased innovation and reduced costs. One of the incidental, yet very significant outcomes, will be lower electricity rates, which will, among other things, improve the international competitiveness of the Canadian manufacturing sector.

3.2 SIM card lock-in undermines redundancy in the smart grid

41. Another issue associated with SIM card lock-in is its deleterious impacts on public safety and the economy by limiting redundancy in the smart grid. SIM card lock-in makes it very expensive and overly complex to create communications redundancy in the smart grid. In the absence of the ability to program SIM cards such that a CEU could switch communications to smart devices to a secondary MNO, when there is a technical problem with the service provided by the primary CEU, the CEU would have to integrate additional communications mechanisms to achieve high availability and seamless switching between communication paths, and that could certainly push additional complexity in to the smart grid devices.

42. As described above, minimizing the frequency and duration of outages is vital to Canada's public safety and the country's economy. Smart devices in the power grid help minimize the

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[19] Organization for Economic Co-operation and Development, *OECD Digital Economy Outlook 2015*, http://www.oecd.org/internet/oecd-digital-economy-outlook-2015-9789264232440-en.htm, at pg 252.

duration and frequency of outages by: (a) allowing CEUs to detect problems in the grid before they transform into a full-blown outage; and (b) enabling CEUs to pinpoint the sources of the problems in the grid precisely when outages do occur, thus allowing for resources to be focused on those problem areas instead of time being wasted while first trying to determine the cause of the problem. Obviously, for these benefits of the smart grid to be realized, the smart devices in the grid need to be able to provide data to CEUs via telecommunications.

43. A frequent issue encountered by CEUs is the inability to communicate with smart devices deployed throughout the grid due to either planned or unplanned outages in the networks of the MNOs contracted to provide connectivity to the smart devices. CEA understands that unplanned outages can occur in the networks of MNOs for a variety of reasons. However, in CEA's experience, it is rare for all the mobile wireless networks in a given area to experience an outage at the same time. Usually at least one mobile wireless network will still be offering service, even if others are down. Accordingly, if smart devices could have access to two or more networks, network availability would clearly be increased.

44. Unfortunately, due to SIM card lock-in, smart devices deployed throughout the grid will not automatically connect to the mobile wireless networks that are still functioning in a given area and use a still functioning network as a new home network. CEA notes that there is no technical justification for this state of affairs; it is merely the business decisions of the MNOs that result in this lack of redundancy existing in the smart grid.

45. This is a serious reliability issue that compromises public safety and has negative economic impacts by hindering the ability of CEUs to monitor and respond to issues in the grid. CEUs face losing visibility into the power grid if they are solely reliant on a single MNO that experiences an unexpected outage and there is no ability for the CEU's smart devices to switch seamlessly onto still functioning mobile wireless networks.

46. Electric utilities are deemed to be critical infrastructure providers by Public Safety Canada and are subject to the National Strategy for Critical Infrastructure, the purpose of which is to strengthen the resiliency of critical infrastructure in Canada in the face of current and emerging

hazards.[20] Accordingly, the current lack of redundancy in CEU's smart devices is highly problematic.

47. In summary, SIM card lock-in, by tying a CEU's smart devices to the network of only one MNO which may experience planned or unplanned service outages, is undermining redundancy by creating single points of failure in the smart grids of CEUs. It is imperative that CEUs smart devices have the ability to automatically connect to still functioning mobile wireless networks in the event that the primary home network of a smart device experiences an outage. The relief sought by CEA in this Application would enable this to occur.

3.3 CEUs need to be able to deploy and interconnect their private networks with the networks of MNOs

48. Aside from the competitive and redundancy issues associated with SIM card lock-in, CEUs have issues with extending mobile wireless network coverage in rural and remote areas not served by MNOs in which the CEUs may have electrical infrastructure.

49. CEA does not necessarily expect MNOs to expand their networks so the entire Canadian electrical grid is served by commercial mobile wireless networks. In many cases, CEUs already deploy their own telecommunications networks. In places where MNOs do not offer cellular coverage, CEUs could deploy their own private wireless networks. However, numbering resources (IMSI / MNC) are required to do so using 3GPP technology.

50. Where coverage is not available from MNOs, a CEU should be able to deploy its private network and interconnect with the existing networks of MNOs in the areas in which they do offer service to the public. The relief sought by CEA in this Application would enable this to occur.

[20] Public Safety Canada, *National Strategy for Critical Infrastructure*, 2009, at pg 2.

3.4 CEUs must be able to secure the smart grid and protect the privacy of confidential information

51. The deployment of the smart grid inherently involves significant security and privacy risks. Each smart device constitutes a potential vulnerability that could be hacked by malicious actors to gain access to confidential information or used as a gateway to attack the rest of the smart grid. These privacy and security concerns are mounting significantly as millions of smart devices are being deployed throughout Canada's power grid.

52. Some security issues are related to the control of the SIM card credentials, also known as security keys, and subscription databases owned and controlled by the serving MNO core networks. CEUs have no control over these aspects and rely completely on the serving MNO to which the SIM card is associated.

53. Without control of the SIM card and Packet Data Network Gateway, CEUs are not able to protect their control systems from network layer attacks. For example, without the SIM card security keys, CEUs have no way of knowing whether a device connected to their networks actually belongs to the CEU or is a device that is operated by a malicious actor. With control of these security keys, CEUs will be able to prevent devices operated by malicious actors from connecting to their networks, thereby ensuring the security of the smart grid. Consequently, CEUs need their own isolated core networks to have control over device and subscription related security aspects while also ensuring the required redundancy and reliability discussed above by being connected to more than one MNO's Radio Access Network ("RAN").

54. CEA has attached as Appendix B to this Application a diagram demonstrating how if they are permitted to operate as PVNOs with their own shared two-digit MNC, CEUs will be able to deploy their own core networks with the key security elements described above, safely under their own control and subject to utility-grade security standards.

55. Accordingly, the relief sought by CEA in this Application, namely allowing CEUs to access a unique two-digit MNC administered by the CEA and permitting CEUs to operate as PVNOs, will address the security concerns by allowing CEUs to develop their own core networks.

4.0 **A shared two-digit MNC for CEUs will overcome the obstacles that CEUs are experiencing and that impede the development of smart grid in Canada**

56. CEA wishes to emphasize that Canada's MNOs are valued business partners who obviously have a vital role to play in the deployment and development of Canada's smart grid. However, current technical and regulatory limitations have hampered CEU's ability to fully leverage the capabilities of Canada's MNOs and have frustrated the timely development of Canada's smart grid. Fortunately, as explained below, there is a simple solution to the problems identified in Part 4.0 above that would help resolve both technical and policy matters: allowing CEUs to share a two-digit MNC.

57. As noted above, to facilitate the necessary deployment of the smart grid in Canada, CEA is requesting that the Commission issue an order directing that the CSCN revise the IMSI Guideline such that CEA may be granted a unique two-digit MNC to be shared amongst its CEU members. CEA would be responsible for providing access to this two-digit MNC to its CEU members.

58. The Commission explained the purpose of an MNC in Telecom Decision 2015-496[21] ("TD 2015-496") as follows:

> An MNC is a unique identification number that identifies a specific wireless service provider's (WSP) network in a given country. The MNC permits a WSP to establish direct roaming agreements with both domestic and international providers because its network can be uniquely identified.[22]

59. If CEA is allocated a two-digit MNC, CEUs will be in a position to share this MNC with its CEU members which, in turn, will be able to deploy their own SIM cards in smart devices, as well as implement the appropriate systems/networks under their own control and negotiate the necessary corresponding commercial agreements with MNOs.

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[21] Telecom Decision CRTC 2015-496, *CISC Canadian Steering Committee on Numbering – Revised Canadian International Mobile Subscriber Identity Guideline*, 6 November 2015 ["TD 2015-496"].

[22] *Id.* at para 2.

60. Having their own MNC, and commercially negotiated service agreements with multiple MNOs in the same area, will allow CEUs to let smart devices select the proper mobile network automatically and switch to another network when quality of service is inadequate or in case of major network failures. It is this ability of an MNC to allow the devices to be directly managed by the CEUs, which CEA believes will solve many the problems identified in Part 3.0 of this Application.

61. With their own MNC, CEUs will be able to overcome the obstacles caused by SIM card lock-in. A unique two-digit MNC, shared amongst CEUs, will allow CEUs to install their own SIM cards in their smart devices, as opposed to SIM cards programmed by the contracted MNO.

62. By having their own SIM cards, CEUs will be in a position to negotiate more competitive pricing for smart devices as mobile wireless service providers will know that CEUs will have the capability of moving to another provider instead of being locked-in due by prohibitive costs arising from the need to physically switch SIM cards on multitudes of deployed smart devices.

63. SIM cards belonging to CEUs with a shared MNC belonging to CEA will also make it possible to address the redundancy issue described in Part 3.0. Currently, if the home network of a smart device experiences an outage, that device does not automatically switch to another mobile wireless network that may still be functioning. This is a serious problem. It means that CEUs lose the enhanced automation and control of their grids provided by cellular enabled smart devices during the outage of the home network.

64. However, with a unique two-digit MNC belonging to CEA, individual CEUs will be able to enter into agreements with MNOs such that if one mobile wireless network in a given area fails, the smart device will switch to alternative mobile wireless networks that are still functioning. Without a unique two-digit MNC, CEUs are unable to enter into these agreements directly and must rely on inter carrier agreements, which effectively precludes their smart devices from being switched to alternative home networks in the event of an outage in the primary home network of the smart device.

65. With an MNC it will also be easier for CEUs to interconnect their private cellular networks with MNOs' networks, in areas where MNOs do not offer coverage so that a CEU can deploy smart devices within its own network. This will ensure that those devices can communicate with the rest of the smart grid, which is served by other MNOs. In this way, the geographic scope of the smart grid will not be unduly constrained.

66. As explained in previous sections, there are security issues related to the control of the SIM card credentials and subscription databases, which are currently owned and controlled by the serving MNO's core network. CEUs currently have no control over these aspects and rely completely on the serving MNO to which the SIM card is associated. With an MNC belonging to CEA, a CEU would be able to have an isolated core network under its own control, connected to more than one RAN, and have control over security aspects while ensuring redundancy and reliability.

67. Overall, if CEA acquires its own unique two-digit MNC, which it will share amongst its CEU members, it will be able to overcome the obstacles noted in Part 3.0 of this Application, which are hindering the deployment and development of the smart grid in Canada. However, as explained further below, CEA will only be able to obtain an MNC through regulatory change.

5.0 Regulatory change is needed for CEA to acquire an MNC and be granted PVNO status

68. The allocation of MNCs in Canada is governed by the ISMI Guideline.[23] Currently, the ISMI Guideline is drafted in a restrictive fashion such that, although they have a bona fide need for an MNC, CEUs are unable to currently receive an MNC from the ISMI Administrator.

69. The following subsections of the IMSI Guideline prevent CEA from applying for an MNC on behalf of its CEU members:

[23] TD 2015-496 at para 2.

7.1 The MNC applicant must be one of the following:

a) an entity who is licensed by Industry Canada for the spectrum utilized by a wireless network and be registered as a telecommunications carrier with the CRTC to operate in the area in which it intends to provide a mobility service, and who provides evidence of certification to the IMSI Administrator.

b) A public safety related association that has a need to roam onto/from telecommunications carriers' networks in Canada may also be an applicant for an MNC. See Appendix 2.

c) an entity registered with the CRTC as a Full MVNO.

[….]

7.3 The applicant must certify that the MNC will be used for mobile applications. That is, the applicant must certify that the service provided will have the following characteristics:

a) Terminal Mobility – The ability of a terminal to access telecommunication services from different locations and while in motion, and the capability of the network to identify and locate that terminal.

b) Personal Mobility – the ability of a user to access telecommunications services at a terminal on the basis of a personal identifier, and the capability of the network to provide those services according to the user's profile. Personal mobility involves the network capability to locate the terminal associated with the user for the purpose of routing.

[….]

Appendix 2

1. The IMSI Administrator will assign a single, common Mobile Network Code (MNC) for use by all Industry Canada authorized 700 MHz public safety broadband network operators.

2. In addition to the allocation of the single public safety MNC, the IMSI Administrator is authorized to set aside additional MNCs for use by public safety if justified to the IMSI Administrator, CRTC staff and Industry Canada staff.

70. Unfortunately, CEA does not fit neatly into any of the categories required to obtain an MNC under the ISMI Guideline. CEA does not qualify under subsection 7.1(a) as neither it, nor

all its members, are telecommunications carriers for mobility services. CEA also does not qualify under subsection 7.1(c) as neither it, nor its members, are Full MVNOs.

71. CEA closely examined the possibility of applying under subsection 7.1(b) as a public safety related association. Certainly, one of the roles of CEA is advancing public safety and, as detailed above, CEUs play a vital role in public safety through their efforts to maintain the integrity of Canada's supply of electricity. In addition, CEA is participating in consultations related to the 700 MHz public safety broadband network ("PSBN") and expects CEUs to be included as users and/or operators of that network.

72. However, as the PSBN is not yet established, it is not certain that CEU will achieve the desired level of network access and control on a permanent basis.

73. In any event, even if CEA was considered by the Commission to be able to apply for an MNC under subsection 7.1(b) of the ISMI Guideline, CEA's application would still be stymied by the restrictive requirements of subsection 7.3 of the ISMI Guideline, which require that a MNC be used for "mobile applications." Subsection 7.3(a) of the ISMI Guideline specifically requires that an applicant for an MNC use it for "terminal mobility", namely the ability of a terminal "to access telecommunication services from different locations and while in motion." This is a problematic and restrictive definition for CEA as the smart devices that make up Canada's smart grid are mostly fixed in place, although they rely upon mobile wireless networks and technology for connectivity.

74. Thus, CEA would propose the following amendments to the ISMI Guidelines in order to facilitate the granting of an MNC to CEA and all the benefits that will flow from such a grant:

a. Subsection 7.1 amended to add a new paragraph (d) that reads: "An Electric Utility related association, some of whose members operate as PVNOs, may also be an applicant for a two-digit MNC to be shared amongst its members who operate as PVNOs."

b. Subsection 7.3(a) amended to read: "The ability of a terminal to access telecommunication services from mobile wireless networks, regardless of whether the terminal itself is in motion or not, and the capability of the network to identify and locate that terminal."

c. Section 15.0, the Glossary, amended to add a new definition of PVNO as follows: "Private Virtual Network Operator (PVNO): is a full MVNO that only provides telecommunication services to itself and not to consumers, operates core network hardware (e.g., switches, routers) separate from all WSPs and has a service profile management system (e.g. Home Location Register [HLR], Home Authentication, Authorization, and Accounting [AAA], or Home Subscriber System [HSS]) for devices owned and/or operated by the PVNO that can access WSP networks in Canada."

75. As noted above, CEA is proposing that the Commission recognize a new category of wireless service provider, namely PVNOs. A PVNO would be the same, technically, as a full MVNO. However, it would not provide mobile wireless services to consumers, but only to itself (namely for private enterprise needs and internal telecommunication purposes). As such, there should be no requirements for PVNOs to adhere to any of the consumer-centric obligations imposed on MVNOs or wireless carriers such as wireless number portability. CEUs would be recognized as PVNOs.

76. CEA notes that while it would be the entity applying for a unique two-digit MNC, this MNC would then be shared among its CEU members who operate as PVNOs.

77. CEA is open to working with the Canadian Steering Committee on Numbering (CSCN) to further modify the proposed modification to the ISMI Guideline set out above, as well as any other consequential amendments required to the ISMI Guideline, so long as it enables CEA to obtain the necessary two-digit MNC so that its CEU members can share the MNC and operate as PVNOs so that CEUs can use smart devices more efficiently.

78. Regulatory action on the part of the Commission is required for CEA to obtain a shared two-digit MNC for its CEU members that will allow them to operate as PVNOs and access and operate reliable cellular communications systems to support the build out of a cost-effective communications infrastructure for smart grid applications in Canada.

6.0 Other jurisdictions are granting or considering granting MNCs to electrical utilities

79. CEA is aware of at least one other national telecommunications regulator that has granted the relief that CEA is now seeking in this Application. The national telecommunications regulator of The Netherlands created a shared MNC to be used by public utilities and recognized a new category of mobile wireless service provider, namely PVNOs.[24]

80. The Dutch electrical and gas utility Enexis has taken advantage of the opportunity to have its own MNC, independent of the control of the telecommunications companies, to facilitate its roll-out of smart devices throughout its grid.[25] Further, Enexis indicated that the PVNO solution, in which it has access to a shared MNC, allows it to avoid the issue of SIM card lock-in.[26]

81. Other European jurisdictions, namely Belgium and Germany are also considering following the Dutch model and assigning MNC's to electrical utilities.[27] In fact, Europe's Electronic Communications Committee, which is responsible for coordinating spectrum and numbering policy across Europe, issued a report in 2014 which specifically contemplated the possibility of national regulators providing MNC's directly to utilities:

> According to Recommendation ECC/REC/(11)03 on "Numbering and Addressing for Machine-To-Machine (M2M) Communications", M2M is a communication technology where information can be transferred in an automated way with little or no human interaction between devices and applications.
>
> Machine-To-Machine (M2M) communications offer promising opportunities for new and existing market players and the M2M supply chain may vary depending on the nature of the service, the size of the M2M customer (i.e. number of M2M devices) and whether services are provided on a national or global basis. For illustrative purposes we use three examples where E.212 resources are required and where the MNC assignment may be made directly to the end customer, to a specialist intermediary or using the existing MNC and IMSI resources of the underlying mobile network operator.

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24 Enexis, "Enexis Private MVNO Solution" Presented 5 November 2015 at European Utility Week, https://www.engerati.com/sites/default/files/eventpres/151105%20Enexis%20Private%20MVNO%20solution%20PUBLISH_0.PDF, at pg 18 ["Enexis Presentation"].

25 Enexis Presentation, at pg 24.

26 Enexis Presentation, at pg 24.

27 Organization for Economic Co-operation and Development, *OECD Digital Economy Outlook 2015*, http://www.oecd.org/internet/oecd-digital-economy-outlook-2015-9789264232440-en.htm, at pg 253.

[….]

A utility company may deploy millions of smart meters at customer premises over a wide geographic area. If the utility company wishes to move to a new MNO on better commercial terms or for improved network coverage it would need to swap out the SIM card in each of its millions of meters. Visiting each meter would be cost prohibitive and logistically impracticable. Therefore, a network “lock-in” effect is introduced which could have a distortive effect on competition in the market. If the utility company has its own MNC and unique IMSI range then the barrier to switching could be reduced as changes to network systems could be made to facilitate the change rather than through the physical replacement of SIM cards.

Communications for smart metering is essential to facilitate customer billing but it is also an integral component in the development of smart grids. In the future, communications with smart meters will become more critical and utility companies will demand uninterrupted communications by having network redundancy arrangements in place through national roaming agreements. By having its own MNC and unique IMSI range, the utility company could enter into national roaming agreements with all the available network operators to ensure uninterrupted communications. The social and economic benefits of smart metering and smart grids should be considered in assessing the need for MNCs for this purpose.[28]

82. Domestically Canadian Researchers and Manufacturers have been promoting the PVNO operating model for electricity management. In 2014, IREQ and Ericsson published an article in IEEE Canadian Review describing the benefits of the PVNO operating model for Canadian Electric Utilities.[29]

83. Based on all of these developments, it is clear that CEA’s requested relief is not radical, nor unprecedented. Utilities have successfully been granted their own MNC in The Netherlands and other European regulators are also examining the possibility of providing utilities with MNCs to facilitate the “social and economic benefits” of the smart grid.

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[28] European Conference of Postal and Telecommunications Administrations, Electronic Communications Committee, *ECC Report 212*, 9 April 2014, at pgs 18-19.

[29] Basile, et al. “*LTE for Smart Grid Communication The Canadian Outlook*”, *IEEE Canadian Review, 2014*, at pgs 26-29. See http://canrev.ieee.ca/cr72/ICR72_SmarterGrid-LTE.

7.0 <u>The relief requested by CEA advances the policy objectives and is consistent with the Policy Direction</u>

84. The relief requested by CEA advances the policy objectives in section 7 of the Telecommunications Act and is consistent with the Policy Direction.[30]

85. CEA's requested relief will advance the following policy objectives:

a. The policy objective in subsection 7(a) will be advanced as the smart grid will provide more reliable and more affordable electricity for all Canadians than is currently available from the present power grid, thus advancing the economic and social fabric of Canada and its regions.

b. The policy objective in subsection 7(b) will be advanced as significant amounts of Canada's telecommunications infrastructure and devices rely upon electricity generated and delivered by CEUs. By improving the reliability and affordability of electricity in Canada, the smart grid will also enhance the quality of telecommunications services in Canada by ensuring that telecommunications devices and infrastructure are always able to function.

c. The policy objectives in subsection 7(c) and 7(f) will be advanced by addressing the problem of SIM card lock-in. SIM card lock-in severely limits the ability of CEUs to switch between mobile wireless carriers and is therefore a bar to effective competition. In effect, a single carrier can lock in a utility customer for years even if another carrier offers better rates or service due to the high cost of switching associated with locked-in SIM cards. If a carrier has an effective monopoly on the smart grid business provided by a CEU once it wins the initial contract, then, by definition, neither competition nor market forces are present.

d. The policy objective in subsection 7(g) will be advanced by the relief requested by CEA by placing Canada at the forefront of innovation when it comes to smart devices. The requested relief will also give Canada a vital competitive edge in the race to deploy smart grids.

e. The policy objective in subsection 7(i) will be advanced by addressing security issues and privacy of customers as CEUs would be in a position to have isolated core networks under their own control, with their own subscriber databases and management tools, thereby giving the CEUs control over all the security aspects of the service.

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[30] *Order Issuing a Direction to the CRTC on Implementing the Canadian Telecommunications Policy Objectives*, SOR/2006-355 ["Policy Direction"].

86. The relief requested by CEA is also consistent with the Policy Direction. By addressing the problem of SIM card lock-in, the relief will enhance competition as well as increase reliance on market forces.[31] Obviously, if a mobile wireless service provider has an effective monopoly on the provision of service to a CEU's smart devices, there can be no competition or reliance on market forces.

87. The relief is also efficient and proportionate and only requires minor changes by the Commission to definitions in the ISMI Guideline to enable CEUs to obtain their own MNCs,[32] and the creation of a PVNO category.

88. The relief sought is also competitively neutral and does not favour any particular technology, carriers, or "resellers".[33]

89. Overall, CEA's requested relief advances the policy objectives in section 7 of the *Telecommunications Act* and is consistent with the Policy Direction.

8.0 Conclusion

90. Canada's power grid, while still enviable by many international standards, needs upgrading to meet the energy needs of the country in the twenty first century. The Canadian economy demands 'always on' reliable and affordable electricity. Governments are requiring CEUs to reduce their carbon emissions and deliver energy more efficiently. Individual consumers want more control over how they consume electricity and, in some cases, to sell electricity that they generate, for example, via solar panels, back to CEUs.

91. To meet these demands, CEUs need to invest in transforming their individual grids, which collectively make up the network of networks that is Canada's national electrical grid, into a smart grid. This transformation requires the deployment of millions of smart devices connected to mobile

[31] Policy Direction at ss 1(a)(i)-(ii).
[32] Policy Direction at s 1(a)(ii).
[33] Policy Direction at s 1(b)(iv).

wireless networks throughout the grid to remotely monitor and modify the flow of electricity throughout the grid as necessary.

92. Unfortunately, the issue of SIM card lock-in stemming from CEUs' inability to operate their own MNC is slowing the development of Canada's smart grid by imposing significant costs and hindering the establishment of redundancy throughout the smart grid. CEUs also have significant security concerns stemming from their inability to control the security certificates associated with SIM cards that they currently receive from the MNO with whom they contract provide connectivity to their smart devices.

93. However, these obstacles will be overcome, and the deployment of the smart grid in Canada facilitated, by the Commission enabling CEA to obtain a unique two-digit MNC to share amongst its CEU members, which is the principal relief requested by CEA in this Application. In order to achieve this result, CEUs will also need to be granted PVNO status.

94. With their own MNC, CEUs will be able to avoid the problems associated with SIM card lock-in, interconnect their private networks with those of other MNOs, ensure that security protocols meet utility standards, and ensure the best network reliability possible.

95. The relief sought by CEA is not only technically feasible, but it has already been implemented in The Netherlands and is being examined by national telecommunications regulators in other European jurisdictions.

96. Consequently, CEA urges the Commission to grant its request for relief in this Application and allow it to have access to a unique two-digit MNC to be shared amongst its CEU members.

97. By enabling CEA to have its own MNC, the Commission will be clearing the way for CEUs to continue deploying smart devices throughout Canada's power grid in order to transform it into a true, twenty-first century, smart grid, with all the associated benefits for reliability, affordability, the environment, and public safety that the smart grid entails.

APPENDIX A

THE SMART GRID:
A PRAGMATIC APPROACH

A "State-of-Play" Discussion Paper Presented by the Canadian Electricity Association

Canadian Electricity Association | Association canadienne de l'électricité


Charging
Current
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EXECUTIVE SUMMARY

The electricity sector has become the focus of heightened policy interest in Canada, as elsewhere, in the context of escalating concerns over emissions, security, and energy demand growth. In this elevated policy context, the smart grid has been much discussed often as a panacea rather than simply the continued maturation of an electricity network that was already on a steady path to automation—and indeed already had some "smart" components.

Unfortunately, this has led to heightened expectations by customers that have yet to be met. As such, the industry finds itself at a crossroads between initial enthusiasm based on industry excitement, and the more pragmatic, cautious path forward. It simply cannot be overemphasized: without customer consent, the deployment of the smart grid will surely stall.

To progress towards a smart grid roll-out that is both valuable to stakeholders and widely accepted by customers it is important to understand exactly what a smart grid is. There are numerous definitions, but the electricity industry in Canada sees the smart grid as a suite of information-based applications made possible by increased automation of the electricity grid, as well as the underlying automation and communication infrastructure itself. As the underpinning to the business case, the various applications and automation technologies must deliver on one or more of the following benefits: grid resilience, environmental performance, or operational efficiencies.

The transition to a more automated grid—in pursuit of the above mentioned benefits—entails changes and enhancements across the grid value chain, from how the electricity supplier operates, to how the network is structured, to how the end user interacts with the grid infrastructure. These changes can be organized into five categories, and constitute the smart grid's key characteristics or capabilities: demand response, facilitation of distributed generation, facilitation of electric vehicles, optimization of asset use, and problem detection and mitigation. Hard infrastructure, such as smart meters, network devices, energy storage, and smart appliances, as well as soft infrastructure such as interoperability standards, cyber security protocols, the 1.8 Ghz spectrum, and stakeholder engagement, represent the building blocks that support the five key capabilities. Interwoven into each of these characteristics and building blocks is the theme of improving the customer experience through new service offerings, reduced delivery charges for those offerings, and faster response times.

With this understanding of what constitutes a smart grid, it is important to review growing pains and early lessons learned in order to assess how, as a sector, we must adapt to move forward. Security, privacy, implementation cost and stakeholder engagement have each been areas of concern to date; vendors, policy-makers, regulators and utilities must work together to ensure that our collective shareholder, the customer, recognizes the full worth of each installed component of the smart grid.

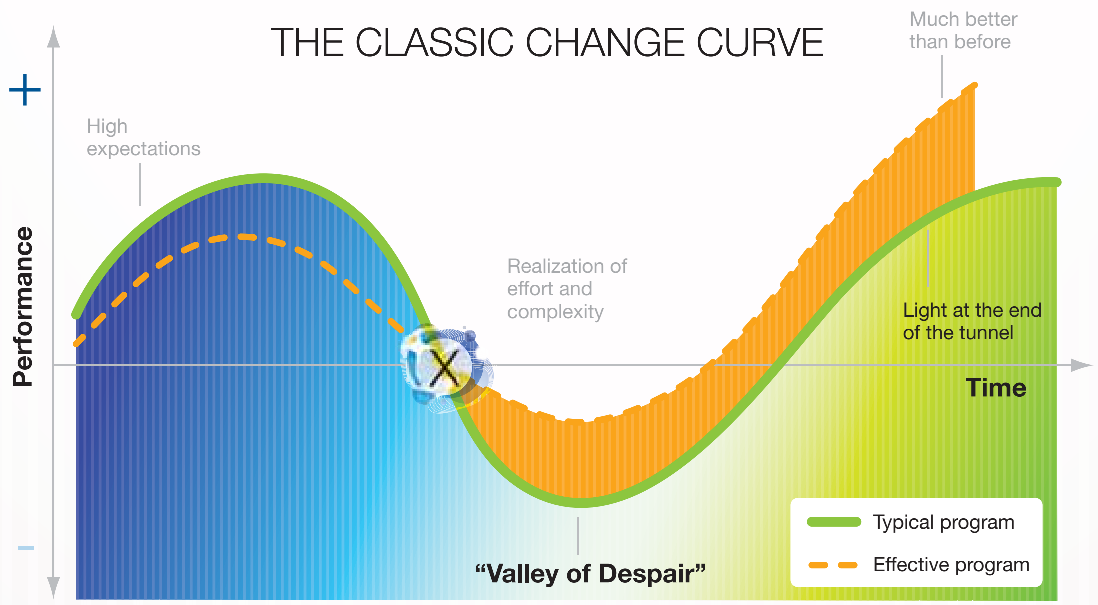
Generally speaking, the business case for automation has been proven time and time again, and the electricity industry will gain value from automation as well. The remaining question marks surround not *if,* but rather *which technologies, at who's pace, and at what level of public acceptance*. This paper provides the basis for discussion of how we will collectively move from "high expectations" through "the valley of despair" and onto "continuous improvement"; this ought to be done through a process of confronting reality, crafting a vision, and communicating belief in the process.

INTRODUCTION

To some, the term "smart grid' has already overstayed its welcome. Governments in some jurisdictions, such as Ontario, are having to defend their mandated smart grid roll-outs to a public that is increasingly wary of smart meters and time-of-use pricing, is pushing back against near-by distributed generation projects, and has been slow to show interest in electric vehicles. In addition, electricity regulators are cautiously examining the costs and benefits to electric utility customers, and utilities are examining whether the smart grid equipment available today is quite as "smart" as it is touted to be. Therefore, despite theoretical benefits and some early demonstrated successes, the smart grid appears to be at a critical phase in its development. A change management consultant with a flair for the dramatic might say that at least some aspects of the smart grid concept have entered "the valley of despair" which often follows "high expectations" and precedes "continuous improvement" on a typical graph showing the phases of change.

HIGH EXPECTATIONS

As a concept, the smart grid is intuitive and elegant. Digitization has drastically changed the world of telephony, a mechanic more often wields a diagnostic computer than a wrench, the internet has transformed shopping, and email has replaced the hand-written memo. It was only a matter of time before the electricity grid, recognized by many as the world's biggest machine, was automated as well.



In addition, and more importantly, the smart grid provides a plausible response to a very important question: how will we, as a society, bring together the elements required to ensure that our energy use is sustainable for future generations. Among other benefits, the smart grid facilitates the integration of wind and solar and geothermal; it enables a car to be powered by (mostly) hydro power rather than conventional fossil fuels; and it gives customers the knowledge and tools to make the right choices. What's not to like?

This view has been promoted most eagerly by the vendor community that has developed the equipment and software to make it happen. In one recent ad, a scarecrow dances on power lines singing the Wizard of Oz classic "If I Only had a Brain"; similarly, President Obama has been asked to "adopt the goal of giving every household and business access to timely, useful and actionable information on their energy use... [in order to] unleash the forces of innovation in homes and businesses... harness the power of millions of people to reduce greenhouse gas emissions - and save consumers billions of dollars."[1] Now *that* is marketing.

Governments themselves, such as the current Obama administration, have also played a role in the cycle of high expectations, touting smart meters as a way for customers to save money (rather than shift consumption to better optimize generating assets), and assuming that grid advances would allow for the connection of a near unlimited supply of variable generation. Some utilities, as well, underestimated the volume and precision of communication and relationship building required to change a customer base of passive electricity users into active market participants.

REALITY CHECK

This push-back by the customers is what has led, for some technologies in some jurisdictions, to the rather hyperbolically named "valley of despair". Questions have arisen about the benefits of the smart grid by those who pay the rates, and as such a closer examination of the underlying business case appears to be underway, industry-wide.

This is not a new phenomenon; large movements of technological change are almost always over-promised and under-delivered in the first several years of implementation. An obvious illustrative example is the internet; early expectations were that online shopping would quickly replace bricks-and-mortar stores, a stock bubble formed, expectations were adjusted to the realistic pace of change, and the bubble burst. This is not to say, of course, that online shopping was conceived on a false premise. When the dust settled, the strong online applications remained and a better understanding of the space has led to a process of continuous improvement. The speed at which the utilities and other stakeholders translate lessons learned by the front runners to best practices for all will determine how quickly the smart grid moves towards that final, steady, upward slope.

CONTINUOUS IMPROVEMENT

Just as with online shopping, at the heart of the smart grid is a rational concept with real value. Increased automation of the electricity grid will improve its performance and allow for the integration of various applications and usages. That improvement, however, will depend on a myriad of utility-specific factors including the energy supply mix, the infrastructure already in place, and their relationship with their customers.

This paper seeks to explain the broad functionality of the smart grid as it pertains to Canada and the benefits that it affords to both customers and grid operators, while also setting the stage for all stakeholders to work together for the continuous improvement of the smart grid. Because call it what you would like, the smart grid is moving forward—and that's a good thing.

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[1] *A Letter to the President of the United States.* April 5, 2010. Google Inc. et al.

I. DEFINITION AND OBJECTIVES OF THE SMART GRID

A) Definition

The smart grid represents an array of visions to an array of stakeholders. Due to this variance, as well as the complexity of the technologies involved, it is not surprising that the smart grid has given rise to a number of definitions and explanations. Here are three examples of descriptions recently published by trusted authorities:

» "A smart grid is a modern electricity system. It uses sensors, monitoring, communications, automation and computers to improve the flexibility, security, reliability, efficiency, and safety of the electricity system."[2]

» "The smart grid takes the existing electricity delivery system and makes it 'smart' by linking and applying seamless communications systems that can: gather and store data and convert the data to intelligence; communicate intelligence omnidirectionally among components in the 'smart' electricity system; and allow automated control that is responsive to that intelligence.[3]

» "An automated, widely distributed energy delivery network, the Smart Grid will be characterized by a two-way flow of electricity and information and will be capable of monitoring everything from power plants to customer preferences to individual appliances. It incorporates into the grid the benefits of distributed computing and communications to deliver real-time information and enable the near-instantaneous balance of supply and demand at the device level."[4]

From these definitions key themes emerge: communication, integration and automation that is sustainable, economic, and secure. Incorporating these themes, this paper offers the following concise definition of a smart grid: the smart grid is a suite of information-based applications made possible by increased automation of the electricity grid, as well as the underlying automation itself; this suite of technologies integrates the behaviour and actions of all connected supplies and loads through dispersed communication capabilities to deliver sustainable, economic and secure power supplies. From this definition, the key objectives of the smart grid come into view.

B) Objectives

Drawing on the above definition, smart grid investments should support at least one of the following objectives: increase grid resilience, improve environmental performance, or deliver operational efficiencies including workplace safety.

RESILIENCE

Grid reliability is non-negotiable. A 2004 study by researchers at the Berkeley National Laboratory found that power interruptions cost the American economy $80 billion per year; other estimates are as high as $150 billion per year.[5] Moreover, the North American Electric Reliability Corporation has noted that "reliably integrating high levels of variable resources—wind, solar, ocean and some forms of hydro—into the North American bulk power system will require significant changes to the traditional methods used for system planning and operations."[6] Proponents claim that the smart grid will facilitate these changes by enabling additional dispersed supply and by enhancing corrective capabilities where problems occur. While the smart grid may indeed enhance security in some aspects, however, the additional information technology of the smart grid may also render it more vulnerable than the conventional grid to cyber attacks, and as such may pose a very real threat to reliability.

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2 Paul Murphy et. al., *Enabling Tomorrow's Electricity System: Report of the Ontario Smart Grid Forum*, http://www.ieso.ca/imoweb/pubs/smart_grid/Smart_Grid_Forum-Report.pdf (September, 2010)

3 Miles Keogh, *The Smart Grid: Frequently Asked Questions for State Commissions*, The National Association of Regulatory Utility Commissioners, May 2009, p. 2, http://www.naruc.org/Publications/NARUC%20Smart%20Grid%20Factsheet%205_09.pdf, (June, 2010)

4 *The Smart Grid: An Introduction*, U.S. Department of Energy, http://www.oe.energy.gov/DocumentsandMedia/DOE_SG_Book_Single_Pages(1).pdf (September, 2010)

5 Kristina Hamachi LaCommare and Joseph H. Eto, *Understanding the Cost of Power Interruptions to U.S. Electricity Consumers*, Ernest Orlando Lawrence Berkeley National Laboratory, September 2004, e.g., Figure ES-1 among other discussions in the paper: http://certs.lbl.gov/pdf/55718.pdf (September 2010).

6 *Accommodating High Levels of Variable Generation*, special report of the North American Electric Reliability Corporation, Princeton, New Jersey, April 2009, Executive Summary, http://www.nerc.com/files/IVGTF_Report_041609.pdf (August, 2010).

ENVIRONMENTAL PERFORMANCE

Politicians, environmental stakeholders and the general public are increasingly looking to the electricity sector to reduce the emissions resulting from power generation as well as to drive further emission reductions by replacing liquid fossil fuels in the transportation sector. The smart grid is expected to drive carbon emissions reductions by facilitating renewable power generation, enabling electric vehicles as replacements for conventional vehicles, reducing energy use by customers, and reducing energy losses within the grid. Each of these positive outcomes requires vital information to be available to the grid operators that has not traditionally been available; distribution automation furnishes these required tools.

OPERATIONAL EFFICIENCIES

The smart grid will be expensive to develop and deploy, but if implemented pragmatically should provide operational efficiencies that outweigh these costs. The electricity industry went through a growth phase in the 1970's and 1980's, and aging infrastructure is coming due for replacement. In fact, the electricity industry in Canada is expected to invest $11 billion in infrastructure replacement in each of the next 20 years just to replace existing assets. This is a cost that must be incurred with or without the automation of the grid. Rather than replacing assets with identical assets, however, the smart grid, if planned pragmatically, represents the technological upgrades that will pay a positive return on the investment over the deployed life cycle through energy demand reductions, savings in overall system and reserve margin costs, lower maintenance and servicing costs (e.g. reduced manual inspection of meters), and reduced grid losses, and new customer service offerings.

While some benefits to operational efficiency fit quite nicely into a business plan, such as line loss reduction or improved asset management, some elements rely on a societal assessment of worth, rather than an accountant's calculation of "value". For example, new subdivisions since the 1960s have been built with a preference for hiding distribution wires underground. While this practice provides tangible benefits that can be measured (i.e. extending the life of wires because they are not exposed to the elements), the business case is also supported by intangible benefits (i.e. the aesthetics value of not seeing the distribution system running through the neighbourhood).

This concept of tangible versus intangible operational efficiencies can also be illustrated through workplace safety, a topic that Canadian utilities take very seriously. This commitment to safe work environments is supported by several functionalities available through the smart grid, notably by reducing time on the road for meter reading, alerting workers of islanding, and allowing for some grid repairs to be performed remotely. Avoiding injuries certainly provides tangible operational benefits such as reducing lost time due to injury, but a portion of the benefit is attributed to the intangible health and safety benefits accrued to any worker whose job is made safer.

Operational improvements such as these are tough to quantify in a business case, but like undergrounding, once their worth is proven, rather than simply their "value", they are likely to become the new industry standard.

II. THE SMART GRID'S FIVE CAPABILITIES

The transition to a more automated grid—in pursuit of environmental, efficiency and resilience benefits—entails changes and enhancements across the grid value chain, from how the electricity supplier operates, to how the network is structured, to how the end user interacts with the grid infrastructure. These changes can be organized into five broad categories, and constitute the smart grid's key characteristics or "capabilities".

A) Demand Response

This capability refers to the capacity of the user or operator to adjust the demand for electricity at a given moment, using real-time data. Demand response can take the form of active customer behaviour in response to various signals, generally the price of electricity at the meter, or it can be automated through the integration of smart appliances and customer devices which respond to signals sent from the utility based on system stability and load parameters. For example, a residential hot water heater could be turned off by a utility experiencing high electricity loads on a hot day, or could be programmed by its owner to only turn on at off-peak times. Active demand management can help smooth load curves, which in turn can reduce the required reserve margins maintained by electricity generators. Some pilot projects can already claim results in this respect: the Olympic Peninsula Project, overseen by the Pacific Northwest National Laboratory on behalf of the US Department of Energy, dropped peak power usage by 15 percent. A similar project from Constellation Energy in Baltimore, Maryland, cut peak power demand by at least 22 percent—and as much as 37 percent. [7]

These capabilities have been rolled out in several Canadian jurisdictions to date; however the value of this technology depends on a number of factors. The first, of course, is customer take-up. If electricity customers do not sign up for voluntary utility load control programs or do not purchase the smart appliances and devices required, demand response programs will have little effect. Additionally, if the generating mix in a particular jurisdiction allows it to economically adapt to electricity demand, the value of demand response programs is diminished. In Alberta, for example, the average power divided by the peak power output, or "load factor", for the province is about 80%, which is quite high. As such, the value of peak shaving programs is diminished as compared to other Canadian jurisdictions with load factors below 80%.

It is important to note that demand response and energy conservation are not one and the same. Successful demand response smoothes out consumption levels over a 24-hour period, but does not encourage decreased consumption. Smart grid technologies that promote a reduction in the use of electricity include the Advanced Metering Infrastructure (AMI) and the Home Area Network (AM), both of which allow for increased customer control over their energy use.

B) Facilitation of Distributed Generation

As demand response is the management of system outputs, the facilitation of distributed generation is the management of system inputs. Some in the industry refer to the combined optimal management of both to be the "achievement of flow balance."

Traditionally, the grid has been a centralized system with one way electron flows from the generator, along transmission wires, to distribution wires, to end customers. One component of the smart grid allows for both movement and measurement in both directions, allowing small localized generators to push their unused locally generated power back to the grid and also to get accurately paid for it. The wind and the sun, however, generate energy according to their own schedule, not the needs of the system. The smart grid is meant to manage intermittency of renewable generation through advanced and localized monitoring, dispatch and storage.

In Ontario, the Energy Board has directed that it is the responsibility of the generator to mitigate any negative effects that connected supply may have

[7] David Biello, *The Start-Up Pains of a Smarter Electricity Grid*, Scientific American, May 10, 2010, http://www.scientificamerican.com/article.cfm?id=start-up-pains-of-smart-grid (September 2010).

on the distribution grid in terms of voltage variances and power quality. The optimal solution set to accomplish this, however, is still being examined.

In addition to intermittency challenges, distributed generation can cause instances of “islanding” in which sections of the grid are electrified even though electricity from the utility is not present. Islanding can be very dangerous for utility workers who may not know that certain wires have remained live during a power outage. Ideally, real time information will allow islanded customers to remain in service, while posing no risk to utility workers.

Again, the automation afforded by the smart grid offers a means to this end. When Louisiana was hit by Hurricane Gustav on September 1, 2008, an island was formed of about 225,000 customers who were disconnected from the main electricity grid. According to Entergy, the responsible utility, “synchrophasors installed on key buses within the Entergy system provided the information needed for the operators to keep the system operating reliably.”[8] This technology saved the utility an estimated $2-$3 million in restoration costs, and kept all customers in service (thereby avoiding economic losses to regional businesses).[9]

C) Facilitation of Electric Vehicles

The smart grid can enable other beneficial technologies as well. Most notably, it can support advanced loading and pricing schemes for fuelling electric vehicles (EVs). Advanced Metering Infrastructure would allow customers to recharge at off-peak hours based on expected prices and car use patterns, while bidirectional metering could create the option for selling back stored power during on-peak hours. Although significant EV penetration is still a medium to long-term projection, some cities and regions have started experiments and the existence of a smart grid is essential to their uptake.

This area of the smart grid provides an illustrative example of the potential risk to utilities of getting caught in the middle. Many policy makers and car manufacturers correctly point out that widespread charging infrastructure may help incent customers to switch to electric vehicles. While this is true, we must recognize that charging infrastructure alone may not be enough to change customer behaviour; until a breakthrough technology is discovered by the automotive industry, electric vehicles will still have relatively high price tags and limited range. As such, prudence dictates that utility investments in EV infrastructure ought to respond to the automotive purchasing patterns of their customers rather than laying the groundwork for a fuel switch that is still largely dependent on technological breakthroughs. If utilities invest in infrastructure now, and the EV market takes longer than promised to develop, customers may not feel well served.

D) Optimization of Asset Use

Monitoring throughout the full system has the potential to reduce energy losses, improve dispatch, enhance stability, and extend infrastructure lifespan. For example, monitoring enables timely maintenance, more efficient matching of supply and demand from economic, operational and environmental perspectives, and overload detection of transformers and conductors. Or as Miles Keogh, Director of Grants and Research at the National Association of Regulatory Utility Commissioners in the US, argues in a recent paper, system optimization can occur “through transformer and conductor overload detection, volt/var control, phase balancing, abnormal switch identification, and a host of ways to improve peak load management.” Thus, as he concludes, “while the smart meter may have become the ‘poster child’ for the smart grid, advanced sensors, synchro-phasors, and distribution automation systems are examples of equipment that are likely to be even more important in harnessing the value of smart grid.”[11]

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[8] Floyd Galvin and Chuck Wells, “Detecting and Managing the Electrical Island Created by Hurricane Gustav,” *Success Stories*, North American Synchrophasor Initiative, p. 1, http://www.naspi.org/stories/pilot_fundamental/entergy_hurricane_gustav.pdf, (July, 2010).

[9] Galvin and Wells, 2.

[10] Miles Keogh, “The Smart Grid: Frequently Asked Questions for State Commissions,” The National Association of Regulatory Utility Commissioners, May 2009. <http://www.naruc.org/Publications/NARUC%20Smart%20Grid%20Factsheet%205_09.pdf>. [confirm citation].

[11] Keogh, 4.

For example, smart grid monitoring helps utilities asses their line proximity issues as it relates to trees and tree growth, because dense growth results in a significant increase in the number of short voltage blips that occur. Early detection of these short line contacts by trees will assist utilities in their "just in time" tree programs, effectively focussing crews on the correct "problem areas".

In addition, network enhancements, and in particular improved visualization and monitoring, will enable "operators to observe the voltage and current waveforms of the bulk power system at very high levels of detail." This capability will in turn "provide deeper insight into the real-time stability of the power system, and the effects of generator dispatch and operation;" and thereby enable operators to "optimize individual generators, and groups of generators, to improve grid stability during conditions of high system stress."[12]

E) Problem Detection and Mitigation

Many utility customers do not realize the limited information currently available to grid operators, especially at the distribution level. When a blackout occurs, for example, customer calls are mapped to define the geographic area affected. This, in turn, allows utility engineers to determine which lines, transformers and switches are likely involved, and what they must do to restore service. It is not rare, in fact, for a utility customer care representative to ask a caller to step outside to visually survey the extent of the power loss in their neighbourhood. It is a testament to the high levels of reliability enjoyed by electric utility customers that most have never experienced this; however, it is also evidence of an antiquated system.

While SCADA and other energy management systems have long been used to monitor transmission systems, visibility into the distribution system has been limited. As the grid is increasingly asked to deliver the above four capabilities, however, dispatchers will require a real-time model of the distribution network capable of delivering three things: 1) *real-time monitoring* (of voltage, currents, critical infrastructure) and reaction (refining response to monitored events); 2) *anticipation* (or what some industry specialists call "fast look-ahead simulation"); and 3) *isolation* where failures do occur (to prevent cascades).

On any given day in the United States, roughly "500,000 U.S. customers are without power for two hours or more"[13] costing the American economy between $70 and $150 billion a year.[14] This significant impact on economic activity provides a strong incentive to develop the smart grid, which is expected to reduce small outages through improved problem detection and isolation, as well as storage integration. It is also

[12] *Methodological Approach for Estimating the Benefits and Costs of Smart Grid Demonstration Projects,* EPRI, January, 2010, p. 4–21 (July, 2010).

[13] Massoud Amin and Phillip F. Schewe, "Preventing Blackouts: Building a Smarter Power Grid," *Scientific American*, August 13, 2008, http://www.scientificamerican.com/article.cfm?id=preventing-blackouts-power-grid&page=3, (September, 2010)

[14] Scientific American says that "estimates peg the economic loss from all U.S. outages at $70 to $120 billion a year," while NARUC says "outages cost between $80 and $150 billion every year."

expected to reduce the likelihood of big blackouts, such as the infamous 2003 blackout that impacted most of the Eastern seaboard.

The 2003 blackout left more than 50 million people without power for up to two days, at an estimated cost of $6 billion, and contributed to at least 11 deaths.[15] A root cause analysis revealed that the crisis could not have begun in a more innocuous way: a power line hit some tree branches in northern Ohio. An alarm failed to sound in the local utility, other lines also brushed against trees, and before long there was a cascade effect—a domino of failures—across eight US states and one Canadian province.

With proper monitoring, now capable through smart grid innovations, some proponents believe that a cascading blackout mirroring that of 2003 should become so remote a possibility as to become almost inconceivable.[16] Intelligent monitoring on a smarter grid allows for early and localized detection of problems so that individual events can be isolated, and mitigating measures introduced, to minimize the impact on the rest of the system. The current system of supervisory control and data acquisition (SCADA), much of it developed decades ago, has done a reasonably good job of monitoring and response. But it has its limits: it does not sense or monitor enough of the grid; the process of coordination among utilities in the event of an emergency is extremely sluggish; and utilities often use incompatible control protocols—i.e. their protocols are not interoperable—with those of their neighbours.

If Ohio already had a smart grid in August 2003, history might have taken a different course.[17] To begin with, according to Massoud Amin and Phillip Schewe in a Scientific American article, "fault anticipators… would have detected abnormal signals and redirected the power… to isolate the disturbance several hours before the line would have failed."[18] Similarly, "look-ahead simulators would have identified the line as having a higher-than-normal probability of failure, and self-conscious software… would have run failure scenarios to determine the ideal corrective response." As a result, operators would have implemented corrective actions. And there would be further defences: "If the line somehow failed later anyway, the sensor network would have detected the voltage fluctuation and communicated it to processors at nearby substations. The processors would have rerouted power through other parts of the grid." In short: customers would have seen nothing more than "a brief flicker of the lights. Many would not have been aware of any problem at all."[19] Utility operators stress that the smart grid does not spell the end of power failures; under certain circumstances such as these, however, any mitigation could prove very valuable indeed.

A more reliable grid is also a safer grid. First, as discussed previously, smart grid technology allows for "anti-islanding" when needed. Detection technology can ensure that distributed generators detect islanding and immediately stop producing power. Second, power failures can leave vulnerable segments of the population, such as the sick or elderly, exposed to the elements or without power required by vital medical equipment. Third, safety is also enhanced through electricity theft reductions. As BC Hydro points out, "energy diversions pose a major safety risk to employees and the public through the threat of violence, fire and electrocution." [20]

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[15] JR Minkel, "The 2003 Northeast Blackout – Five Years Later," *Scientific American*, August13, 2008, http://www.scientificamerican.com/article.cfm?id=2003-blackout-five-years-later, (August, 2010).

[16] Amin and Schewe.

[17] Amin and Schewe.

[18] Amin and Schewe

[19] BC Hydro, http://www.bchydro.com/planning_regulatory/projects/smart_metering_infrastructure_program/program_overview_and_status.html (October, 2010)

III. BUILDING BLOCKS

The five capabilities just reviewed—demand response, facilitation of distributed generation, facilitation of electric vehicles, optimization of asset use, and problem detection and mitigation—have excited considerable interest in policy discussions about the smart grid. To assess the merits of each, however, we ought to bear in mind that their value is derived from their ability to contribute towards the three ultimate objectives of increased resilience, improved environmental performance, and operational efficiencies. In other words, we need to consider their contribution in practical terms.

This question of practicality gives rise to a consideration of the building blocks needed to implement the various capabilities. Implementation of a smart grid will require investments and changes in tangible infrastructure complemented by investments and changes in soft infrastructure. A detailed understanding of the benefits and challenges for both of these categories is required when assessing the business case for the various capabilities of the smart grid.

A) Hard Infrastructure

Key investments and changes in tangible infrastructure to deliver smart grid capabilities are the following:

SMART METERS / ADVANCED METERING INFRASTRUCTURE (AMI)

Smart meters and the information backhaul systems required to support them are probably the best known, and also likely the most expensive, building block supporting a smart grid. As of September 30, 2009, electricity distributors in Ontario had installed approximately 2,883,000 residential and 171,000 general service (<50 kW) meters.[21] In the Ontario Energy Board's March 2010 audit of electricity distributors' smart meter regulatory accounting, they found capital expenditures for all meters to be about $633 million, and OM&A expenditures to be $63 million.[22]

Fully enabled smart meters can communicate in real-time between users and energy suppliers about energy use and prices, coordinate household consumption based on these signals and customer preferences, and facilitate measurement and customized pricing. AMI can also enable net-metering which allows for the flow of electricity onto the grid from residential or commercial distributed power generation.

The process of determining electricity usage and then billing accordingly has high transaction costs on a manual meter reading system, especially in regions that involve considerable driving distance from the utility to the meters, as in parts of Canada. A number of reports identify avoided meter reading costs as a major benefit of AMI. The Brattle Group, for instance, provides an illustrative theoretical example of a smart power region with one million residential customers, 100,000 small and medium commercial and industrial customers, and 5,000 large commercial and industrial customers. With annual meter O&M costs assumed to be $18 million per year, the present value of avoided meter reading costs, over a 20 year forecast horizon, amounts to $243 million.[23]

There is also empirical evidence. FortisAlberta has installed 466,000 meters and automated 171 substations across its primarily rural service area. Previously contracted meter readers drove more than six million kilometres annually; escalating fuel costs, coupled with rising labour costs, led to a $1.7 million increase in the cost of these meter reads from 2005 to 2006 alone. All utilities with an AMI deployment can expect substantial fuel and labour cost savings (along with associated CO_2 and worker safety benefits). Moreover, as the electricity meter is typically the only meter at a residential location with its own power supply (vs. battery power for natural

[21] *Sector Smart Meter Audit Review Report*, Ontario Energy Board Regulatory Audit and Accounting, March 31, 2010, http://www.oeb.gov.on.ca/OEB/_Documents/Audit/Smart_Meter_Audit_Review_Report.pdf, (July 2010).

[22] *Ibid*.

[23] Philip Q. Hanser and Ahmad Faruqui, "Wise Energy Use & Smart Grid Strategy," presentation by the Brattle Group, 2009, p. 8.

gas and water meters), it is best positioned to perform the energy intensive task of backhauling meter data and sending it to the respective utilities. This synergy can significantly bolster the AMI business case for each utility involved.

An additional benefit of AMI, less widely discussed, is that it will allow for real-time load measurement and management, which in turn could detect (and subsequently mitigate) instances of theft. As BC Hydro argues, additional load created by energy diversions contributes to premature transformer failures causing customer outages and increased costs to replace assets. The utility is therefore implementing new technologies and information analytics tools to identify premises where illegal diversions are occurring and reduce the impact on legitimate ratepayers. In the last three years, BC Hydro has shut down more than 1,500 electrical diversions, all of them associated with marijuana growing operations. Enhanced automation and monitoring will allow it to detect more such instances of theft, and faster. [24]

AMI challenges do, of course, exist. In the absence of interoperability and cyber-security standards, further issues may arise from the use of closed and proprietary systems that may be incompatible with common communication standards and protocols and other technologies (further discussed in the soft infrastructure section below).

Additionally, AMI is a system, much like the smart grid itself, on which applications are built. Smart meters allow for customer engagement in their electricity consumption; uptake on this offering, however, is critical to deriving the full value from this significant investment.

Particularly within this context of customer engagement, while smart meters have been identified as an important building block in support of overall system optimization, initial deployments have not been without challenges. We will examine lessons learned later in this paper.

NETWORK DEVICES AND ENHANCEMENTS

Grid enhancements will be required to integrate additional renewable and distributed generation into the grid. These enhancements will include enhancement of monitoring systems—more locations, with better visualisations and improved simulations, as well as improved data processing across the entire grid. They will also include advanced voltage control, increased fault detection, digitization, and (automatic) system protection practices. These improvements have the potential to limit losses, optimize integration of distributed resources and electric vehicles, and enhance the resilience of the system. The distribution grid in particular, as opposed to the already quite "smart" transmission system, could gain significantly from centralized optimization through remote monitoring and control. d optimization through remote monitoring and control.

The challenge faced by utilities is to integrate the various streams of operational data into coherent tools that will augment planning and other asset decisions, such as asset analytics and flow analyses. Many in the industry refer to this is the coming "data tsunami" and vendors are working hard to develop the software applications required to take tera- or even peta-bytes of data and produce concrete information to aid in utility decision making. However, while technologies are developing rapidly, it raises the possibility that what is now a state of the art system could become obsolete in a few years. This concern has caused at least one major Canadian utility to recently re-examine its timelines for rolling out a comprehensive Demand Management System.

[24] "Electricity Theft" BC Hydro, http://www.bchydro.com/safety/marijuana_grow_ops.html, (August, 2010).

DISTRIBUTED ENERGY STORAGE

Distributed energy storage has the potential to optimize the stability of the power supply resulting in reduced grid losses, reduced power outages and improved power quality. Local storage will also enable increased penetration of renewable resources and ensure their integration will not reduce the stability and reliability of energy supply. The main obstacle for employing additional flexible storage solutions such as batteries, or pumped storage, is their relatively high cost. Plug-in electric vehicles could provide distributed storage, but significant penetration is still many years out and it is not yet clear how substantial the storage contribution from electric vehicles will prove to be.

HOUSEHOLD APPLIANCES

To get the full value from the smart grid, customers will require appliances to communicate with a home area network (HAN) that will optimize electricity use depending on market signals (and within limits set by the customers). The magnitude of the replacements or retrofits required—a change that will be dispersed across millions of households—poses some clear challenges at the interplay of technology, standardization among suppliers, and customer behaviour.

B) Soft Infrastructure

Soft infrastructure required includes the following issues:

INTEROPERABLE COMMUNICATION STANDARDS AND PROTOCOLS

One of the lessons of the 2003 blackout, according to Arshad Mansoor, a smart grid expert at the Electric Power Research Institute in California, is that "you can't just look at your system. You've got to look at how your system affects your neighbours and vice versa."[25] Since that time, and as smart grid discussions have advanced, a strong consensus has emerged that the smart grid must have robust protocols and standards to ensure interoperability of smart grid devices and systems. The National Institute of Standards and Technology (NIST), the federal entity tasked with developing smart grid standards in the US context, provides four good arguments for them. First, without standards, there is a risk that "the diverse smart grid technologies that are the objects of these mounting investments will become prematurely obsolete;" second, and worse, they could "be implemented without adequate security measures."[26] To elaborate on the security point, if the technology is proprietary and only well understood by its proponents, it could contain vulnerabilities to hackers or even terrorists.

Third, a "[l]ack of standards may also impede future innovation and the realization of promising applications;" and fourth, on a related note, "standards enable economies of scale and scope that help to create competitive markets."[27] A lack of standards may encourage monopolistic and rent-seeking behaviour.

There is also a fifth argument: protection of customer privacy. This issue does not receive enough attention—it has been called the "sleeper issue" of the smart grid—but is now being addressed, for instance, by the Privacy Commissioner of Ontario, who has proposed a set of principles to support smart grid development.[28]

As NIST notes, whereas the U.S. smart grid market will double between 2009 and 2014, "to nearly $43 billion," over the same time frame "the global market is projected to grow to more than $171 billion, an increase of almost 150 percent."[29] Ideally, therefore, such standards will be global in scope.

In Canada, many smart grid stakeholders have identified electricity system standardization issues and activities as a high priority. They are voicing Canadian perspectives through both American NIST Smart Grid Interoperability Panel activities as well as internationally oriented IEC efforts. The

[25] JR Minkel, "The 2003 Northeast Blackout – Five Years Later," *Scientific American*, August 13, 2008, <http://www.scientificamerican.com/article.cfm?id=2003-blackout-five-years-later&page=2>.

[26] *NIST Framework and Roadmap for Smart Grid Interoperability Standards*, Release 1.0, Office of the National Coordinator for Smart Grid Interoperability, National Institute of Standards and Technology, U.S. Department of Commerce, NIST Special Publication 1108, January, 2010, p. 14.

[27] NIST, 14.

[28] *Smart Privacy for the Smart Grid: Embedding Privacy into the Design of Electricity Conservation*, PbD, Information and Privacy Commissioner, Toronto, Ontario, November 2009, p. 3, http://www.ipc.on.ca/images/resources/pbd-smartpriv-smartgrid.pdf (July, 2010).

[29] NIST, 14.

key challenge will be to identify, and help resolve, discrepancies between NIST and IEC standards development. As operators within the North American power grid that reply on global supply chains for technological solutions and equipment, Canadian utilities must remain keenly focused on this challenge.

Additionally, Canada's Federal Government must recognize the benefit of standards to the broader public interest, namely lowering the cost and risk associated with smart grid deployment, by funding the Standards Council of Canada's work in this important area.

CYBER SECURITY STANDARDS

As previously noted in this paper, the addition of communications capabilities to the grid network creates countless additional points of entry into both the utility billing systems and the grid control systems. Cyber security standards are being developed at both the NIST and the IEC levels, but protocols will need to be continually re-assessed and updated.

There are two ways to think about this issue. The first is that there are now millions of new hackable points on the electricity grid network. Power supplies might be shut off to critical services such as first responders or hospitals; voltage control devices could be altered, frying equipment and devices attached to the network; and co-ordinated attacks could take an entire city offline. It is important to recognize that most power outages today are caused by damage to power lines and poles—equipment that is abundant and easy to quickly replace. An attack that requires systematic diagnostic testing and the replacement of equipment that is generally built to order could take weeks or even months.

That is the worst case. The second way to look at the issue is to look to the other industries for which cyber security is critical—banking, wireless communications, government networks, etc. While each of these sectors must remain vigilant of their systems, and attacks do regularly occur, containment protocols have been developed to ensure that hacking attempts can be isolated and dealt with. Canadian electric utilities are working with vendors and standards bodies to ensure that it is this second vision that will play out.

Even with this pragmatic approach, utilities will have to determine what actions are appropriate for customers who have attempted to breach security protocols (or have been unwittingly used as a conduit by hackers)—can the utility cut them off from service? At what point should be police become involved? These questions do not yet have definitive answers, but the issues are clearly looming.

1.8 GHZ SPECTRUM

The Canadian utility industry was recently awarded a dedicated slice of radio spectrum for various applications including high speed teleprotection, supervisory control and data acquisition (SCADA), telemetry and mobile radio, and smart grid development.

The electricity sector continues to emphasize to Industry Canada the critical infrastructure nature of the industry and the need to protect and enhance existing spectrum resources as well as ensure access to necessary bandwidth at a reasonable cost and without having to compete with nonessential and/or commercial services. Utility developers worldwide are asking for a similar allocation and regulatory treatment, including in Australia and the United States.

CUSTOMER ENGAGEMENT

There is a general lack of public awareness of the smart grid, and a lot of confusion in sorting through the various claims and definitions that are being advanced to explain it. It will be important for customers to have a much better understanding

of the benefits of smart grids if they are to be introduced effectively and sustainably. Since the high cost of smart grid implementation will, directly or indirectly, be shared by customers, if they are not convinced by claims regarding current and future benefits, they are likely to resist and challenge those costs over time.

In addition, as Canada emerges from the recent economic crisis, customers are especially sensitive to the cost of electricity. This statement is supported by CEA customer attitudes research, which reveals that the most significant driver of customer dissatisfaction is price, which in turn reinforces the importance of renewed consumer dialogue and education in advance of a capital-intensive project like the smart grid.[30]

Customers must be made aware that the grid infrastructure is aging and needs to be replaced, and is concurrently being upgraded to take advantage of the latest technologies. Utilities, vendors and policy-makers must deliver on the promised functionality without expecting an immediate reorienting of the typical electric utility customer from passive market participant to active energy manager.

CHANGES IN CUSTOMER BEHAVIOUR

Complicating this need for customer buy-in is the fact that the value of the smart grid system is intrinsically tied to their willingness to use the tools made available to them to manage their electricity use.

It is important to note that households *already* have an array of options for reducing energy use and saving money that go untapped (e.g., isolation of heating and cooling, better insulation, lighting changes). Thus history shows that even where energy savings have a short-term financial pay-off, it may not be enough to convince the customer to act. Customer education will likely need to be combined with regulatory incentives and disincentives before full participation can be realized.

STAKEHOLDER AGREEMENT AND COORDINATION

The coordination challenges involved in deploying a smart grid to its full potential is daunting: to be done properly it will have to involve governments, regulators, electricity generators (both centralized and distributed), transmitters, distributors, equipment and service providers, final customers, and neighbouring jurisdictions. But the challenge is more than just finding agreement and coordinating steps forward.

Many of the issues that involve coordination will involve changes to the industry's traditional business model. There will be new entrants, new forms of interaction, and new areas of uncertainty and overlapping

[30] Drawn from the results of two decades of CEA customer polling.

accountabilities that will have to be resolved. Issues for coordination, agreement, and change management will include, at a high level: a shared understanding of the benefits and risks involved in implementing a smart grid; the speed of and order of the roll-out; cost/benefit sharing mechanisms among private sector participants, and between the public and private sectors; and technological standards.

C) Summary Map of Building Blocks

The table below illustrates conceptually the strongest relationships between the various infrastructure requirements or building blocks and the various smart grid capabilities. In other words, there could be relationships other than those identified but these are meant to focus attention on the most important.

		Smart grid capabilities				
		Demand Response	Facilitation of Distributed Generation	Facilitation of Electric Vehicles	Optimization of Asset Use	Problem Detection & Mitigation
Hard infrastructure requirement	Smart Meters / Advanced metering infrastructure (AMI)	Necessary	Necessary	Necessary		Supporting
	Transmission and Distribution Enhancements	Supporting	Necessary	Necessary	Necessary	Necessary
	Distributed energy storage	Supporting	Necessary	Supporting	Supporting	Supporting
	Household appliances communication	Supporting				
Soft infrastructure requirement	Standards for communication	Necessary		Necessary		Supporting
	Customer education	Necessary	Necessary	Necessary	Supporting	Supporting
	Customer behavioural adjustments	Necessary	Supporting	Supporting		
	Stakeholder agreement and communication	Necessary	Necessary	Necessary	Necessary	Necessary

● (green) = Necessay requirement ● (blue) = Supporting requirement

IV. GROWING PAINS AND LESSONS LEARNED

As illustrated in this paper, the smart grid offers a number of proven and potential benefits. But it still has some ways to go in demonstrating its full value and in addressing implementation challenges. A survey of international smart grid reports, media articles and discussions with experts yields a number of growing pains—early difficulties and challenges—for the smart grid. Key difficulties can be grouped into the following categories: security, privacy, the cost of pilot projects and stakeholder engagement.

SECURITY

» **Worries about Vulnerability to Sabotage.** The smart grid means more information technology, and some observers worry that it will be vulnerable to sabotage. A CNN article in 2009 cited tests showing that "a hacker can break into the system, and cybersecurity experts said a massive blackout could result."[31] A security firm, IOACtive, found that a hacker, with only $500 in equipment and a limited electronics and engineering background could "take command and control of the [advanced meter infrastructure] allowing for the en masse manipulation of service to homes and businesses."[32] Commenting on the controversy, William Sanders, principal investigator for the National Science Foundation Cyber Trust Center on Trustworthy Cyber Infrastructure for the Power Grid, responds: "I don't think the sky is falling. I don't think we should stop deployment until we have it all worked out. But we have to be vigilant and address security issues in the smart grid early on."[33]

A number of observers point to two steps that could mitigate these security risks: first, industry standards; second, "an open platform, which will allow developers to be able to contribute their best solutions."[34]

PRIVACY

» **Worries about Invasions of Privacy.** A number of smart grid experts believe the risk of potential privacy violations has not received adequate attention. As Ann Cavoukian, Ontario's Information and Privacy Commissioner, sums up the concern, the smart grid "introduces the possibility of collecting detailed information on individual energy consumption use and patterns within the most private of places—our homes. We must take great care not to sacrifice consumer privacy... Information proliferation, lax controls and insufficient oversight of this information could lead to unprecedented invasions of consumer privacy."[35] As mentioned earlier, this issue needs to be addressed with clear standards and strict oversight.

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[31] Jeanne Meserve, "'Smart grid' may be vulnerable to hackers," CNN.com, March 21, 2009, <http://edition.cnn.com/2009/TECH/03/20/smartgrid.vulnerability/?iref=mpstoryview>, (September, 2010).

[32] Meserve.

[33] Meserve.

[34] See e.g. Katie Fehrenbacher, "Securing the Smart Power Grid from Hackers," *Bloomberg Business Week*, March 23, 2009, http://www.businessweek.com/technology/content/mar2009/tc20090320_788163.htm, (August, 2010).

[35] *Smart Privacy for the Smart Grid: Embedding Privacy into the Design of Electricity Conservation*, PbD, Information and Privacy Commissioner, Toronto, Ontario, November 2009, p. 3, http://www.ipc.on.ca/images/resources/pbd-smartpriv-smartgrid.pdf (July, 2010).

PILOT PROJECT COSTS

- **Criticism of Cost of Boulder's Smart Grid Initiative.** The smart grid city initiative in Boulder, Colorado, has cost Xcel and its partners $100 million, or $2,000 per customer. Mike Carlson, the now-former chief information officer at Xcel Energy in Minneapolis, Minn., which is running the "smart grid city", said quite bluntly that "it is unsustainable and nondeployable at that cost." He further noted that cost would have to drop to $500 per customer to be viable. "We know these things will be effective in delivering something. The question is: will they justify their cost? "[36]

  As a pilot program, the Boulder Smart Grid Initiative was a first mover on many of the technologies deployed, and certainly paid a premium on per-unit and per-household costs to do so. That is to be expected. The real lesson from Boulder is that the high costs of pilot programs are best alleviated by democratizing both the cost burdens and the lessons learned; in Canada, the Federal government has proven successful at mitigating the jurisdictional costs of pilot programs, while industry associations such as CEA play a vital role in disseminating industry best practices.

STAKEHOLDER ENGAGEMENT

- **Regulator Cites Obsolescence (and more) in Rejecting Smart Meter Proposal.** In June 2010 the Maryland Public Service Commission (PSC) rejected Baltimore Gas and Electric's initial proposal to deploy smart meters. The fear of technological obsolescence had an impact on the outcome; in its decision, PSC noted that "All the federal funding in the world would not have made Sony's Betamax a wise investment, for example… Those who invest in new technology as it becomes available often find themselves re-investing much sooner than they anticipated."[37] It was not, however, only technological concerns that derailed BG&E's submission. PSC encouraged the utility to re-file, but to pay special attention to three areas: modify the cost recovery mechanism to incorporate some form of shareholder risk; eliminate the mandatory time-of-use rate mechanism; and include a specific customer education plan. The PSC approved BG&E's refilling that took into consideration these recommendations.

  Technologies are maturing, and interoperability standards are under development, abating to a degree the fear of obsolescence. The latter three concerns, however, are increasingly being cited by utility regulators, and can be summarized as: risk/return balance, new mandatory services for customers and non-technological elements of deployment programs. The lessons learned by BG&E allow Canadian utilities to better address these latter three recommendations when designing and proposing smart grid deployment programs.

- **Class-Action Lawsuit Against Pacific Gas & Electric.** In Bakersfield, California, in what has been called a "PR nightmare," PG&E is being sued by thousands of residents seeking damages from the utility and third parties involved in its 6.7 million meter, $2.2 billion rollout. The residents claim "their new smart meters are malfunctioning because their bills are much higher than before." PG&E, meanwhile, "claims higher bills are due to rate hikes, an unusually warm summer, and customers not shifting demand to off-peak times when rates are lower."[38] The accuracy of the meters has since been verified by an independent study, vindicating PG&E legally; however, as one observer comments, "It seems that PG&E's rollout is woefully under resourced at the back-end… Transparency and communications failures can lead to utilities being sued by their customers… The PR fallout from the Bakersfield rollout… may potentially set back smart grid projects in California for years."[39]

  The customer is always right—even when they are wrong (in this case, about the poor accuracy

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[35] *Smart Privacy for the Smart Grid: Embedding Privacy into the Design of Electricity Conservation*, PbD, Information and Privacy Commissioner, Toronto, Ontario, November 2009, p. 3, http://www.ipc.on.ca/images/resources/pbd-smartpriv-smartgrid.pdf (July, 2010).

[36] David Biello, *The Start-Up Pains of a Smarter Electricity Grid*, Scientific American, May 10, 2010, http://www.scientificamerican.com/article.cfm?id=start-up-pains-of-smart-grid (September 2010).

[37] Order No. 83410, Maryland Public Service Commission, June 21, 2010, pg. 40, http://webapp.psc.state.md.us/Intranet/sitesearch/whats_new/Order%2083410_BGE%20AMI%20Application_CN%209208.pdf (September, 2010).

[38] "PG&E smart meter problem a PR nightmare," November 21, 2009, http://www.smartmeters.com/the-news/690-pgae-smart-meter-problem-a-pr-nightmare.html, (July, 2010)

of the meters). PG&E has provided stakeholders with perhaps the most important lesson to date, and Canadian utilities have taken the message to heart. In mid-September in Ontario, the conversation moved in a similar direction to California, with such media as the Financial Post ("*Are You Frying Your Eggs at 4a.m. Yet*") and the Globe and Mail ("*Ontario's Hydro's Smart Meters Give Dumb Results: Critics*") airing the complaints of a segment of outspoken customers. As Ontario utilities continue their engagement campaigns in step with the provincially mandated AMI roll-out schedule, the customer concerns seem to be easing. It has, however, certainly underscored for all Canadian utilities the need to put the customer first when in any way altering the service delivery model that customers have, in almost all cases, grown up with—cheap, reliable electricity with minimal participation required.

» **Consumer Groups Criticize Southern California Edison's AMI Program.** The theme of customer engagement can be expanded to other stakeholders in the regulatory process, whether they are, for example, consumer groups, NGOs, industry associations, or aboriginal representatives. When Southern California Edison introduced an AMI program, and despite the California Public Utility Commission's "conclusion on the positive benefits," some leading consumer groups in California were "unconvinced."[40] The PUC decided to approve the program despite the opposition, and the utility has since had to work very hard at communicating benefits to its customers, generally using a customer by customer approach. It is an instructive case because it shows that it is not enough to obtain support from the regulator—stakeholder engagement at the consultative stages are also important.

A clear message that has emerged in Canada is that there is no shortage of stakeholders who feel that the smart grid will have at least some impact (generally positive) on the mandate they have been asked to deliver by those they represent. For example, the Alberta Utilities Commission has been directed to review how smart grid technology, such as advanced metering or smart metering infrastructure, can be used to modernize the electricity system in Alberta.[41] Procedural submissions were accepted throughout much of the summer, and the varied list of stakeholders is indicative of the smart grid's potentially broad applicability and impact. Registered parties include, among the utilities and many others: the Pembina Institute, Citizens Advocating for the Use of Sustainable Energy, the City of Lethbridge, the City of Red Deer, GE Canada, Honeywell and Telus.

Electric utilities provide a vital "enabling service" for many other groups and industries. Canadian utilities have long understood this, and indeed pragmatism is ingrained in the industry's careful approach to change. The lesson learned through the AUC process and others, however, is that as the smart grid evolves, utilities must continually scan their business environment for emerging stakeholders (i.e. the automotive sector), and interface accordingly.

Some of these difficulties concern matters of perception, and are not insoluble. But matters of perception—especially at this early stage of smart grid deployment—are no less significant for electric utilities, because they go to the very credibility of the smart grid effort. Customer and stakeholder support will be essential for sustainable deployment. These lessons learned underscore the criticality of advocates, including both utilities and outside stakeholders, being able to explain and eventually prove the benefits of each component of the smart grid to the customers who purchase the service.

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[39] Tom Raftery, "PG&E smart meter communication failure – lessons for the rest of us," Green Monk blog, December 16, 2009, http://greenmonk.net/pge-smart-meter-communication-failure/, (June, 2010)

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[41] "Special Inquiries", Alberta Utilities Commission: http://www.auc.ab.ca/items-of-interest/special-inquiries/Pages/default.aspx

V. AN OPTIMAL PATH FORWARD

The smart grid is many things, but one thing it is not is a technological mystery. The key capabilities are fairly well understood, as are the building blocks, although new technologies will emerge and existing technologies will continue to mature. What remains somewhat unclear is to what extent the suite of technologies will ultimately deliver value to the end customer, and how this value is best communicated. In order to provide clarity on these issues, all stakeholders must work together, including vendors, governments, regulators and utilities. We are at a cross-roads with respect to customer buy-in and it is incumbent on all parties to introspectively examine how best to proceed.

VENDORS

After the last major electric utility infrastructure build-out of the early 1980s, most utilities in Canada shed their R&D arms in an effort to reduce costs. This arrangement has mostly served its purpose, with the utility industry reliant on partnerships with external technological developers to meet its needs. This has become especially acute with the advent of the smart grid, and again the utilities by-and-large feel well served.

However, the smart grid has brought about the need for another area of collaboration, this one less technological in nature, around managing expectations of what the electricity grid is capable of. It is here that the two groups who best understand the technologies involved need to be on the same page, but it is also here that some discordant messaging has emerged. It is certainly an exciting and promising time for the industry, but recent customer and regulator push-back has underlined the need to stick with the age old adage of "under-promise and over-deliver."

GOVERNMENTS

Just as with the vendor community, policy-makers across Canada and the United States have been learning to be wary of hyperbole and treat the smart grid as they would any other pragmatic, incremental upgrade to the electricity system. This is not to say that elected officials should not tout the benefits of these improvements, only that they must work closely with the utilities within their jurisdictions to understand the pace and scope of the roll-outs.

Furthermore, it is important to note that many of the environmental performance benefits that the smart grid will deliver are benefits not restricted to one geographic area and as such rate payers may end up shouldering different levels of cost for the public good. For example, efforts in one service territory to integrate increased levels of non-emitting power supplies (i.e. wind and solar) may raise rates for some while assisting all Canadians towards our shared goal of reducing green house gas emissions by 17% by 2020. Federally funded pilot programs help to spread the burden of technological and operational development more equitably; moreover, this approach allows the industry as a whole to learn from the initiatives of their peers thus reducing the overall cost of development. For these reasons of equitability and efficiency, the federal government should initiate a second round of pilot programs under Natural Resources Canada. Similarly, the federal government should increase its financial support for the development of smart grid interoperability standards that serve all Canadians and provide the base on which to build our digital economy.

REGULATORS

The Smart Grid is certainly on the radar screen of every provincial electric utility regulator in Canada, and as is appropriate, each sees the smart grid through the lens of the jurisdiction over which they regulate.

Miles Keogh, Director of Grants & Research Development at the National Association of Regulatory Utility Commissioners, breaks down the smart grid from a regulatory perspective that is well supported by this paper. The smart grid, he says, can be broken down into direct value and option value. Direct value "represents the quantifiable value of components that, when introduced, will immediately improve the efficiency of the system and create cost-benefits such as distribution optimization and visualization. Benefits begin to accrue upon deployment rather than waiting for customer behaviour or further component deployment." Option value, on the other hand, refers to applications that "rely on additional activities before their value can be fully realized. In certain cases, like demand response enabled by smart prices and smart meters, realizing the value depends on customers changing their behaviour including responding to price signals. For other applications, such as distributed generation and PHEVs, customers must purchase, install, and utilize them before their value can fully be realized.

The addition of smart grid components creates the option for these technologies and activities to be deployed. This "option value," while not directly quantifiable, is nonetheless measurable and should be considered along with "direct value" components as applications for smart grid warrant."[42]

UTILITIES

Technologically, Canadian utility operators are in the best position to determine the scope and the pace of smart grid deployment in Canada. With respect to scope, they must consider the myriad of factors that vary strongly by region, including existing infrastructure and current grid characteristics, power supply mix (i.e. Quebec's hydropower resources vs. Alberta's use of fossil fuels), the distances connecting generation, wires and load, and even weather patterns. Business cases must be based on pragmatism operational experience, and customer buy-in, not the latest technological capability. As such, the Canadian utility industry has developed a list of key principles that will guide the deployment of the smart grid in Canada:

1. The relationship between the customer and the utility is paramount. The smart grid should be rolled out at a pace and at a scope to allow for this relationship to evolve and strengthen.
2. The existing grid has for many years delivered high quality low-cost electricity. Customers expect this and the rationale for rate increases will have to be communicated clearly.
3. Smart grid implementation should not pose any risk to reliability and quality of electricity service.
4. Smart grid investments should be rooted in a business case that identifies and quantifies the potential for sustainable value delivery, and is informed to the extent possible by experience elsewhere. This prudent approach can be achieved in part through R&D, pilots and demonstration projects, in partnership with the Federal government.
5. The optimal design and roll-out should be linked to local variables including current and intended generation mix, customer base, geographic profile, and other factors. Utilities themselves are in the best position to assess the impact of these variables on their service territory, and must consider them accordingly.
6. Cyber security must be taken seriously and customer privacy is of utmost importance.
7. Smart grid policies and standards should promote a flexible, non-proprietary, open infrastructure that is upgradable to avoid excess costs as a result of obsolescence.
8. Smart grid implementation requires careful attention to soft infrastructure, including forms of coordination and customer education, as much as it requires attention to hard infrastructure.
9. All stakeholders should be properly consulted before major smart grid investment decisions are made.

[48] Keogh, 5.

CONCLUSION

As we have seen, the smart grid is facilitating significant changes to the process of producing, transmitting and consuming electricity. Technological building blocks are allowing for new grid capabilities that, in turn, better support the utility mandate that increasingly includes certain societal benefits such as environmental performance and customer control. Early adopters have faced hurdles, but clear lessons have emerged that will assist all stakeholders as they carry out their respective roles.

The challenge, then, is to engage in a process of grid renewal that, through pragmatism and realistic expectations, can move beyond short term volatility to long term stability—and do it as quickly as possible with the greatest extent of stakeholder buy-in. In other words, to move beyond "high expectations" and the "valley of despair" and onto "continuous, incremental improvement" by confronting reality, crafting a vision, and communicating a belief in the process.

CONFRONTING REALITY

This paper strives to present an accurate and current "state-of-play" for the smart grid in Canada, drawing on the reality of the smart grid as seen through the eyes of utility operators and utility customers. While the operators understand the technologies, utility customers experience the end result, either good (i.e. a plug-and-play roof top solar array) or bad (i.e. rising electricity prices). As such, we must closely monitor both viewpoints closely.

The CEA conducts an annual Customer Attitudes Survey that tracks the Canadian electric utility customer experience across Canada. This information, as well as best practices discussed at meetings of the CEA Customer Council, provides a basis for understanding the smart grid "reality" as seen by customers. In addition, the CEA Distribution Council and Transmission Council both work to confront the smart grid reality as seen by utility operators. Together, this work can contribute to the development and maintenance of an accurate and realistic understanding of the smart grid that evolves along-side technologies and customer perceptions.

CRAFTING A VISION

The establishment of this generally accepted state-of-play understanding will provide the base upon which the Canada-specific smart grid vision can be built.

This will require the input from an even more diverse stakeholder group than that of the Alberta Utilities Commission process, and will not be easy to accomplish. Indeed, for any progress to be made, each stakeholder will need to continually confront reality and re-orient their positions to the reality of technological constraints and customer preferences.

It is also important to note that the Canadian smart grid will not be developed or deployed in a vacuum. The United States, Europe, much of Asia, Australia and New Zealand are all moving forward with smart grid innovation and messaging. Monitoring and engaging those conversations will be vital to ensuring that the Canadian smart grid vision is congruent to those of other jurisdictions.

COMMUNICATING BELIEF IN THE PROCESS

Finally, it is critical for the industry and stakeholders to maintain faith in the vision that emerges, even as aspects of the smart grid work their way through the change curve presented earlier in the paper. If the state-of-play is regularly and pragmatically assessed, and the vision is allowed to evolve and adapt over time, each stakeholder can be confident that the smart grid is being developed with the best information available. High expectations will become reasonable expectations, the valley of despair will become the flat plains of transition, and a state of continuous improvement will be achieved much more rapidly.

With the publication of this document, Canadian utilities signal our commitment to this process. We hope you will participate as well.

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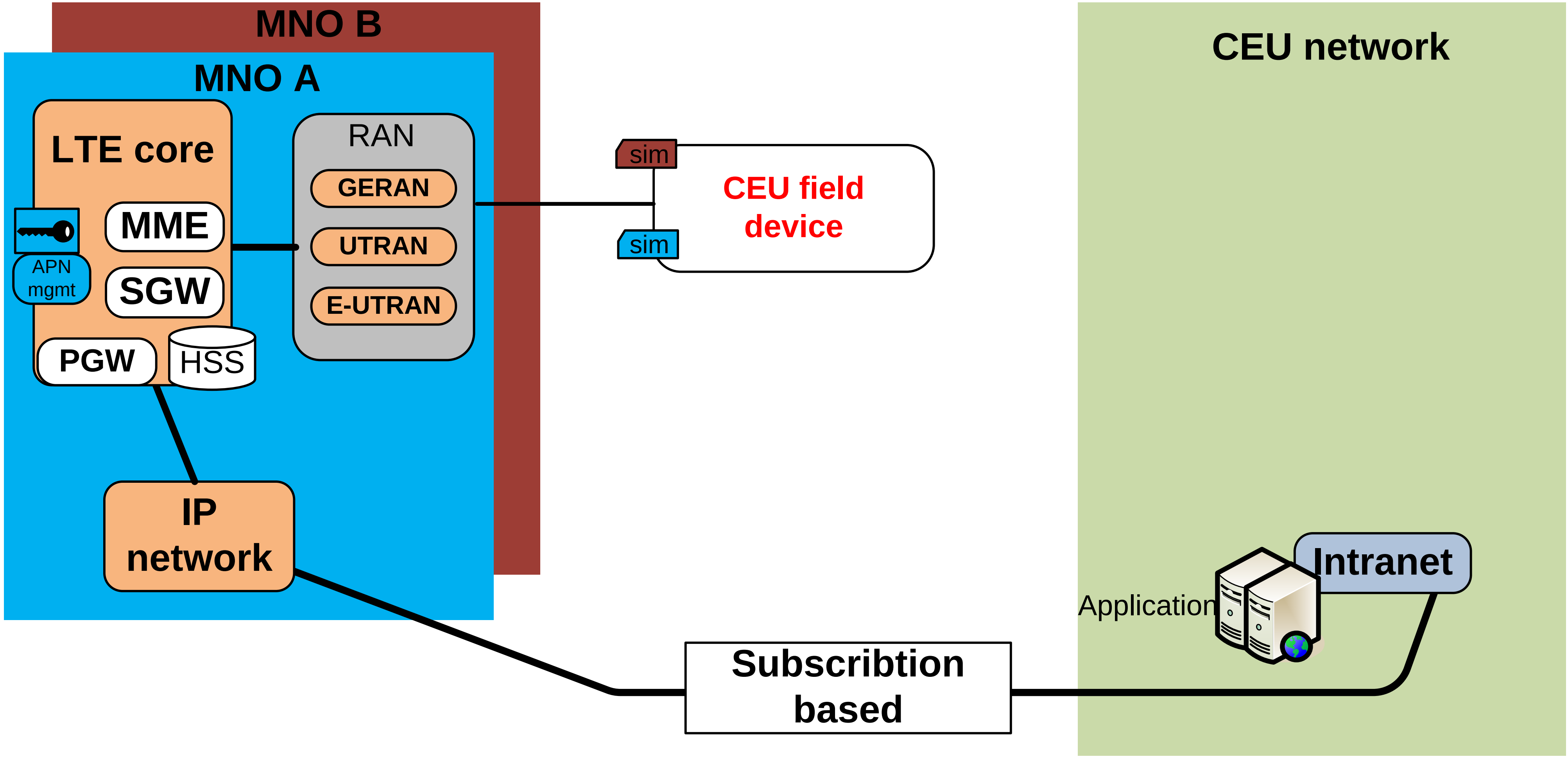
APPENDIX B

Actual (Subcription based over dedicated APN)



PVNO – (Full-MVNO with wholesale agreements)