Smart grid-related innovation: the emerging debate

Ontario Smart Grid Forum

July 14, 2015

Purpose of this Paper:

About the Ontario Smart Grid Forum:

The Ontario Smart Grid Forum includes member organizations from Ontario's utility sector, industry associations, non- profit organizations, public agencies and universities working together to propose a vision for a smart grid in Ontario and examine the many components that comprise it. It is supported by the Corporate Partners Committee, which represents more than 45 private sector organizations active in the smart grid space – including electric vehicles, energy retailers, energy management companies, systems integrators and equipment manufacturers.

For further information, and to download a copy of the Forum's previous 2013 report, 'Ontario Smart Grid Progress Assessment: A Vignette' please visit: **www.IESO.ca**

This discussion paper is being put forward by the Ontario Smart Grid Forum. Its intended purpose is to aid and focus an emerging discussion regarding how the province of Ontario and its energy sector should approach the topic of innovation – particularly insofar as smart grid technologies are concerned.

For six years the Smart Grid Forum has monitored and contributed to a debate that has been emerging in Ontario, and indeed across Canada, with respect to the role of public investment in energy innovation. Since its inception in 2008, the Forum has advocated for the realization of innovation-related benefits from the smart grid and has made recommendations in its previous public reports on this topic. With the help of the Forum this notion was formally enshrined in Ontario's high-level smart grid objectives that continue to guide today's regulatory framework.[1] Now however, the debate has turned to the ongoing facilitation of innovation. While it may be relatively easy to achieve consensus on high-level objectives, more challenging questions regarding how this should achieved, and who should be responsible for it are beginning to surface.

The emerging debate over the "*who*?" and "*how*?" questions regarding smart grid development is beginning to yield differing opinions on how to proceed. Fundamental questions have been raised with respect to the allocation of risk from innovation-related investment across various facets of our society, such as government, regulated utility companies, private sector ventures, taxpayers, and energy ratepayers. Several organizations have entered the public arena and offered their opinions on this matter – some of which will be highlighted in this paper. Even within the Smart Grid Forum, there are implications for its various member organizations[2] , and its Corporate Partners Committee (CPC). The Forum and CPC include representation from virtually every type of organization that may be affected by the "who?" and "how?" questions. It is hoped that this report might provide a snapshot of that debate as it currently stands and aid informed deliberations on the risks and rewards associated with the different options.

[1] Minister of Energy's Directive to the Ontario Energy Board (OEB)(Ontario Order-in-Council 1515/2010, November 23, 2010 section 4, and Appendices 'A' 'B' and 'C' – see OEB website for complete version of the Directive)
[2] See "*List of Forum and Corporate Partners Committee member organizations*" at the end of this report

Introduction:

The late economist Joseph Schumpeter once postulated that there are essentially five types of innovation:

- the development of new products (including service products);
- the development of new methods of production;
- the identification of new sources of supply;
- the exploitation of new markets; and,
- the implementation of new ways to organize business.3

In essence, the smart grid exhibits manifestations of all five of these forms of innovation. Exploiting this innovation potential is expressed in the official, legislated definition of 'smart grid' that resides in *Ontario's Electricity Act, 1998* (right). Over the past six years the Smart Grid Forum has deliberated extensively on the causes and effects of smart grid-related innovation, and has published papers on the matter[4]. In its 2013 assessment of smart grid progress in Ontario, the Forum noted the vast array of innovation activities taking place within academic institutions, private industry, utilities, and various funding programs taking place at the federal and provincial levels to help assist this process[5].

As the smart grid continues to establish itself as a permanent fixture of Ontario's electricity landscape, the debate has matured. In aggregate, the various, disparate efforts examined by the Smart Grid Forum in 2013 are now yielding more sophisticated questions for policymakers. Where and how should smart grid innovation be facilitated over the longer term? More recently, Ontario's energy sector has engaged in a wider discourse on how best to encourage innovation and what roles should be played by the various entities in Ontario's electricity sector.

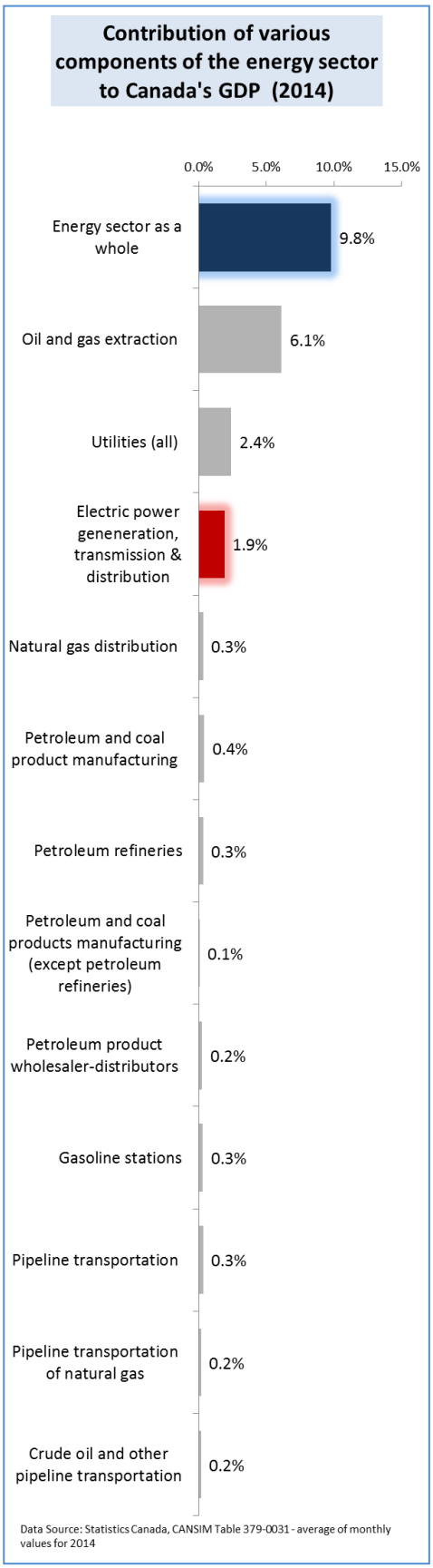
"Smart Grid" – the official definition in Ontario's *Electricity Act, 1998*:

*"(1.3) For the purposes of this Act, the **smart grid** means the advanced information exchange systems and equipment that when utilized together improve the flexibility, security, reliability, efficiency and safety of the integrated power system and distribution systems, particularly for the purposes of*

- enabling the increased use of renewable energy sources and technology, including generation facilities connected to the distribution system;
- expanding opportunities to provide demand response, price information and load control to electricity customers;
- accommodating the use of emerging, innovative and energy- saving technologies and system control applications; or
- supporting other objectives that may be prescribed by regulation. 2009, c. 12, Sched. B, s. 1 (5)."

{S.O. 1998, CHAPTER 15, Schedule A, section 1.3}

[3] Schumpeter, J. A. "*The Theory of Economic Development*", Harvard University Press, 1934, Tenth printing, 2004. , pg. 66
[4] See bibliography section for a complete list of the Forum's past smart grid papers
[5] Ontario Smart Grid Forum, "*Ontario Smart Grid Progress Assessment: A Vignette*", September, 2013


Contribution of various components of the energy sector to Canada's GDP (2014)
0.0%
5.0%
10.0%
15.0%
Energy sector as a whole
9.8%
Oil and gas extraction
6.1%
Utilities (all)
2.4%
Electric power geneneration, transmission & distribution
1.9%
Natural gas distribution
0.3%
Petroleum and coal product manufacturing
0.4%
Petroleum refineries
0.3%
Petroleum and coal products manufacturing (except petroleum refineries)
0.1%
Petroleum product wholesaler-distributors
0.2%
Gasoline stations
0.3%
Pipeline transportation
0.3%
Pipeline transportation of natural gas
0.2%
Crude oil and other pipeline transportation
0.2%
Data Source: Statistics Canada, CANSIM Table 379-0031 - average of monthly values for 2014

Innovation in the electricity sector is not just about electricity, and some of the most important influences on the development of the electricity system come from non- electrical domains. A smart electrical grid ultimately needs to integrate with the broader concept of ”smart energy networks.” As noted in the graph at right, electricity is part of a broader energy system that leant almost 10 per cent of the value of Canadian domestic output in 2014. Innovations across the various components of this energy network create synergies that can and should augment this value contribution over time. Over the course of the past several years, both the Smart Grid Forum and the Corporate Partners Committee have expanded their dialogue beyond the electricity sector to engage players from other parts of the energy system. This is particularly pertinent to any discussion regarding innovation and the smart grid. With these considerations comes a broader context for the Smart Grid Forum and the Corporate Partners Committee to consider.

So how should innovations benefits be realized? This paper aims to convey the essence of the emerging debate in Ontario. While there may be some degree of consensus that smart grid- related innovation requires some form of permanent framework, there are differing visions as to what that might look like. This paper will seek to draw out those competing viewpoints by examining a series of high-level questions that were developed by the Smart Grid Forum and its Corporate Partners Committee during the fall of 2014. As noted earlier, these questions largely centre around “who” should play a role in this framework and “how” it should be carried out. The five main questions that this paper addresses are as follows:

1. How should innovation be funded within and from the electricity sector?
2. How does the electricity sector ensure that innovation remains customer-focused?
3. Where are innovative ideas for the electricity sector most likely to come from?
4. How can regulated utilities facilitate and support innovation?
5. What are the best mechanisms to measure success and move innovation into broad adoption within the sector?

Much progress has been made with smart grid development in Ontario. In just the past two years since the Forum's 2013 assessment of Ontario's smart grid progress[6], the province's regulated utilities sector has undertaken a multitude of projects from pilots to full-scale roll-outs. These innovative efforts have already covered a diverse range of topic areas including data access, data analytics, microgrids, energy storage, electric vehicles, system monitoring, grid automation, operations and energy conservation, to name a few. Harnessing the capabilities of smart grid technologies in such areas is something that the Ontario Smart Grid Forum has been advocating for since 2009. During this time, regulated utilities in Ontario have done much to advance various smart grid-related innovations, while working within the scope of their current regulated rate of return structures. Nonetheless, the current innovation environment is under close scrutiny at the moment - particularly in the context of how to increase the pace and amount of innovation. For example, just as this report was being finalized, a Navigant Consulting report, "*Ontario Smart Grid Assessment and Roadmap,*" commissioned by the Ontario Ministry of Energy, made this observation:

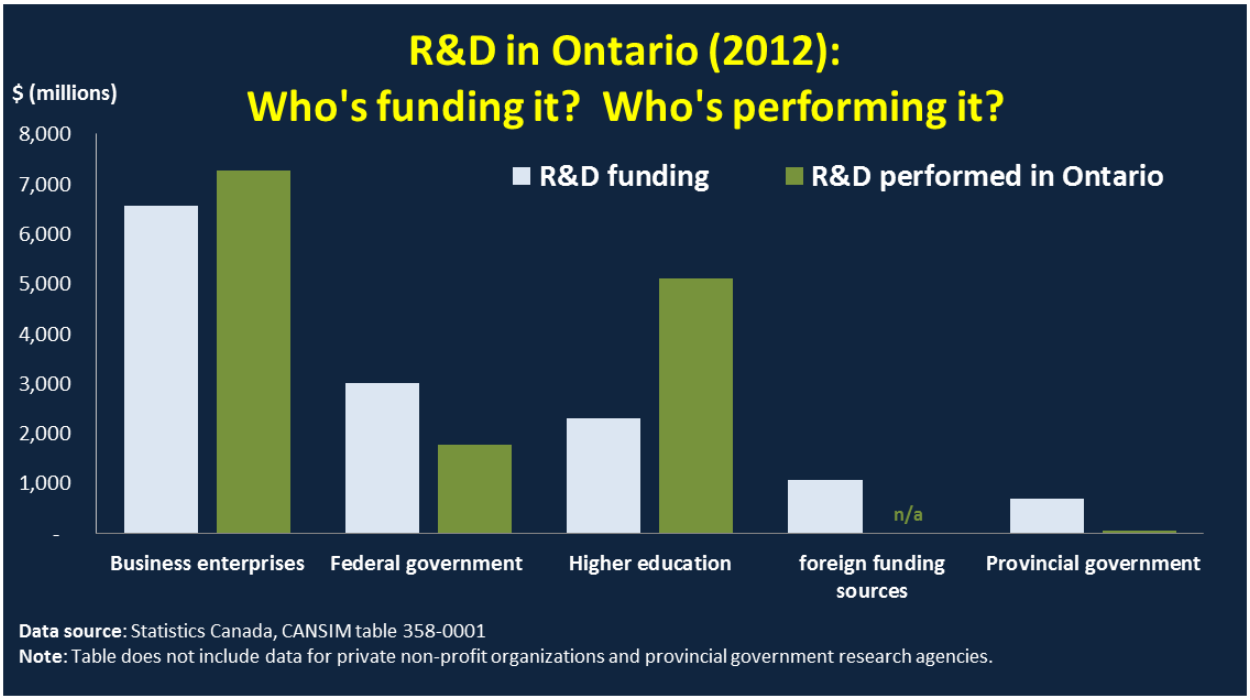
"The distribution sector in Ontario is undergoing a period of renewal, replacing assets installed 20, 30, 40, or even 50 years ago. This renewal requires substantial capital investment. At present, the funds for these investments are not coming from utility shareholders injecting new capital into the sector but rather from deferred earnings (i.e., municipal and provincial shareholders choosing to forgo dividends and reinvest profit back into the organisation). This is certainly an acceptable approach, but there is a limit to how much growth or innovation utilities can fund through these means. At some point the sector will require new incremental capital." [7]

This is a common theme in a long-running debate regarding what the role of the regulated utility company should be in the innovation process and to whom those costs should be allocated. This paper will examine some of the new models and positions already taken by other organizations in this debate. Just as importantly, this paper will also discuss various conduits for new smart grid innovation that *do not* rely upon the involvement of the public utility company. This is particularly pressing for behind-the-meter technologies that can evolve independently of the utility's electricity system – and represent one of the fastest growing segments of smart grid-related investment.

If Ontario is to maintain its unique lead with respect to smart grid innovation then it must continually assess the success of its current and ongoing innovation efforts. This report and the recent Navigant report make similar suggestions regarding the need to develop some form of more formalized innovation success metrics in order to support good policymaking and choices amongst the options presented in this paper. Over the coming pages, this report will examine the (sometimes competing) choices that might be faced by policymakers in this crucial area. Around the world, one can find a growing array of specific examples where some of these approaches have been applied – each with its respective benefits and drawbacks. It is hoped that by exploring both the competing solutions and opinions surrounding these options, this paper might underscore both the importance of this issue and lend clarity to its surrounding discourse.

[6] Ontario Smart Grid Forum, "Ontario Smart Grid Progress Assessment: A Vignette", September, 2013
[7] Navigant Consulting, "*Ontario Smart Grid Assessment and Roadmap*" pg. 42

Section 1: How should innovation be funded within and from the electricity sector?

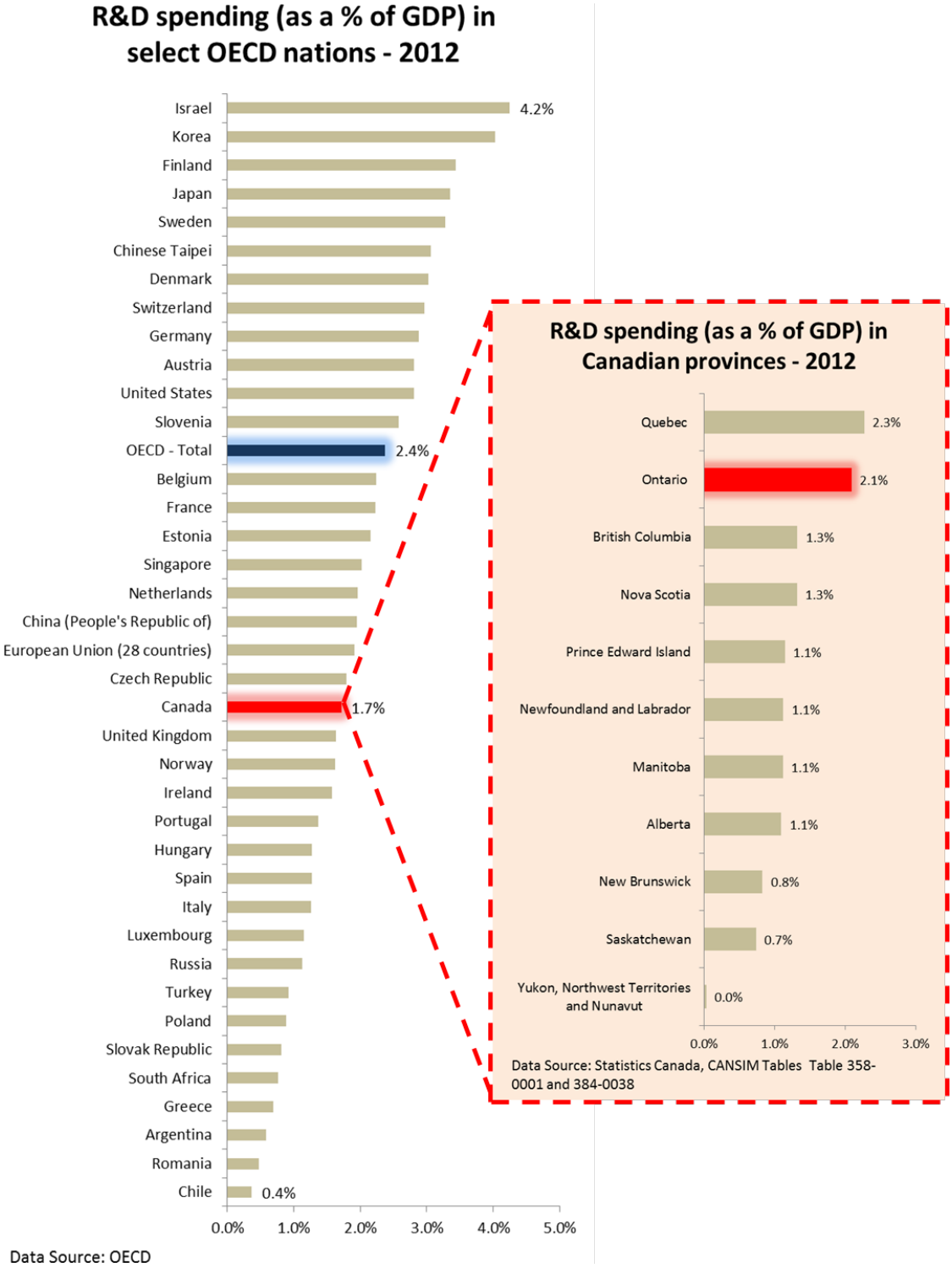


The entire portfolio of Ontario's research and development (R&D) funding and performance activity spans a wide variety of public and private sector institutions. Many of these same funding and performance options present themselves to the electricity sector at all stages of the innovation process spanning R&D to demonstrations to mainstream adoption. The interactions between these various innovation options is rather complex. Some forms of innovation require the involvement of the utility company in order to validate, test and develop them. Others do not. In between these two extremes are a wide range of innovation processes where the role of the utility company may be somewhat discretionary. And it is here where the question of how to finance these activities can become rather complicated.

Should utility companies play a bigger role in the innovation process and if so, how should those activities be funded? In many respects this first question draws out several of the most important dimensions to the innovation-related policy debate unfolding in Ontario and elsewhere. The appropriate answer to how innovation should be funded is premised on one's viewpoint on several underpinning questions:

- Why innovate at all?
- Is the utility company solely a user of the latest smart grid technologies? Or, are they in fact best-suited to guide the innovation process?
- Who should bear the financial risks?

Research and Development Funding Around the World and Within Canada (2012 figures)



Why Innovate At All?

Since its inception, the Ontario Smart Grid Forum has connected smart grid innovation to the underlying goals and principles of why Ontario's electricity system needs to modernize. Many of these principles and objectives were eventually enshrined in the Minister's 2010 directive to the Ontario Energy Board, which are repeated in Appendix 1 of this report[8]. In aggregate, all of those high-level principles express the value of a modernized, capable electricity system. Some of them explicitly connect to the notion that the smart grid itself should become a centre point of innovation, economic growth and future adaptability of the electricity system. For example, consider the following excerpts from that Directive:

From "general objectives

"ECONOMIC DEVELOPMENT: Encourage economic growth and job creation within the province of Ontario. Actively encourage the development and adoption of smart grid products, services, and innovative solutions from Ontario-based sources."

From "Adaptive Infrastructure" objectives:

"FLEXIBILITY: Provide flexibility within smart grid implementation to support future innovative applications, such as electric vehicles and energy storage.

FORWARD COMPATIBILITY: Protect against technology lock-in to minimize stranded assets and investments and incorporate principles of modularity, scalability and extensibility into smart grid planning.

ENCOURAGE INNOVATION: Nest within smart grid infrastructure planning and development the abilty to adapt to and actively encourage innovation in technologies, energy services and investment / business models.

MAINTAIN PULSE ON INNOVATION: Encourage information sharing, relating to innovation and the smart grid, and ensure Ontario is aware of best practices and innovations in Canada and around the world." [9]

To date, these principles have shaped key regulatory and strategic policies around Ontario's smart grid development. Now, however, a more complex discussion of the broader innovation environment has begun. More recently, the focus on innovation has been coupled with a growing awareness that the modernization of the electricity system is inextricably tied to the development of the broader energy system Achieving the above objectives is highly dependent on developments around the periphery of the electricity sector and the ways in which the electricity sector connects its own innovation activities with them.

[8] Ontario Order-in-Council 1515/2010, November 23, 2010 section 4, and Appendices 'A' 'B' and 'C'
[9] Ibid.

Is the utility company solely a user of the latest smart grid technologies? Or, is it, in fact, best suited to guide the innovation process?

These questions have come to the forefront of the debate across Canada, including right here in Ontario. Already, numerous organizations have waded into this question, and a few examples are highlighted below.

Examples of public positions on the role of utilities in the innovation process:

2009 Ontario Smart Grid Forum: *"Utilities that wish to investigate and test smart grid technologies on their systems should be encouraged to propose demonstration projects that will assist them in testing the performance of available smart grid technologies and quantifying their costs and benefits. The non- proprietary results of these projects should be made widely available."* [10]

2009 IBM Global Business Services:
"Utilities will also have to evaluate new competitors and offerings. If the offerings are easily replicable by the utility, a rapid response can keep the utility "relevant" in consumers' minds. If the offerings cannot be replicated, substitute offerings must be developed – or revenue models must be adjusted to reflect a world in which these customers have moved some or all of their business elsewhere."[11]

2012 MaRS Discovery District:
"There is a compelling case for creating a separate organization to oversee projects, especially those undertaken in partnership with academia. As Müller notes, with incentives to foster smart grid development, it is important to ensure end-customers and taxpayers do not pay more than once to support the same research."
12

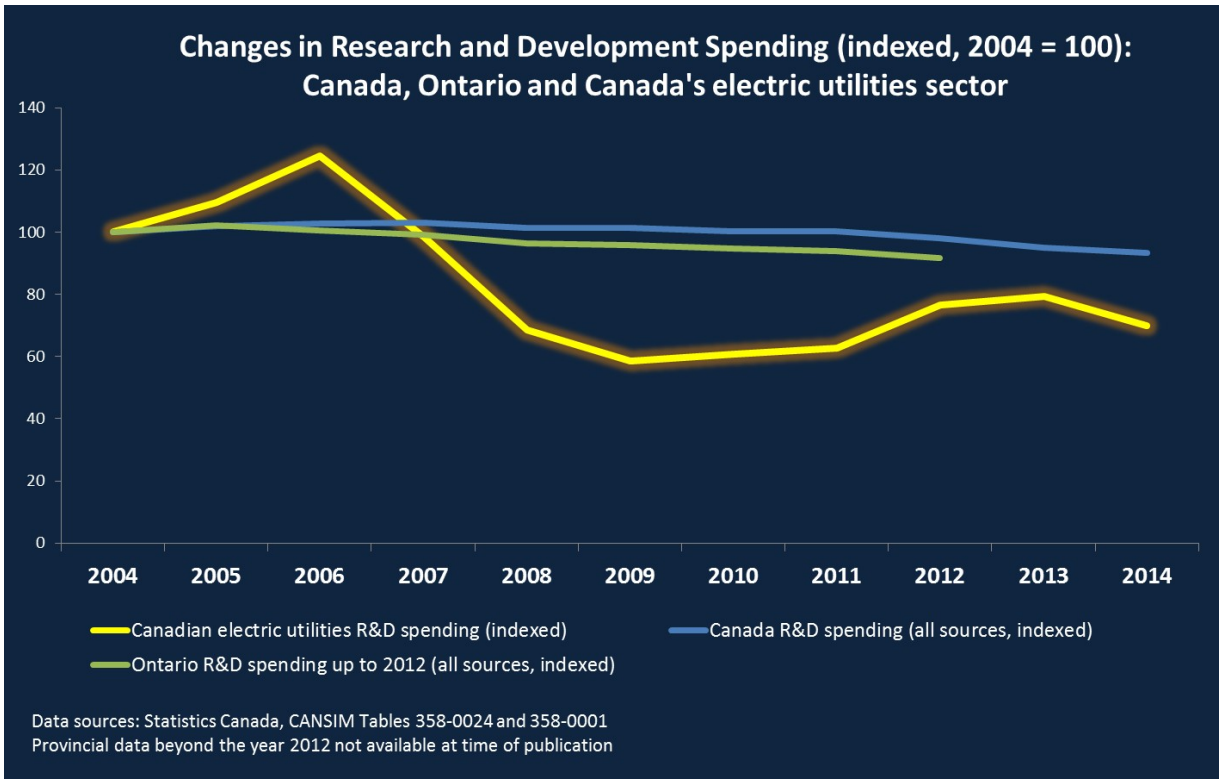
2012 The Mowat Centre:
{recommendation for the Ontario government}:
"Direct the OEB to develop a rate- recovery mechanism for collaborative industry research."
[13]

2014 The Canadian Electricity Association and the Canadian Gas Association:
"Canadian natural gas and electric utility customers stand to gain substantially from increased levels of innovation. Overarching analyses of the returns from investments in innovation generally and utility and energy innovation demonstrate that benefits to society and utility customers substantially outweigh the costs of innovation investments."[14]

2014 Council of Canadian Academies:
*"Past investments that cannot be recovered, known as sunk costs, may prevent operators from making further investments, despite the benefits they would achieve. A further obstacle may be technological path dependency because it is difficult to implement an ICT application if it is a deviation from what is already known and understood. Additionally, there are serious risks associated with locking into an ineffective, or less effective,
technology early on."*[15]

[10] Ontario Smart Grid Forum, "*Enabling Tomorrow's Electricity System*", February 2009, page 24
[11] IBM Global Business Services, "*Plugging in the consumer: Innovating utility business models for the future*" pg. 17
[12] MaRS Market Insights, Briones, J. et al., "*Ontario Utilities and the Smart Grid: Is there room for innovation?*", pg. 22 Christine Müller is a researcher with "WIK" Wissenschaftliches Institut für Infrastruktur und Kommunikationsdienste GmbH cited in the MaRS report.
[13] Mowat Centre, "*Smarter and Stronger: Taking Charge of Canada's Energy Technology Future*." pg. 55
[14] Concentric Energy Advisors, Yardley, B., "*Stimulating Innovation on Behalf of Canada's Electricity and Natural Gas Consumers: A discussion paper prepared for the Canadian Gas Association and the Canadian Electricity Association*", August, 21, 2014 pg. 2
[15] Canadian Council of Academies, "*Enabling Sustainability in an Interconnected World*", Ottawa, 2014 pg. 71

Several organizations, including the ones listed above, have made specific and direct recommendations regarding the extent to which regulated utilities should be involved in the innovation process. The risk of cost overruns, impact on ratepayers, stranded assets and technological obsolescence are just a few of the considerations that the regulated utilities must consider before making any sort of investment in innovation-related technologies. Even organizations that have advocated for greater utility involvement in the innovation process have highlighted the risks in doing so, and in some cases, offered potential solutions to mitigate those risks.



Over the past decade, electric utility-related spending on research and development across Canada has declined considerably. However, the above graph does not tell the whole story, particularly in the province of Ontario. Over the past few years, Ontario has seen a marked increase in smart grid-related innovation activities undertaken by academic institutions, the provincial government and its agencies, and private industry. To date, however, much of this has taken place without a formalized determination of roles and responsibilities across Ontario's extensive portfolio of innovation activities. Some of these efforts have been ad hoc in terms of their duration, while other efforts have brought about enduring institutions, testing facilities, and frameworks. In other words, a foundation has been set – but what will be built upon it?

Who should bear the financial risks?

Innovation is not a risk-free proposition from an investment standpoint and poses a dilemma for public utilities. Where does that risk get allocated to? The choice often falls between the regulated returns earned by the utility on behalf of its shareholders, or its customers. This dilemma creates both incentives and disincentives for the LDC to participate in the innovation process. On the one hand, innovation can provide a necessary competitive edge in a world where demand from the conventional electricity system is falling, infrastructure is aging and new entrants are poised to enter the marketplace. On the other hand, the risk of failure before the regulator and the utility's customers can often prompt utilities to opt for tried and true technologies to avoid drastically affecting near-term return on equity.
All these considerations have come to the fore recently during the Forum's deliberations on this topic.

Historically across Ontario the shareholder of given public utility is, in many cases, the municipal government. The provincial government also holds ownership over a large portion of distribution assets in the rural and remote regions of the province. At the time of drafting this paper this, too, is the subject of much public debate given the final recommendations of the Premier's Advisory Council on Government Assets to divest a portion of Hydro One.[16] Distribution sector structural reforms and funding models may not be the central subject of this paper, but it is difficult to completely divest this crucial topic from the innovation debate – particularly if Ontario is to give due consideration to the proposal now being put forward by the Canadian Electricity Association and the Canadian Gas Association.[17] More recently, they have also factored into the recommendations of the Navigant Consulting report commissioned by the Ministry of Energy, which include long-term funding arrangements for innovation projects and catalyst funds backed by shareholders.[18]

Since 2011 the Ontario Energy Board has been implementing its *Renewed Regulatory Framework for Electricity* which governs the manner in which Ontario's LDCs may recover costs and earn a regulated rate of return. While the framework allows, and indeed encourages, utilities to make use of smart grid technologies, there are other pressures that may affect how a regulated utility participates in the innovation process:

- **From ratepayers:** ultimately, the risk of investment failure in an emerging technology is borne by the ratepayer if the costs are put in the rate base. In addition, new smart grid innovations may have little discernable short-term impact on reducing bills while in the pilot project phase.
- **From shareholders:** some have argued that some or all of the innovation-related investment costs should be borne by the shareholder. This would potentially mean allocating a portion of

[16] Premier's Advisory Council on Government Assets "*Striking the Right Balance: Improving Performance and Unlocking Value in the Electricity Sector in Ontario* " April 16, 2015 Pgs. 5
[17] Concentric Energy Advisors, Yardley, B., "Stimulating Innovation on Behalf of Canada's Electricity and Natural Gas Consumers: A discussion paper prepared for the Canadian Gas Association and the Canadian Electricity Association", August, 21, 2014
[18] Navigant Consulting, "*Ontario Smart Grid Assessment and Roadmap*" pg. 6

the rate of return that many regulated utility shareholders covet. This is a significant obstacle the Ontario distribution sector review panel explored in 2012.[19]

- **From the regulator:** the regulator must balance several considerations before approving a rate case including overall rate impact, preventing overlap between LDCs, technological viability and ensuring that other societal goals such as reliability and efficiency are met.
- **From other funding sources:** Occasionally public institutions intervene with direct funding to encourage innovation in specific areas. In Ontario a recent prominent example of this is the allocation of the Ontario Smart Grid Fund. The Smart Grid Fund has a finite amount of provincial government funding for a variety of projects, many of which involve the participation of
- Ontario's public utilities alongside private sector funding recipients.

With these competing interests come competing ideas on how to motivate utility involvement in the innovation process. Some of these potential solutions will be explored in further depth elsewhere in this paper, but they generally fall into two major categories that were ably described in the Mowat Centre's 2012 report as follows:

1. "Technology-push": In this case innovation is funded either directly or indirectly through tax credits, public funding, etc. in the hopes that it might yield technologies that provide a public benefit in key strategic areas. This has certainly been an approach employed in various instances in Ontario and other prominent jurisdictions around the world.

2. "Demand-pull": Such policies seek to develop consumer demand for certain technologies through various methods as rebates, taxes and tax incentives. Again in Ontario there are recent examples of such activities, such as electric vehicle incentives and various conservation programs which are in the process of being augmented in this province, as part of the 2015- 2020 Conservation First Framework which is now being implemented. The Conservation First Framework will provide a significant amount of pull-based innovation funding over the next five years. [20]

In some cases the current regulated utility model doesn't directly connect to some of these incentives but can still influence their behaviour. For example, recent policies in Ontario to promote consumer adoption of electric vehicles may not *directly* affect a utility's rate of return, but it may prompt utilities to seek out innovative technologies and programs to manage electric vehicle charging load and infrastructure demands. One of the principal arguments behind the notion that Ontario's innovation model should change is the strength of that motivational connection. A regulated utility doesn't necessarily feel the same imperative as a start-up company to take on the risk of field testing a new type of grid automation equipment for example. However, if the project is successful, it could yield a multitude of efficiency and reliability benefits for both customers, and the electricity system as a whole.

[19] Ontario Distribution Sector Review Panel, Elston, Murray et al., "*Renewing Ontario's Electricity Distribution Sector: Putting the Consumer First*", pgs. 36-28

[20] Ontario Power Authority public presentation, *"Target and Budget Allocation Methodology: Conservation First Framework LDC Tool Kit"* December 16, 2014, slide 10

Funding innovation - Potential Options:

Again, as in so many issues related to the innovation process, there are diverging views as to how innovation funding might be secured. In today's environment, utility-led innovation could potentially be funded by a variety of sources:

- The rate base – which involves a rigorous review by the provincial regulator to ensure the proposed project doesn't overlap with other utilities' projects
- Ad hoc public funding – such as the Ontario Smart Grid Fund, for example, which as of the date of this paper was nearing the end of its original 2009 budgetary allocation21
- The utility company's shareholder equity – as noted by Ontario's 2012 distribution sector review panel (see below), there is little evidence to suggest that many regulated utilities are materially using their own retained earnings in this manner

Then of course, there are a variety of potential private and public funding models that do not centre around the role of the utility company and draw from private financing, public funding, and collaboration between such sources (see also, table on next page).

There have been numerous examples of regulated utility companies in Ontario assisting various facets of the innovation process. At the same time, however, various suggestions for improvement have also been made. The recent discourse around the present innovation environment has highlighted several arguments that the current innovation funding framework in Ontario is lacking in certain areas, including:

- Lack of coordination and overlap: the combination of public funding, rate base allocations and private ventures almost guarantees that there is no one organization that can authoritatively ensure that research and innovation activity isn't being duplicated across the province's project portfolio. This can also confuse the strategic direction that the province as a whole is taking.
- Lack of continuity: by its very nature, ad hoc public funding from government budgets or single-purpose funding offers no guarantee of sustainability, which some types of research and innovation programs may require.
- Lack of control by the utilities themselves: innovation funds from outside sources or approved through the ratemaking process might have certain aims and restrictions attached to them that might not be in the direct interest of the utility company.
- Lack of risk pooling: As some innovation investments are inherently riskier than conventional electricity infrastructure investment, individual utilities are often not well suited to take on all of the risk from an individual project, particularly when that project is funded through the rate base.

Some of these issues have factored into the nine major barriers to smart grid development recently identified by Navigant Consulting's recent report, "*Ontario Smart Grid Assessment and Roadmap*." [22] As will be explored further in this paper, the Canadian Electricity Association and the Canadian Gas Association recently commissioned a paper making a significant recommendation for a pooled funding model in which new utility-level innovation is funded by some form of charge on the rate base. It is aimed squarely at the problems mentioned above. It does, however, make an underlying assumption

[21] Ontario Ministry of Finance, *2009 Ontario Budget: Confronting the Challenge: Building Our Economic Future*, pg. 26
[22] Navigant Consulting, "*Ontario Smart Grid Assessment and Roadmap*", pg. 4

that most or all utility innovations directly benefit customers proportionately more than utility shareholders. Again, however, this particular innovation path is not necessarily the avenue that all smart grid-related innovations take on the path to commercialization and widespread adoption.

Today, one can find a wide range of examples of innovation funding models in Ontario, a few of which are illustrated in the table below. It is apparent that most innovative endeavours involving public utility companies are ultimately funded by the ratepayer through regulated cost recovery - as opposed to the retained earnings of the utility company. Despite this notable absence, the Forum notes that Ontario benefits from a wide variety of funding models. This is particularly advantageous given that some of these models are better suited to certain stages of the innovation process.

Table – Examples of different innovation funding models currently in place in Ontario and other public proposals

Potential models - current and proposed	Potential funding sources: Ratepayers	Taxpayers	Public utility shareholders	Private sector equity and debt financing
Recovery from rate base	Renewed Regulatory Framework IESO Conservation Fund	n/a	n/a	n/a
Pooled funding model	CEA/CGA proposal	n/a	n/a	n/a
"Push"-type innovation incentives	IESO Conservation Fund	Ontario Smart Grid Fund Ontario Centres of Excellence MaRS Investment Accelerator Fund	n/a	MaRS Investment Accelerator Fund Ontario Smart Grid Fund Other venture capital funds
"Pull"-type innovation incentives	Conservation First Framework & Conservation Fund	Electric vehicle rebates	n/a	n/a
Direct funding of utility R&D and piloting	IESO Conservation Fund	Sustainable Development Technology Canada (SDTC)	Navigant Consulting "Catalyst Funds" proposal ("Ontario SG Assessment and Roadmap")	Sustainable Development Technology Canada (SDTC)
Private R&D funding	IESO Conservation Fund	n/a	n/a	Various
Voluntary industry collaboration	Ontario Green Button Initiative	Partnerships with academia (e.g. Canada Foundation for Innovation & McMaster University)	n/a	Partnerships with academia (e.g. Ryerson Centre for Urban Energy)
Partnerships between private companies and public utilities	Forum/CPC "Sandbox" recommendation (see note 1)			
	CEATI Collaborative Projects Program (note 2)	n/a	n/a	CEATI Collaborative Projects Program (note 2)

Legend

Example exist in Ontario today

Public recommendations for Ontario from various organizations

Notes

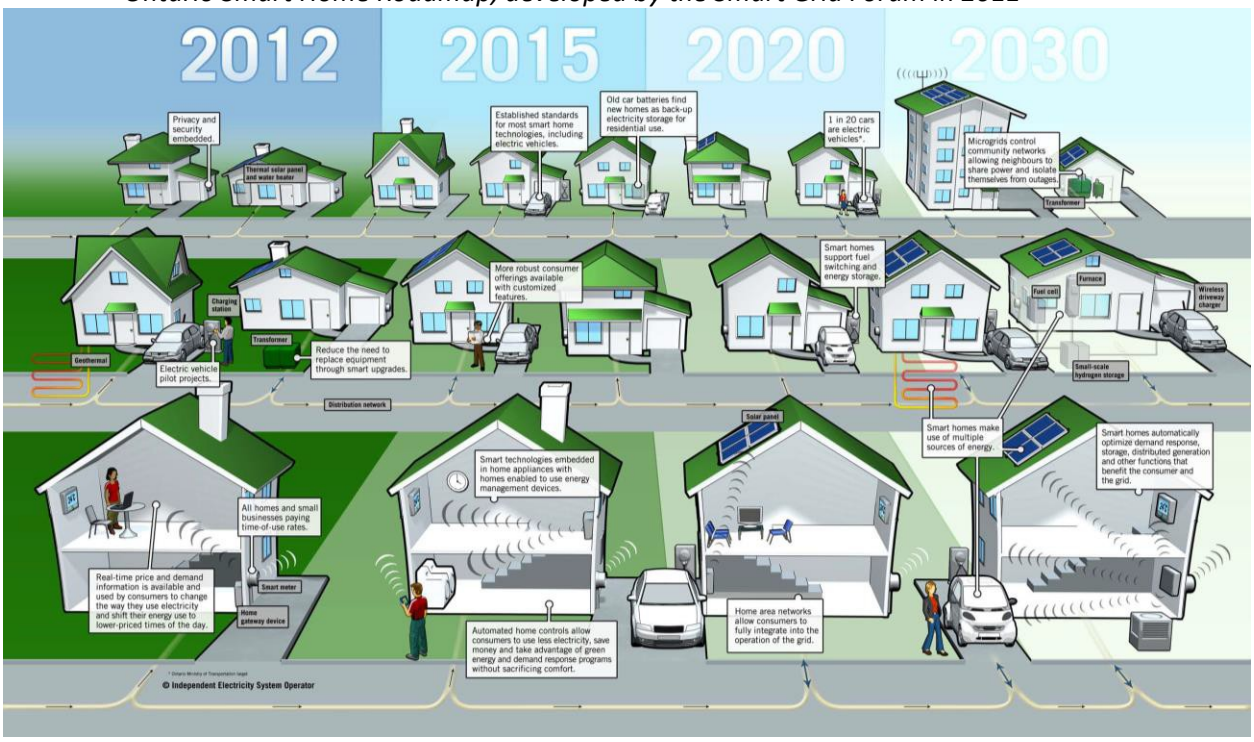
Note 1: This proposal stems from a 2011 recommendation by the Smart Grid Forum for a common testing platform ("sandbox") in regards to the province's Advanced Metering Infrastructure. The proposal from the Corporate Partners Committee can be supported by a wide range of potential funding sources.

Note 2: "CEATI" stands for "Centre for Energy Advancement through Technological Innovation"

Note 3: Private sector equity and debt financing column includes public funds that can compel contributions from private sector participants

Section 2: How does the electricity sector ensure that innovation remains customer-focused?

Ontario Smart Home Roadmap, developed by the Smart Grid Forum in 2011



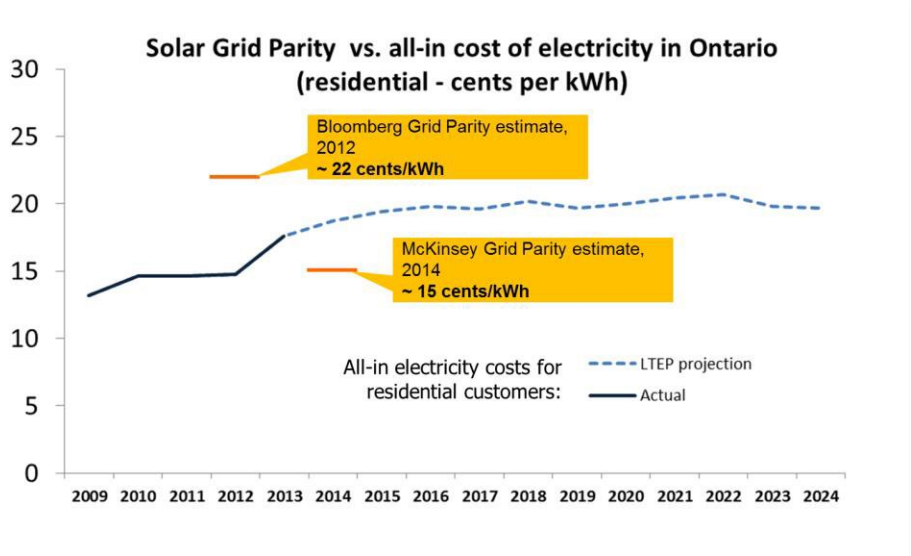
Involvement of the consumer in the innovation process has been an ongoing aim of the Smart Grid Forum for quite some time now. In the lead-up to the publication of its 2011 report[23], the Smart Grid Forum developed the ***Ontario Smart Home Roadmap***, in part to highlight how the smart grid must continue to connect to the needs of the consumer. The recommendation underpinning that report was as follows:

"Industry and government should work toward meeting the development timelines established in the Smart Home Roadmap to bring greater control, choice, market participation and other benefits to electricity consumers. The Forum will monitor developments."[24]

Today, many of these considerations from the Forum's 2011 recommendation are still important – particularly when it comes to involving the customer in the innovation process. The presence of a vibrant marketplace for new products and services is the ultimate arbiter of competing innovations and ensuring that the true consumer value is being extracted from the smart grid. The reverse is also true: the smart grid needs to be able to harness the capabilities of consumer-side expenditures to provide value back to the grid itself. Distributed generation, distributed storage, micro combined heat and power, electric vehicles, smart home systems and smart appliances are just a few examples of the types

[23] Ontario Smart Grid Forum, "Modernizing Ontario's Electricity System: Next Steps", May 2011
[24] Ibid.

of innovative products that can have a tremendous impact on the broader power system by providing such services as demand response, ancillary services and overall energy conservation.



By most projections, including those of the provincial government, Ontario's all-in electricity costs will continue to rise over the coming decade. By some estimates at a national level for Canada, such as those illustrated above, the cost of solar power is in the vicinity of the "grid parity" point at which the price of self-generation for many consumers is lower than the retail cost of electricity from the legacy system.[25] This cost trend has the potential to be both a driver and hindrance of smart grid-related innovation in the province:

> **As a driver:** rising per-unit costs from the conventional electricity system may have the propensity to drive further customer investment in distributed generation, storage, load management and energy efficiency technologies for example. On the other side of the meter, rising costs may prompt public utilities to make more intensive use of smart grid technologies to accommodate customers' increasingly sophisticated use of the electricity system – a point the Smart Grid Forum has raised in several of its previous reports.
>
> **As a hindrance:** rising costs are already making some utility companies reluctant to adopt an innovation funding framework that might cause a short-term increase in customer rates, or result in public failures of high-risk projects that involve ratepayer funds.

This raises an interesting dilemma from a public policy standpoint: customers may indeed be motivated to adopt new smart grid-related innovations, but on their side of the electricity meter. Is there any need for a customer to "engage" with utility-driven innovation if the most apparent cost reduction opportunities lie within the scope of their own investments? Certainly in Ontario there have been, and

[25] Note: the illustrated cost estimates do not account for the costs of energy storage which would enable the customer to use such electricity outside of daylight hours. Data sources for the graph include: i. Bloomberg, Roston E. and Yanofsky D. "Solar Silicon Price Drop Brings Renewable Power Closer" March 13, 2012 and ii. McKinsey Quarterly, David Frankel, Kenneth Ostrowski, and Dickon Pinner, "The disruptive potential of solar power" April 2014, iii. *Ontario Long-Term Energy Plan*, December 2013

continue to be, extensive efforts underway to connect customer-side investment with those of utility companies. A vast array of conservation and demand management programs are administered by utility companies, the former Ontario Power Authority and now the IESO. Some of these programs have targeted specific investment in emerging innovations such as controllable thermostats. Others have adopted a demand pull approach by assisting customers phase out older, energy inefficient appliances, or undertake building retrofits to achieve greater energy efficiency.

"Users of electricity, including residential, commercial, and public-sector users, have the most to gain from the use of open data applications. But they need to understand the potential benefits and how to capture them."

McKinsey Global Institute, "*Open data: Unlocking innovation and performance with liquid information,*" October 2013, Pg. 66

As of the date of this paper, the Province of Ontario is in the process of launching an augmented Conservation and Demand Management Framework that is targeting a 7 TWh reduction in overall electricity use by the end of this decade. This too has tremendous potential to shape customer motivations towards innovative smart grid technologies over the medium and long term. The Energy Minister's specific directive to implement the conservation goals of the province's *Long-Term Energy Plan* included in its guiding principles the notion that "*Innovation and the adoption of new technologies will be encouraged*."[26] Among the budgetary measures included in the Conservation First Framework is a funding allocation to the *LDC Program Innovation Stream,* which is intended to design, pilot and phase in the full-scale implementation of next generation conservation programs.[27] Customer-side investments in smart grid technologies can indeed address both cost and energy efficiency imperatives for the customer, and Ontario has reserved substantial resources to also harness those investments for the broader benefit of the electricity system.

Keeping the focus on the customer - Potential Options:

Previous Smart Grid Forum Recommendations:

The Smart Grid Forum is already on the public record for ensuring that customers are placed at the forefront of innovation policy – particularly by setting out a roadmap by which customers themselves can make a determination of what is of value to them in the Smart Home marketplace.

Previous Forum recommendation (2011): "Industry and government should work toward meeting the development timelines established in the Smart Home Roadmap to bring greater control, choice, market participation and other benefits to electricity consumers. The Forum will monitor developments."

[26] Ontario Ministry of Energy, Office of the Minister, "*Re: 2015 – 2020 Conservation First Framework*", March 31, 2014
[27] Source: IESO website: www.ieso.ca - Conservation First Framework webpage accessed on May 14, 2015

More generally, the Forum has also advocated for a better understanding of the way in which utility companies and third-party service providers interact with one another – not just for residential consumers but also to capture the potential of the commercial and industrial sectors:

Previous Forum recommendation (2011): "The interactions between LDCs and third-party service providers in each area of the smart grid value chain should be examined with an eye to removing barriers to consumer service adoption. The Forum and its Corporate Partners Committee will work with industry to facilitate this effort."

In some jurisdictions, this particular notion of opening the marketplace has become the crucible for an overhaul of the distribution sector as a whole. For example**,** in April 2014, the New York State Public Service Commission launched the "*Reforming the Energy Vision*" (REV) initiative. The REV has two major work streams, the first being a fundamental examination of the role of the distribution company – particularly insofar as facilitating market-based approaches to load management and meeting over-arching energy efficiency goals. The second work stream will examine the types of tariffs and market incentives and structures that are appropriate to achieve those goals.

Of particular interest in the New York REV process is the conceptualization of a common distributed system platform (DSP). The DSP concept extends beyond the conventional discussion of merely separating a utility from its 'wires' business. It is intended to afford the opportunity for distributed generation, storage, and controllable load to participate in a marketplace in a uniform manner that spans the state, and the boundaries between different distribution companies. In so doing this, the DSP concept reflects a growing recognition that distribution companies increasingly have some of the same types of commercial and operating challenge as a system and market operator.

The Smart Grid Forum also believes that there are other policy approaches that could and should be explored in order to ensure that future innovations continue to centre around the ultimate needs of the customer. Below are a few approaches that merit further consideration:

- Foster better understanding of the motivations of driving customer investments in smart grid technologies
- Promote innovations that tap into the potential of non-electrical energy products and services (e.g., thermal storage, ice storage, CHP, absorption chilling, etc.)
- Provide local marketplaces for consumers to sell ancillary services back to the distribution system (e.g. New York State REV process)
- Define how aggregators can provide services to both the bulk electricity system and the local distribution system
- Develop new means of valuing localized balancing and ancillary services at the distribution system level in order to accommodate higher penetration of renewables, distributed storage, electric vehicles, etc

Section 3: Where are innovative ideas for the electricity sector most likely to come from?

Historically, Ontario's Hydro-Electric Power Commission was often able to translate its own needs for innovation into practical research at its own laboratories, conduct its own pilot projects and eventually move innovation from its laboratories into mainstream use. In the wake of the 1965 northeastern blackout for example, the Commission was soon applying the latest innovations in solid state electronics to the development of sophisticated frequency trend relays in its own laboratory. Today, various utilities across the province are still undertaking a wide array of innovative activities ranging from microgrid pilot projects to exploiting the potential of open standards such as the Ontario Green Button initiative.

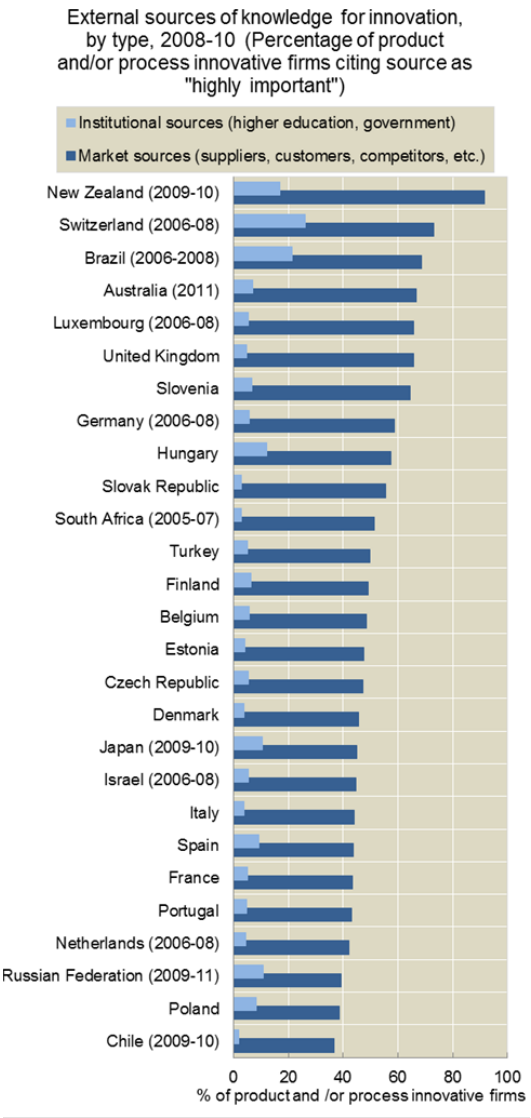
1966: Frequency Trend Relays with solid state electronics being developed at the Hydro- Electric Power Commission of Ontario laboratories.
Image source: Hydro-Electric Power Commission of Ontario. *Annual Report, 1966*

There is a crucial difference with today's context, however. For the most part, gone are the days of the centralized utility laboratory in Ontario. The vast majority of research and development funding in Ontario is now carried out by private enterprise and higher education institutions. To be sure, these non- utility R&D streams are producing a multitude of new products and services that could be harnessed to provide benefits to the wider electricity system. Unlike the Hydro-Electric Power Commission's development of frequency trend relays in the 1960s however, there is now a separation between the different institutions involved in requirements gathering, research, product development, pilot testing and implementation.

2015 Consumer Electronics Show: Incipio
Wireless Home Outlet compatible with the Apple HomeKit suite
Image source: Incipio.com

The separation of responsibilities over various stages of the innovation process is a crucial question that has been debated within the Smart Grid Forum and the Corporate Partners Committee over the past year. During this dialogue, a couple of major themes have emerged:

1. Some utility members have expressed the notion that not all products and solutions offered to them get to the heart of their most pressing problems.
2. Some private sector members have expressed the concern that there often isn't a clear dialogue or framework for companies to better understand the problems and needs of the utility company.



Source: OECD Science, *Technology and Industry Scoreboard*, 2013

In other words, today's electricity sector does not suffer from a lack of innovative ideas, but there is a clear need for cooperation at the requirements gathering and problem definition stage of the innovation process.

As noted earlier, the Forum has already put a high degree of emphasis on putting the needs of the customer first in defining the requirements for the innovation process – particularly in the context of achieving the *Ontario Smart Home Roadmap*. Centering innovation around the needs of the customer certainly seems to fit the sentiment of a study conducted by the Organisation for Economic Co-operation and Development (OECD) in 2010 (right).[28] The study seems to show an overwhelming consensus amongst firms in a wide range of countries that choices made by customers, suppliers and competitors do more to inform the innovation process than institutional sources. There is much that can be done to realize the innovation requirements of both the *Ontario Smart Home Roadmap* and the broader vision of a modern 'smart energy network' – and certainly the innovation process needs to be conducive to developing good ideas from many different sources.

[28] OECD Science, *Technology and Industry Scoreboard*, 2013

Developing innovative ideas - Potential Options:

Previous Smart Grid Forum Recommendations:

In addition to advocating for a vibrant marketplace for smart home-related products and services, the Smart Grid Forum has also sought to ensure that innovative, non-utility firms get access to that marketplace. In doing so, the Forum has made this previous recommendation regarding third party access to electricity consumption data:

Previous Forum recommendation (2011): "*Barriers to facilitating third-party access to electricity consumers and their real-time consumption information should be addressed. The Forum and its Corporate Partners Committee will work with industry to resolve outstanding access issues, consistent with the Smart Grid Objectives set out in the government's directive to the Ontario Energy Board*."

Since this recommendation was made, considerable work has been carried out on this topic. In 2012, the Forum elaborated on this particular topic in its report, "*Access to Consumer Data: A Vignette*". Work has also been undertaken in Ontario by a variety of groups and organizations ranging from private industry to government. For example, the Ontario Green Button Initiative, led by the MaRS Discovery District and supported by government, utility companies and private industry has done extensive work to bring about common data access standards for Ontario's smart metering data. The value of projects such as Green Button is that they potentially pave the way for further innovation – often from outside of the utilities sector.

Much work still needs to be done in the area of opening up utility-side data to third parties for further innovation development. For example, recently both the MaRS Advanced Energy Centre and the IESO have launched consultations to examine the access rules for aggregated consumption data that can be potentially used for research and innovative product development.

Another important recommendation of the Forum that is closely related to widening the innovation field in Ontario, is the subject of open interoperability standards. In 2011, the Forum adopted the following recommendation:

Previous Forum recommendation N13: "Industry should take advantage of widely used interoperability standards for defining smart grid specifications. Attention should be paid to the upcoming national recommendations from the Canadian National Committee of the International Electrotechnical Commission and its Task Force on Smart Grid Technology and Standards (facilitated by the Standards Council of Canada), which is monitoring international standards discussions."

Adoption of open interoperability standards continues to be a pressing issue in Ontario and in other jurisdictions around the world. Not all industry players have wholeheartedly adopted the notion of non-proprietary standards, seeing them as a potential threat to their competitive advantage. However, the promise of using open standards to create new markets, foster competition, and drive further innovation remains as important as ever. In September 2014 the U.S. National Institute of Standards and Technology (NIST) made the following observation in the latest release of its smart grid interoperability standards framework:

"Shared standards and protocols help reduce investment uncertainty by ensuring that new technologies can be used throughout the grid, lowering transaction costs and increasing compatibility. Standards also encourage entrepreneurs by enabling a significant market for their work."

NIST "*Framework and Roadmap for Smart Grid Interoperability Standards, Release 3*.0" pg. 32

Other options:

- Continue to facilitate cross-industry dialogue and information sharing and, where necessary, encourage voluntary cross-industry consortiums to form
- Allow utility-side conservation and demand management programs to be more reactive to changing customer needs, investments and consumption decisions
-
- Encourage open interoperability standards in key strategic areas where utilities interface with third-party service providers and their customers
-
- Consider a strategic review of publicly funded energy-related research to ensure that enough effort is being devoted to the concept of smart energy networks
-
- Develop complementary policies to encourage utilities to ensure minimum data quality standards are adhered to when facilitating third-party access to consumption data. In addition to ensuring consumer consent to third-party data access (e.g. through Green Button), the quality and consistency of the data being transacted across the utility interface to third parties should be treated as an important attribute of this service.

Section 4: How can regulated utilities facilitate and support innovation?

Distribution transformer monitoring equipment Image source: Grid 20/20 and Ontario Ministry of Energy

Top: Zen Thermostat
Bottom: Ecobee EMS Si Thermostat
Two examples of customer-focused energy management products developed in Ontario

On the face of it, this question seems to imply that there is a finite set of optimum ways to bring *any* new innovation into mainstream use. But can a single innovation mechanism really apply to all smart grid technologies? For example, should a smart thermostat take the same route to commercialization as a new form of sub-station monitoring and control equipment?

In their recent report[29], the Canadian Electricity Association and the Canadian Gas Association took a comprehensive inventory of different approaches to commercializing innovations ranging from taxpayer-financed activities to ratepayer-funded models. The latter of these approaches is central to the CEA/CGA recommendations, and in their report they cited numerous examples around the world where this

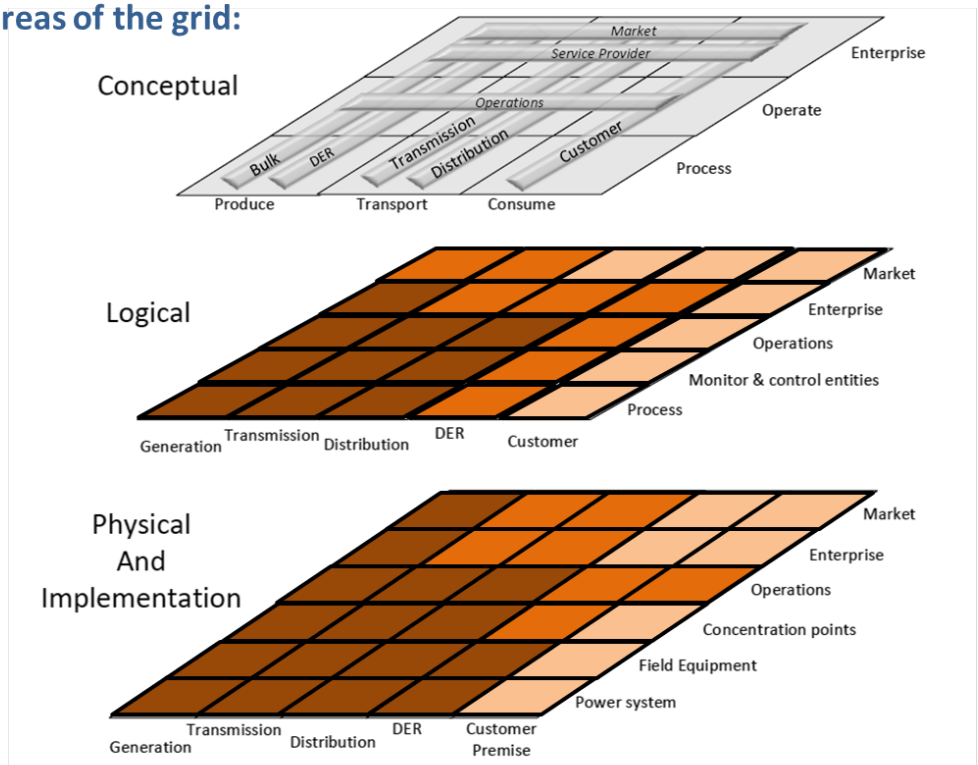
[29] Concentric Energy Advisors, Yardley, B., "*Stimulating Innovation on Behalf of Canada's Electricity and Natural Gas Consumers: A discussion paper prepared for the Canadian Gas Association and the Canadian Electricity Association*", August, 21, 2014

approach is being taken. Within Canada, there are certainly organizations devoted to the specific purpose of commercialization, including Sustainable Development Technology Canada (SDTC), MaRS Cleantech, Ontario Smart Grid Fund, IESO Conservation Fund and Ontario Centres of Excellence (OCE) to name a few. Some of these organizations and funds offer alternatives to solely relying on the sponsorship of a public utility – recognizing some of the challenges with today's utility funding model that have been discussed throughout this paper.

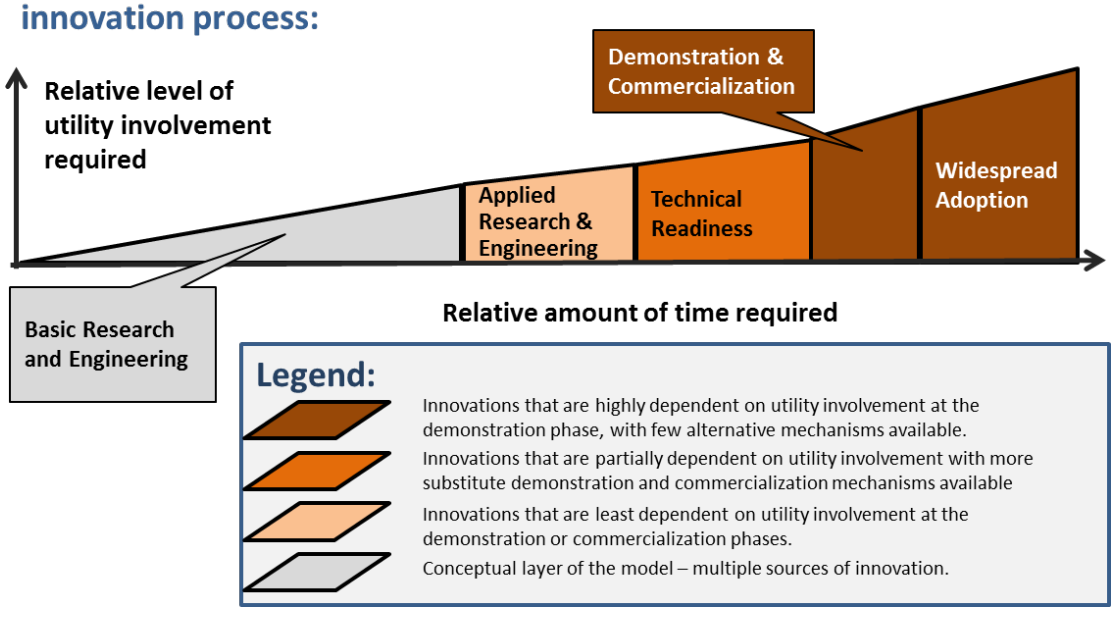
In short, there are multiple smart grid technologies and domains as well as various mechanisms for getting them to market. So what does the field of possibilities look like? In some ways the U.S. National Institute for Standards and Technologies (NIST) provides one of the most comprehensive conceptual models of the smart grid, which the Forum has referenced in its previous reports. The NIST interoperability framework has been updated three times (most recently in May 2014), and now stands as a mature conceptual model of the smart grid in its entirety. The NIST Smart Grid Architecture Model (SGAM) provides an overview of the conceptual, logical and physical layers of each of the domains of the smart grid spanning from bulk generation to the customer site. It also provides an excellent visualization that can be used to determine which types of technologies may be more or less dependent on the involvement of a utility company in order to achieve commercialization. This is most apparent at the physical layer of the model. Technologies physically rooted in the infrastructure base owned by utilities will likely have a higher dependency on utility involvement at the requirements gathering and pilot project stage. Conversely, technologies firmly rooted in the customer domain of the smart grid might not be nearly as dependent on utility involvement in the innovation process

Figure – Adapted NIST smart grid architectural model, colour-highlighted to indicate where innovations may be more heavily dependent on utility involvement[30]

Relative dependency on utility involvement in innovation in different areas of the grid:



Relative dependency on utility involvement at different stages of the innovation process:

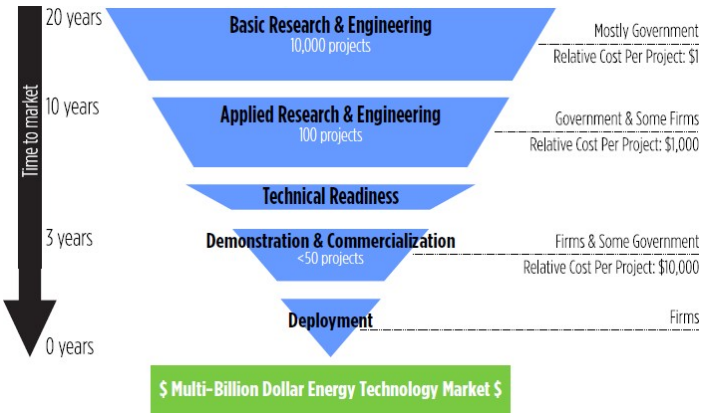


[30] Adapted from a diagram appearing in: "*NIST Framework and Roadmap for Smart Grid Interoperability Standards, Release 3.0*" pg. 134

Rate-funded models, tax-funded models, industry consortia, and private partnerships are all potentially viable ways to assist the commercialization process. However, their applicability may depend on what types of smart grid innovations that one is seeking to develop. From a public funding standpoint, this might be driven by a strategic assessment of which smart grid domains might have the greatest spillover benefits for the electricity system and society at large. Certainly in some jurisdictions around the world, research and commercialization activities in various domains of the smart grid are specifically targeted. This in turn has yielded a specific set of institutions, funding models and strategic policies that seek to develop an innovation chain in chosen areas of the above model. If Ontario is to focus its attention on utility-side smart grid development (i.e., the dark-shaded squares in the previous diagram) then certainly proposals such as the one put forward by the CEA/CGA merit serious consideration. On the other hand, if the province intends to focus its innovation efforts on distributed energy resources (DERs) and customer-side innovations, then perhaps other types of mechanisms and funding models (including those already in place) need to be bolstered.

In Ontario, the Smart Grid Forum has made considerable contributions to the development of high-level goals for the smart grid – including assisting the innovation process. Now however, more sophisticated choices may need to be made. Is there a strategic focus for Ontario's smart grid innovation efforts? And if so, what sort of innovation mechanisms might be best suited for that purpose? These are crucial questions for the province, particularly if ad hoc funding mechanisms such as the Ontario Smart Grid Fund are to be supplanted over the longer term.

Over the past several months, the Ontario Smart Grid Forum and its Corporate Partners Committee have begun to have a more exacting discussion regarding what exactly is meant by the "innovation process". This is an important question, especially in the context of any discussion of the role of public utilities. In Ontario, LDCs effectively have a guaranteed local monopoly over licenced distribution services. As such, they are further restricted from other commercial activities unless done through an affiliate where regulated and unregulated business functions are firmly regulated and must be compartmentalized from one another. While this alone should not
necessarily stop an LDC from assisting the development of innovative smart grid products, it does raise important questions regarding what portions of the innovation process that they should focus on. Here, there is no shortage of different viewpoints and examples from which to draw.



In its 2012 report, the Mowat Centre provided an overview diagram (right) suggesting the preferred role that various types of institutions should play in the innovation process.[31] The diagram suggests a strong role for government and academic institutions in taking on the risk of conducting early-stage research and development of technologies that might never come to fruition from a commercial standpoint. As the research and attendant technology matures, firms and utility companies can make a more definitive assessment of the risk/return potential of that investment. It is here at the demonstration and commercialization stage where the debate around the role of the utility company intensifies.

For various forms of smart grid technology, utility involvement in the development process ranges from essential to non-essential, including just about every grade in between those two extremes. Equipment that will directly affect utility operations must first be tested in a safe, controlled environment to make sure performance and safety standards are met and then undergo pilot projects in real-world environments. Other types of equipment and services may have a substantial, indirect impact on utility operations, but reside on the customer side of the meter. Here again, the utility company may have an interest in being involved in pilot project testing to ensure the technologies are ready for widespread adoption.

Electric vehicles, microgrids, distributed storage and smart inverters are just a few recent examples where Ontario LDCs have been proactively involved piloting technologies that may one day have a substantial operational impact on distribution systems. Today, most of this happens within the auspices of the Ontario Energy Board's *Renewed Regulatory Framework for Electricity Distributors*. As previously reported by the Smart Grid Forum, the *Renewed Regulatory Framework* encourages LDCs to evaluate the various technological alternatives to building traditional electricity infrastructure that the smart grid has to offer. It is within this framework that most rate-funded innovation activities takes place. The CEA and CGA however, have recently proposed a different approach to innovation activities. In essence, they have proposed a pooled funding model that levies a charge on ratepayers that is specifically devoted to higher risk innovation activities, which is separate and distinct from the rate base. The various contrasts between this proposed approach and the way in which utility innovation is accommodated in today's regulatory framework is illustrated in the table that follows on the next page.

[31] Mowat Centre, "*Smarter and Stronger: Taking Charge of Canada's Energy Technology Future*." September 2012

A comparator of the CEA/CGA proposal for innovation funding vs. current accommodation within today's regulatory framework.

	Ontario today	CEA/CGA concept[32]
Requirements identification and setting research direction	• LDCs work with customers, suppliers and stakeholders to develop rate cases within the Ontario Energy Board's (OEB) Renewed Regulatory Framework • OEB helps reduce overlap between pilot projects of various LDCs and scrutinizes the rate impact on consumers	• Funded by customers through a charge that is separate and distinct from distribution rates • Pooled funding model to support innovation and research outside of the main rate base • Centralized, coordinated allocation of funding to reduce overlap between projects
Facilitating research and development	• Some larger LDCs provide funding or in-kind contributions to academic institutions and other research institutions, but the R&D work is rarely carried out by the LDC itself	• Funding for riskier innovation projects comes from the central funds pool which has some degree of oversight from the regulator
Conducting Research and development	• Very limited in the utilities sector. • Typically research is conducted by the participating academic and/or private sector institutions	• Centralized clearinghouse for research information and project results
Pilot projects	• Various projects as approved by the Ontario Energy Board which helps safeguard customers against overlap and providing oversight. • LDCs serve as proponents and hosts of Conservation Fund pilots	• Investment pool selects pilot projects and shares risks amongst all utilities, with some degree of regulatory oversight
Full-scale Implementation	• Utility-side technologies selected and funded through the auspices of the OEB Renewed Regulatory Framework • LDCs pilot then deploy new local, regional and provincial conservation programs	• No change. Not intended to replace the OEB Renewed Regulatory Framework for mainstream, rate-funded capital investment

[32] See also, Concentric Energy Advisors, Yardley, B., "*Stimulating Innovation on Behalf of Canada's Electricity and Natural Gas Consumers: A discussion paper prepared for the Canadian Gas Association and the Canadian Electricity Association*", August, 21, 2014

Facilitating innovation - Potential Options:

How can regulated utilities facilitate and support innovation?

To a certain extent, there is a variety of policy choices presented in this paper that are predicated on the active participation of the utility company in order to move innovation forward. As we saw in the previous section, pooled funding models such as the CEA/CGA proposal can further bolster the importance of the regulated utility company. Other options also continue to place the regulated utility in an important role within the innovation process. A few such examples are as follows:

- Pull-based incentives administered by utilities (e.g. IESO Conservation Fund, LDC Program Innovation Stream of Ontario Conservation First Framework)
- Overhaul of the role of distribution companies to facilitate local markets for services to the grid (e.g. New York State REV process)
- More focus on encouraging utility deployment of new innovations (e.g. OEB Renewed Regulatory Framework, Ontario Smart Grid Fund, IESO Conservation Fund)

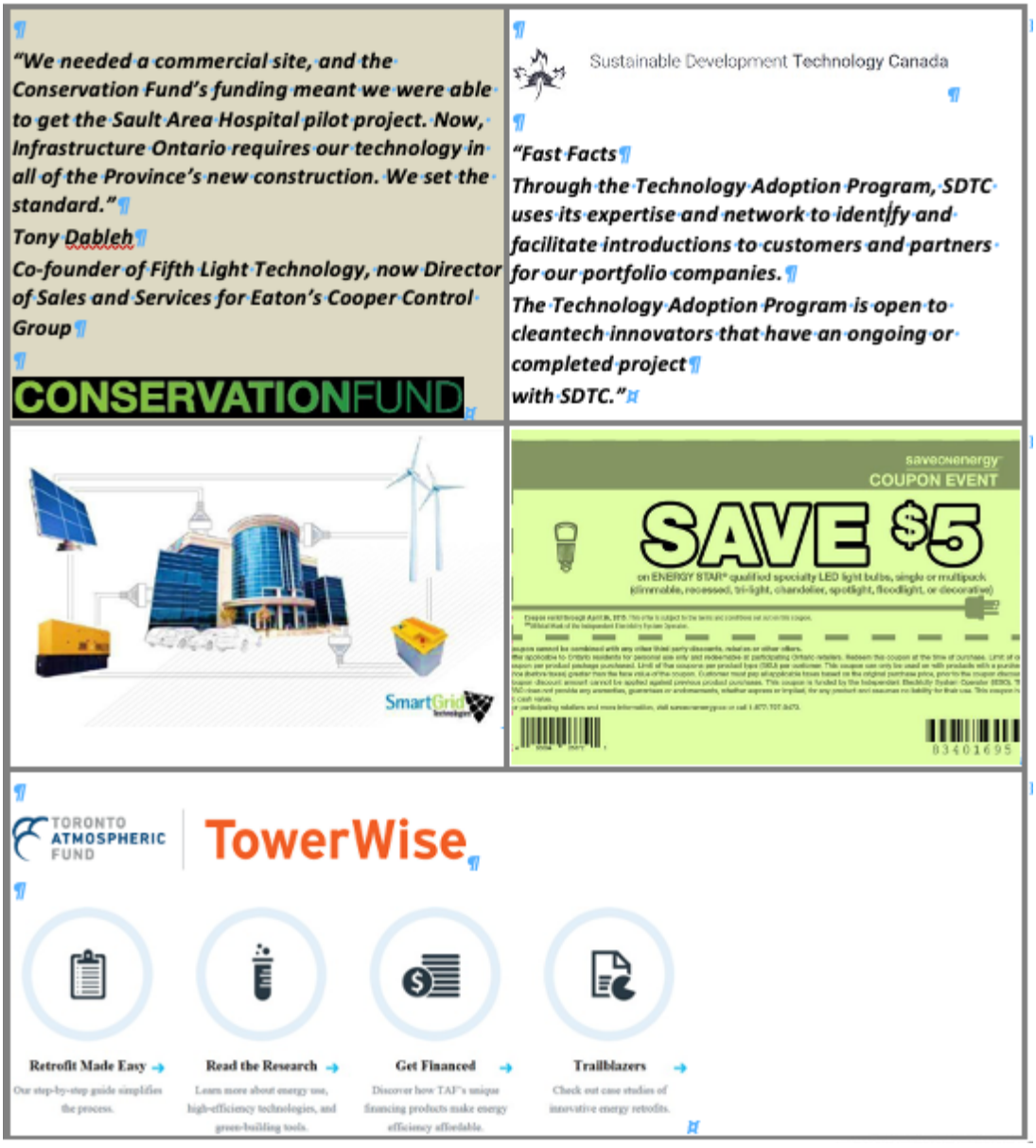
As discussed in this section however there are also a number of viable policy options that don't rely as heavily on utility involvement in the innovation process. For example, in 2011, faced with the need to test home energy network gateway devices with Ontario's many proprietary Advanced Metering Infrastructure (AMI) interfaces, the Forum recommended the development of a common test bed facility as follows:

Previous Forum recommendation (2011): *"A test bed environment should be established, devoted to furthering interoperability between emerging products and services, as well as the various proprietary Advanced Metering Infrastructure (AMI) systems deployed across the province as part of the Smart Metering Initiative. The Forum and its Corporate Partners Committee will work with industry to investigate the best path forward."*

To date the Corporate Partners Committee has continued to expand upon this recommendation and the Ryerson Centre for Urban Energy has created its own test lab facilities to simulate various aspects of Ontario's' distribution system. Such efforts could further provide new options for innovators to test and validate new concepts outside the domain of the utility company. Other such options that can help facilitate innovation without direct reliance on utility company involvement include:

- Pull-based incentives administered by non-utility entities (e.g. Ontario electric vehicle rebate program, greenhouse gas reduction policies, and public expenditure policies to encourage demand for innovative energy solutions such as the European Commission and United
- Kingdom's Green Public Procurement (GPP) policies)
- More focus on commercialization programs (e.g. MaRS CleanTech, Ontario Centres of Excellence)
- More public funding focus on applied research programs (e.g. National Research Council, Natural Resources Canada).

Section 5: What are the best mechanisms to measure success and move innovation into broad adoption within the sector?



The question of how to move viable innovations from the testing phase to widespread commercial adoption is a crucial one. The above images[33] provide just a few representative examples of the types of methods, incentives and techniques that are already being used in Ontario and various jurisdictions

[33] Image sources: i. Quote and image from the website of Sustainable Development Technology Canada ii. PowerStream microgrid project (image source: PowerStream, iii. Ontario "saveONenergy" spring 2015 coupon event (image source: IESO), iv. Toronto Atmospheric Fund TowerWise information page (image source: Toronto Atmospheric Fund)

around the world. They reflect several of the policy options previously suggested in various sections of this paper:

- Public funding of demonstration and commercialization projects: The Ontario Conservation Fund and the Sustainable Development Technology Canada (SDTC) have specific funding programs to assist innovative technologies make the crucial step towards practical demonstration and widespread adoption.
-
- Utility-led demonstration projects: In this example PowerStream, an Ontario local distribution company is validating and testing microgrid technologies through a pilot project at its own headquarters.
-
- "Pull-based" programs funded from the rate base: In this case, the Ontario saveONenergy program and Conservation Fund administered by the IESO seek to build up consumer demand for energy efficient technologies.
-
- "Pull-based" programs funded from the tax base: The Toronto Atmospheric Fund "TowerWise" program seeks to connect building owners with information on innovative, energy-efficient technologies and, where necessary, implementation financing.

In addition to the above, the Ontario government recently announced a new dimension to its policy options which may affect financial incentives in the broader energy sector. On April 13, 2015 the Ontario government announced that Ontario will soon be adopting a form of "cap and trade" greenhouse gas emission trading scheme.[34] A significant amount of Ontario's historic emission reductions have been realized from Ontario's electricity sector.[35] While the details of this new initiative have yet to be clarified as of the date of this paper, the Forum notes that the incentives of a cap and trade regime could also have an indirect "pull" effect on some form of smart grid-related innovation, particularly where the integration of renewables and energy efficiency measures are concerned.

In Ontario, a wide range of adoption methods are used. Members of the Smart Grid Forum and the Corporate Partners Committee have identified several challenges during recent deliberations, particularly at the crucial stage of the innovation process when new technologies must prove themselves in the real world before they can expect serious take-up by the marketplace. Some of these challenges are listed below.

[34] Ontario Ministry of the Environment and Climate Change, news release, "*Cap and Trade System to Limit Greenhouse Gas Pollution in Ontario,*" April 13, 2015
[35] Ontario Ministry of the Environment and Climate Change "*Ontario's Climate Change Discussion Paper, 2015*" , February 2015

Current challenges with…

- **"Pull-based" programs funded from the rate base:** As noted earlier, any new costs that drive up the cost of power provided through the traditional electricity system can be a double-edged sword from an innovation standpoint. Rising costs of the electricity system may further create customer incentives to adopt innovations that reduce their dependency on the electricity system – creating a bias in favour of one type of innovation over others. This argument also is applied to the question of whether or not the province should adopt a pooled funding model for supporting utility-led innovations.

- **Initiating utility-led demonstration projects:** To some members of the Corporate Partners Committee there is sometimes a mismatch between the risk-return stance of company promoting an innovative technology and the local utility company. As noted earlier, the risk aversion of a utility company under the current regulatory construct often means that additional sources of funding may be required in order to compel a utility company to participate.

- **Private sector development of innovations for the utility sector:** As noted earlier in this report, there is an identified need for the private sector to better gather requirements directly from utility customers before committing to extensive and costly innovation development projects.

- **Cross-industry collaboration:** In Ontario, the regulation of public electrical utilities is separate and distinct from other forms of energy, although the Ontario Energy Board is common regulator for both the electricity and natural gas sectors. In addition, the activities of the regulated LDC are compartmentalized from the activities of unregulated affiliates and private sector players. In some cases this makes it difficult to establish innovation partnership between regulated industries, or between regulated and unregulated parties.

- **Instituting data access protocols:** As noted earlier, much work has been and continues to be done in Ontario towards establishing means of third-party access to electricity consumption data in a manner that protects the consumer. However, much of this work still remains several steps removed from much sought-after real-time consumption data. To date, the Green Button "Connect My Data" protocol, which would establish the technical layer to a third-party data access framework for smart metering, is still in its testing phase in Ontario and is not available across all LDCs.

- **Grid integration capacity:** Over the past several years, Ontario has made significant inroads in integrating large-scale renewables with the bulk electricity system, as well as distributed generation and storage at the distribution level. However, as the adoption of these technologies by consumers becomes more widespread, the capacity of the grid to accommodate large scale adoption will be put to an even greater test. Evidence from other jurisdictions such

as Hawaii, Europe and California shows that smart grid-related innovations can play a significant role in resolving this problem – a point the Ontario Smart Grid Forum has been making for several years now.

How does one "measure success" when promoting the adoption of innovative technologies?

In some cases the above challenges are compounded by the differing success measures used by the various organizations involved in the innovation process. For example, an Ontario start-up may see success in terms of being able to validate their product in their home market before beginning to develop export markets abroad. A local distribution company, by contrast, may see success in terms of maintaining reliability and rate stability for its customers. As noted earlier, many innovations are inherently risky at the developmental stage. Competing success measures can lead to differing levels of interest in participating in demonstration projects. Harmonizing success metrics and related incentives between various parties to the innovation process may well prove to be one of the most important steps towards a framework that streamlines the adoption process. It is also one of the principal arguments behind pooled funding approaches.

Broad adoption of innovation - Potential Options:

There is still a significant amount of work to do in order to remove some of the barriers to innovation adoption that have already been identified by the Forum. In addition, the design of success metrics for all parties in the innovation process may yield further insight into the design of attendant incentives and investments needed in order to realize the widespread adoption of innovations that truly lend high value.

Previous Forum recommendations:

Once again, the Forum's previous recommendation regarding third-party data access remains an important objective towards both the development and widespread adoption of some forms of smart grid-related innovations.

Previous Forum recommendation (2011): "*Barriers to facilitating third-party access to electricity consumers and their real-time consumption information should be addressed. The Forum and its Corporate Partners Committee will work with industry to resolve outstanding access issues, consistent with the Smart Grid Objectives set out in the government's directive to the Ontario Energy Board*."

In conjunction with the above recommendation on third-party data access, the Forum also recognized the importance of consumer data privacy in its 2011 report and advocated for the following principles to be applied:

Previous Forum recommendation (2011): "*Recognizing that the seven Privacy by Design principles developed by the Ontario Information and Privacy Commissioner provide valuable guidance with respect to compliance with applicable privacy laws and protecting consumers, these principles should be considered as best practice in the implementation of the smart grid in Ontario for both regulated and unregulated service providers."*

Privacy remains an important consideration in the discussion of innovation of and third-party data access. It is also becoming ever more pressing as the Internet of Things grows in prominence. The number of devices connected to the Internet is expected to rise from ~ 15 billion in 2014 to between 30 billion and 50 billion by 2020[36] and with this trend comes the prospect of deeper innovation insights from the burgeoning field of data analytics. Mishandling of privacy issues in the process could undermine consumer confidence and, by extension, the environment in which such innovations can take hold.

The Forum has also advocated for the tracking of smart grid success metrics by various groups and institutions – as alluded to in this 2011 recommendation:

Previous Forum recommendation (2011): "*Industry and government, in collaboration with the Forum, should facilitate the gathering of data to support the early benchmarking and ongoing tracking of smart grid "success metrics". These metrics will be used to assess, over time, whether smart grid investments are delivering promised benefits."*

Market Transformation and Innovation: an example

Since 2005 the IESO (via the OPA prior to January 1, 2015) through the Conservation Fund has supported market-driven innovation in conservation and demand management, generation and distribution technologies and management practices. The IESO's innovation support programs utilize a market transformation model, the goal of which is to advance the availability and adoption in Ontario of next generation solutions. Market transformation begins by enhancing the availability of new solutions and reducing barriers to adoption to the point where further publicly funded intervention is no longer needed.

The goal: long-lasting, sustainable changes in the structure or functioning of the market. Supporting "push-type" early stage development and demonstration projects led by solutions providers in partnership with representative clients, a pipeline of innovative new solutions is developed and tested. These efforts also provide support for pull-based commercial-scale program pilots, LDC program pilots, saveONenergy programs, storage/ancillary service pilots and demand response.

Additional options:

To date, few success metrics related to smart grid-related innovation have actually been formalized or put under institutional ownership to track over time. This could and should be a crucial first step towards resolving the problem of mismatch between risk-return motivations between various entities involved in the innovation process. The Smart Grid Forum is not alone in supporting this idea. In fact, this suggestion was also recently advocated in Navigant Consulting's recent report

[36] Data sources: McKinsey, "The Internet of Things: Sizing up the opportunity", December 2014 and CISCO Systems, Internet of Everything device counter.

commissioned by the Ministry of Energy.[37] Some of the possible innovation-related metrics could include:

- Ontario's national and international trade balance with respect to smart grid products and services
- Quantifying the realization of societal benefits such as GHG reductions
- Monitoring consumer-take up rates of various forms of innovations that have the potential of providing benefits back to the broader energy system
- Quantification of the economic activity generated by third-party open data access
- The electricity system's capacity to accommodate consumer investment in distributed generation and storage
- Tracking and quantification of the formation of smart grid-related intellectual property in the province.
- Evaluating the success of the province's Feed in Tariff (FIT) and microFIT programs in encouraging renewable energy adoption
- Quantifying the extent to which ratepayers actually benefit from utility pilot projects that are funded (wholly or partially) from the rate base
- Providing a more formalized feedback loop for various forms of innovation mechanisms to track their respective success rates against the above measures

[37] Navigant Consulting, "*Ontario Smart Grid Assessment and Roadmap*", Prepared for Ontario Ministry of Energy, January 2015 pg. 6.

In Conclusion…

Since the Forum's last public report in 2013, smart grid-related innovation has continued to change the landscape. Consider just a few of the following recent examples in the context of Schumpeter's five-part definition of innovation:

- **Development of new products:** A visit to the Ontario Smart Grid Fund webpage provides a glimpse of some of the latest smart grid-related innovations that are nearing the commercialization stage in Ontario. In November 2014 the latest round of funding encompassed projects in the areas of energy storage, electric vehicle integration, "behind-the- meter" technologies (i.e., in the customer domain), microgrids, grid automation and data analytics.[38] The Ontario Smart Grid Fund is just one of many conduits by which new smart grid- related products might be further developed in Ontario.

- **Development of new methods of production:** By all accounts the rapid fall in the cost of solar modules stands out as an example where global competition in the realm of production innovation is driving down the costs of smart grid technologies. According to an October 2014 estimate National Renewable Energy Laboratory (NREL) and Lawrence Berkeley National Laboratory (LBNL) the costs of solar modules in the U.S. fell by 12 −19% in 2013 and were expected to fall a further 3–12% over the course of 2014.[39] It is but one of many recent examples, where innovation in production is contributing to the long-run economic viability of smart grid technologies.

- **New sources of supply:** By the year 2032, Ontario's Long-Term Energy Plan projects that Ontario's supply mix will include 13% from non-hydro renewables[40] – most of which were absent from Ontario's supply mix just a few years ago. Accommodating new sources of supply with smart grid technologies is a pressing issue, and there is ample evidence to support this imperative. Consider, for example, the most recent numbers from the Fraunhofer Institute in Germany. In 2014 Germany once again shattered all of its previous records when non-hydro renewable sources provided 27% of the nation's energy.[41]
- The exploitation of new markets: Bloomberg recently estimated that in 2014, worldwide investment in renewable energy came in at $310 billion. [42] It is a significant increase from the

- $60.2 billion in global investment that Bloomberg projected just a decade earlier.[43] Behind the general moniker of "renewable energy" is a host of attendant smart grid technologies that are necessary in order to reliably and cohesively integrate renewable energy into the electricity system. This is often a strategic imperative from a public policy standpoint. For example, in January 2015, the U.S. Department of Energy's Advanced Research Projects Agency committed

[38] Ontario Ministry of Energy news release, "*Ontario Supports Leading Edge Smart Grid Projects: Smart Grid Fund Helps Secure Ontario's Energy Future*", November 27, 2014
[39] U.S. Department of Energy, National Renewable Energy Laboratory, news release, "*Solar Energy Prices See Double-digit Declines in 2013; Trend Expected to Continue PV pricing to drop another 3 – 12 percent in 2014*", October 20, 2014
[40] Ontario Ministry of Energy, *Achieving Balance: Ontario Long-Term Energy Plan*, December 2013, pg. 24
[41] Fraunhofer Institute for Solar Energy Systems, Dr. Harry Wirth, "Recent Facts about Photovoltaics in Germany", January 7, 2015, pg. 5
[42] Bloomberg New Energy Finance news release, "*Rebound in clean energy investment in 2014 beats expectations,*" January 9, 2015
[43] Ibid.

$30 million (US) for a new innovation program to boost the capability of transmission and distribution systems to accommodate higher levels of renewable energy penetration.[44]

- New ways to organize business: In December 2014, Europe's fourth largest utility company, E.ON, announced that it would break itself into two –with one of the new companies devoted to exploiting the burgeoning energy services market. It is but one example of how both incumbent utility companies and new entrants are looking at new ways to fully exploit the potential benefits of innovation through smart grid technologies. Another example of particular interest is the New York Public Service Commission's 'Reforming the Energy Vision' (REV) process, which is the conceptualization of a common distributed system platform (DSP) – mentioned earlier in his paper (see also, page 18). It is intended to afford the opportunity for distributed generation, storage, and controllable load to participate in a marketplace in a uniform manner that spans the state, and the boundary between different distribution companies.[45]

In 2013, the Ontario Smart Grid Forum concluded its previous public report with this observation:

"With five years of relevant experience to capitalize on, Ontario is well poised to tackle the remaining challenges and reap the substantial rewards associated with the implementation of the smart grid. However, as the smart grid dialogue continues to spread out amongst a wider array of groups, organizations, and ultimately individual customers, Ontario will need to ensure that its focus, and willingness to stay in the lead of smart grid development, does not diminish. "[46]

During the two years since that report was published, Ontario has undertaken innovative pilot project testing and commercialization activities in virtually every domain of the NIST smart grid model (discussed earlier in this paper), often with the participation of Ontario's utility companies. At the other end of the innovation chain, Ontario's academic institutions have participated widely in the research and development stage that may someday yield new innovations. As the Forum noted in 2013, however, Ontario is not alone in its enthusiasm for smart grid technologies and global competition in this arena is fierce.

In a globalized marketplace, keeping an open mind regarding the innovation process is important. For example, some alternative ways of moving innovation forward that arguably have not received as much attention here in Ontario include:

1) Non-utility energy services companies: In other jurisdictions around the world, some companies have shown an impressive capacity to rapidly bring new innovative products to market that can assist traditional public utilities. While their present role is relatively small in Ontario's electricity sector, the Forum and its Corporate Partners Committee have already noted that there is ample commercial interest to warrant a reconsideration of the current paradigm.
2) Innovations in non-electrical technologies: The smart grid is often portrayed as being additive to the existing electricity system. However, innovations that serve thermal energy efficiency and efficiencies in related "smart energy networks" could have a profound, albeit indirect,

[44] U.S. Department of Energy, Advanced Research Projects Agency, *The ARPA-E Newsletter: February 5, 2015*
[45] With reference to: New York State Department of Public Service, Staff Report, "*Reforming the Energy Vision*" CASE 14-M-0101, April 24, 2014
[46] Ontario Smart Grid Forum, *"Ontario Smart Grid Progress Assessment: A Vignette"*, pg. 23

influence on the future viability of the electricity system itself. For some time now, the Smart Grid Forum has attempted to broaden Ontario's smart grid discourse to encompass the interconnectedness of smart energy networks. For example, various aspects of our energy system also have important intersection points with water management – and organizations such as the United Nations and the OECD have identified opportunities for innovation in this area[47]. It should also be noted that broadening the innovation framework to include non-electrical forms of energy was a specific recommendation of the 2012 Mowat Centre report referenced earlier in this discussion paper.[48]

3) Crossover innovations from other industries: The purpose of this paper is not to speculate on the prospects of specific smart grid-related products or services. It has become apparent, however, that many innovative technologies that may have a major influence on the energy industry will not necessarily come from the energy industry itself. Smart home technologies, materials sciences, telecoms, and information technologies are just a few interrelated industries that have provided anecdotal evidence of crossover innovations.

This is not to say that Ontario has completely ignored these alternative avenues. If anything, Ontario has probably excelled beyond many jurisdictions in terms of its ability to keep open multiple avenues for innovation during the past five years since it established its high-level objectives for the smart grid. And this probably leads to one of the most complex policy dilemmas in this paper: Should Ontario target specific domains of the smart grid for innovation specialization and build a specific innovation framework for that strategic purpose, or should it continue to keep all avenues open? The former option takes on the risk that Ontario makes an adverse selection in the areas where it should target its efforts. The latter option runs the risk of missing a specific opportunity by failing to specialize where such a strategy is often a key success factor for a jurisdiction aspiring to compete on the world stage.

As noted at the beginning of this paper, the Smart Grid Forum and its Corporate Partners Committee represent a broad spectrum of organizations and interests in the innovation landscape today. This paper is intended to help set the stage for an informed debate over the future of smart grid-related innovation in this province. It is already clear that Ontario has exhibited a tremendous enthusiasm for its possibilities and assigned great importance to its outcome.

[47] With reference to, United Nations "Water and Energy" webpage under the "Water for Life Decade" pages, and OECD webpage, "Water-Energy-Food: Taking on the Nexus", Opening Remarks by Angel Gurría, OECD Secretary-General, delivered at the Global Forum on the Environment: New Perspectives on the Water-Energy-Food Nexus, 27 November 2014, Paris, France

[48] Mowat Centre, "*Smarter and Stronger: Taking Charge of Canada's Energy Technology Future*." Pg. 55

Appendix 'A' - Ontario's Smart Grid Objectives

Extracted from: Minister of Energy's Directive to the Ontario Energy Board (OEB)
(Ontario Order-in-Council 1515/2010, November 23, 2010 section 4, and Appendices 'A' 'B' and 'C' – see OEB website for complete version of the Directive)

OVERVIEW: This table includes the principles/objectives that are to be considered by the provincial regulator, when
considering the smart grid activities and plans of licenced, regulated utilities in the province of Ontario.

GENERAL OBJECTIVES TO BE CONSIDERED BY THE OEB IN EVALUATING SMART GRID ACTIVITES OF REGULATED ENTITIES

EFFICIENCY: Improve efficiency of grid operation, taking into account the cost-effectiveness of the electricity system.

CUSTOMER VALUE: The smart grid should provide benefits to electricity customers.

COORDINATION: The smart grid implementation efforts should be coordinated by, among other means, establishing regionally coordinated Smart Grid Plans ("Regional Smart Grid Plans") including coordinating smart grid activities amongst appropriate groupings of distributors requiring distributors to share information and results of pilot projects, and engaging in common procurements to achieve economies of scale and scope.

INTEROPERABILITY: Adopt recognized industry standards that support the exchange of meaningful and actionable information between and among smart grid systems and enable common protocols for operation. Where no standards exist, support the development of new recognized standards through coordinated means.

SECURITY: Cybersecurity and physical security should be provided to protect data, access points, and the overall electricity grid from unauthorized access and malicious attacks.

PRIVACY: Respect and protect the privacy of customers. Integrate privacy requirements into smart grid planning and design from an early stage, including the completion of privacy impact assessments.

SAFETY: Maintain, and in no way compromise, health and safety protections and improve electrical safety wherever practical.

ECONOMIC DEVELOPMENT: Encourage economic growth and job creation within the province of Ontario. Actively encourage the development and adoption of smart grid products, services, and innovative solutions from Ontario-based sources.

ENVIRONMENTAL BENEFITS: Promote the integration of clean technologies, conservation, and more efficient use of existing technologies.

RELIABILITY: Maintain reliability of the electricity grid and improve it wherever practical, including reducing the impact, frequency and duration of outages.

CUSTOMER CONTROL OBJECTIVES
ACCESS: Enable access to data by authorized parties who can provide customer value and enhance a customer's ability to manage consumption and home energy systems. **VISIBILITY:** Improve visibility of information, to and by customers, which can benefit the customer and the electricity system, such as electricity consumption, generation characteristics, and commodity price. **CONTROL:** Enable consumers to better control their consumption of electricity in order to facilitate active, simple, and consumer-friendly participation in conservation and load management. **PARTICIPATION IN RENEWABLE GENERATION:** Provide consumers with opportunities to provide services back to the electricity grid such as small-scale renewable generation and storage. **CUSTOMER CHOICE:** Enable improved channels through which customers can interact with electricity service providers, and enable more customer choice. **EDUCATION:** Actively educate consumers about opportunities for their involvement in generation and conservation associated with a smarter grid, and present customers with easily understood material that explains how to increase their participation in the smart grid and the benefits thereof.
POWER SYSTEM FLEXIBILITY OBJECTIVES
DISTRIBUTED RENEWABLE GENERATION: Enable a flexible distribution system infrastructure that promotes increased levels of distributed renewable generation. **VISIBILITY:** Improve network visibility of grid conditions for grid operations where a demonstrated need exists or will exist, including the siting and operating of distributed renewable generation. **CONTROL AND AUTOMATION:** Enable improved control and automation on the electricity grid where needed to promote distributed renewable generation. To the extent practical, move toward distribution automation such as a self-healing grid infrastructure to automatically anticipate and respond to system disturbances for faster restoration. **QUALITY:** Maintain the quality of power delivered by the grid, and improve it wherever practical.
ADAPTIVE INFRASTRUCTURE OBJECTIVES
FLEXIBILITY: Provide flexibility within smart grid implementation to support future innovative applications, such as electric vehicles and energy storage. **FORWARD COMPATIBILITY:** Protect against technology lock-in to minimize stranded assets and investments and incorporate principles of modularity, scalability and extensibility into smart grid planning. **ENCOURAGE INNOVATION:** Nest within smart grid infrastructure planning and development the ability to adapt to and actively encourage innovation in technologies, energy services and investment / business models. **MAINTAIN PULSE ON INNOVATION:** Encourage information sharing, relating to innovation and the smart grid, and ensure Ontario is aware of best practices and innovations in Canada and around the world.

Ontario Smart Grid Forum and Corporate Partners Committee member organizations

Members of the Ontario Smart Grid Forum

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Michael Angemeer, President and CEO, Veridian Corporation
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Bibliography:

Bloomberg New Energy Finance, "*Global Renewable Energy Market Outlook*", April 23, 2013

Bloomberg *Solar Module Price Index*, March 13, 2012

Bloomberg, Roston E. and Yanofsky D. "*Solar Silicon Price Drop Brings Renewable Power Closer*" March 13, 2012

Bloomberg New Energy Finance news release, "*Rebound in clean energy investment in 2014 beats expectations,"* January 9, 2015

Concentric Energy Advisors, Yardley, B., "*Stimulating Innovation on Behalf of Canada's Electricity and Natural Gas Consumers: A discussion paper prepared for the Canadian Gas Association and the Canadian Electricity Association*", August, 21, 2014

Canadian Council of Academies, "*Enabling Sustainability in an Interconnected World*", Ottawa, 2014

CISCO Systems, Dave Evans, "*The Internet of Things: How the Next Evolution of the Internet is Changing Everything*", April 2011

Edison Electric Institute, "*Rate Case Summary Q3 2014*", 2014

Fraunhofer Institute for Solar Energy Systems, Dr. Harry Wirth, "*Recent Facts about Photovoltaics in Germany*", January 7, 2015

Hydro-Electric Power Commission of Ontario, "*Seventh Annual Report of the Hydro-Electric Power Commission of the Province of Ontario for the Year ended October 31, 1914*", Printed by Order of the Legislative Assembly Ontario, L. K. CAMERON, Printer to the King's Most Excellent Majesty, 1915

International Energy Agency, "*Tracking Clean Energy Progress*", April 2013

IBM Global Business Services, "*Plugging in the consumer: Innovating utility business models for the future*" Updated, 19 Jan 2009

MaRS Discovery District news release, "*Ontario Premier announces new Advanced Energy Centre to be based at MaRS*", February 28, 2014

MaRS Market Insights, Briones, J. et al., "*Ontario Utilities and the Smart Grid: Is there room for innovation*?", January, 2013

Mowat Centre, "*Smarter and Stronger: Taking Charge of Canada's Energy Technology Future*", September, 2012

McKinsey & Company, Kirchner, J., Scherf, G., Suder, K. "*Creating growth clusters: What role for local government?*", July, 2013

McKinsey Global Institute, "*Open data: Unlocking innovation and performance with liquid information*", October, 2013

McKinsey Quarterly, David Frankel, Kenneth Ostrowski, and Dickon Pinner, "*The disruptive potential of solar power*", April 2014

Navigant Consulting, "*Ontario Smart Grid Assessment and Roadmap*", Prepared for Ontario Ministry of Energy, January 2015

New York State Department of Public Service, Staff Report, "*Reforming the Energy Vision*", CASE 14-M-0101, April 24, 2014

Ontario Distribution Sector Review Panel, Elston, Murray et al., "*Renewing Ontario's Electricity Distribution Sector: Putting the Consumer First*", December 2012

Ontario Energy Board, "*Yearbook of Electricity Distributors, 2013*", published August 2014

Ontario Smart Grid Forum, "*Enabling Tomorrow's Electricity System*", February 2009

Ontario Smart Grid Forum, "*Modernizing Ontario's Electricity System: Next Steps*", May 2011

Ontario Smart Grid Forum, *"Access to Consumer Data: A Vignette"*, December 2012

Ontario Smart Grid Forum, *"Ontario Smart Grid Progress Assessment: A Vignette"*, September 2013

Ontario Minister of Energy, Ontario Order-in-Council 1515/2010, November 23, 2010 section 4, and Appendices 'A' 'B' and 'C'

Ontario Ministry of Energy, "*Achieving Balance: Ontario Long-Term Energy Plan"*, December 2013

Ontario Ministry of Energy, Office of the Minister, "*Re: 2015 – 2020 Conservation First Framework*", March 31, 2014

Ontario Ministry of Energy news release, "*Ontario Supports Leading Edge Smart Grid Projects: Smart Grid Fund Helps Secure Ontario's Energy Future*", November 27, 2014

Ontario Ministry of Finance, 2009 Ontario Budget: Confronting the Challenge Building Our Economic Future

Ontario Power Authority public presentation, *"Target and Budget Allocation Methodology: Conservation Frist Framework LDC Tool Kit",* December 16, 2014

Schumpeter, J. A. "*The Theory of Economic Development*", Harvard University Press, 1934, tenth printing, 2004

Statistics Canada, CANSIM database, tables 358-0024, 358-0001, 379-0031

Statistics Canada, "*Gross Domestic Expenditures on Research and Development in Canada (GERD), the Provinces and Territories -National estimates 2004 to 2014 Provincial and Territorial estimates 2008 to 2012*"

Environmental Commissioner of Ontario "*Smart from Sunrise to Sunset: A Primer on Ontario's evolving Electricity Grid*", September 2014

U.S. National Institute of Standards and Technology (NIST) Special Publication 1108r3, "*NIST Framework and Roadmap for Smart Grid Interoperability Standards, Release 3.0*" May, 2014

U.S. Department of Energy, Advanced Research Projects Agency, *The ARPA-E Newsletter: February 5, 2015*

U.S. Department of Energy, National Renewable Energy Laboratory, news release, "*Solar Energy Prices See Double-digit Declines in 2013; Trend Expected to Continue PV pricing to drop another 3 – 12 percent in 2014*", October 20, 2014

U.S. National Institute of Standards and Technology, "*Framework and Roadmap for Smart Grid Interoperability Standards, Release 3*.0", September 2014