Modernizing Ontario's Electricity System: Next Steps

Second Report of the Ontario Smart Grid Forum
May 2011

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THE ONTARIO SMART GRID FORUM

The Ontario Smart Grid Forum comprises members of Ontario's utility sector, industry associations, public agencies and universities working together to propose a vision for a smart grid in Ontario and examine its many components. Materials from Forum meetings are available on the IESO website at www.ieso.ca/smartgridarchives.

Members of the Ontario Smart Grid Forum

Chair: Paul Murphy,
President and CEO, Independent Electricity System Operator (ieso.ca)

Michael Angemeer, President and CEO, Veridian Corporation (veridian.on.ca)

David Collie, President and CEO, Electrical Safety Authority (esasafe.com)

Norm Fraser, Chief Operating Officer, Hydro Ottawa Limited (hydroottawa.com)

Anthony Haines, President, Toronto Hydro-Electric System Limited (torontohydro.com)

Jim Huntingdon, President, Niagara-on-the-Lake Hydro (notlhydro.com)

Ivano Labricciosa*, Vice-President, Asset Management, Toronto Hydro-Electric System Limited (torontohydro.com)

Keith Major, Senior Vice President, Property Management, Bentall Kennedy Real Estate Services (bentallkennedy.com)

Craig Martin, Director, Eastern Canada Power, TransCanada (transcanada.com)

David McFadden, Past Chair, Ontario Centres of Excellence (oce-ontario.org)

Dan McGillivray*, Managing Director, Ontario Centres of Excellence and Sector Lead: Energy & Environment (oce-ontario.org)

Dr. Jatin Nathwani, Ontario Research Chair in Public Policy and Sustainable Energy Management, University of Waterloo (wise.uwaterloo.ca)

Andrew Pride, VP Conservation, Ontario Power Authority (powerauthority.on.ca)

Wayne Smith, SVP, Grid Operations, Hydro One Inc. (hydroone.com)

Don Tench, Director, Market Assessment and Compliance, Independent Electricity System Operator (ieso.ca)

Observers:

Aleck Dadson, Chief Operating Officer, Ontario Energy Board (ontarioenergyboard.ca)

Brian Hewson, Senior Manager, Networks & Smart Grid, Ontario Energy Board (ontarioenergyboard.ca)

Jon Norman, Director, Transmission and Distribution Policy, Office of Energy Supply, Ontario Ministry of Energy (ontario.ca)

Members of the Forum Working Group

Raed Abdullah, Hydro Ottawa (hydroottawa.com)

Edward Arlitt, Independent Electricity System Operator (ieso.ca)

David Barrett, Independent Electricity System Operator (ieso.ca)

David Curtis, Hydro One Inc (hydroone.com)

Lisa Dignard-Bailey, Natural Resources Canada (nrcan-rncan.gc.ca)

Richard Ford, Toronto Hydro-Electric System (torontohydro.com)

John Mulrooney, PowerStream (powerstream.ca)

Bryan Young, Ontario Power Authority (powerauthority.on.ca)

Observers:

Jerry Chwang, Ontario Ministry of Energy (ontario.ca)

Russ Houldin Ontario Energy Board (ontarioenergyboard.com)

Usman Syed, Ontario Ministry of Energy (ontario.ca)

Members of the Corporate Partners Committee

The work of the Forum is supported by the Corporate Partners Committee, which represents private sector organizations active in the smart grid space including: electric car makers, retailers, energy management companies, systems integrators and equipment manufacturers. The Committee works to address specific issues as assigned to it by the Forum.

Chair: Shelley Lewis
Summitt Energy
(summittenergy.ca)

Vice-Chair: Ron Dizy
Enbala Power Networks
(enbala.com)

Jim Alfred
Certicom (certicom.com)

Nick Biase
IBM (ibm.com)

Peter Black
Honeywell (honeywell.com)

Ron Clark
Aird & Berlis LLP
(airdberlis.com)

Alan Clarke
Energate Inc. (energate.ca)

Keyvan Cohanim
Bullfrog Power
(bullfrogpower.com)

Mike Coleman
GE (ge.com)

Nancy Cowan
Nextera Energy
(nexteraenergyresources.com)

James Douglas
Util-assist (util-assist.com)

Gord Ellis
Energent (energent.com)

Ric Forster
Direct Energy
(directenergy.com)

Bryan Goulden
Union Gas (uniongas.com)

Steve Greey
SC Electric (scelectric.com)

Steven Hall
Peel Region (peelregion.ca)

Elise Herzig
Ontario Energy Association
(energyontario.ca)

Stephen Ivins
Sensus (sensus.com)

John Krill
Reliance Comfort
(reliancehomecomfort.com)

Stuart Lombard
Ecobee (ecobee.com)

Dan McGillivray
Ontario Centres of Excellence
(oce-ontario.org)

Ian McLellan
Arisetech (arisetech.com)

Dan Mepham
GM (gm.ca)

Sid Paquette
Deloitte (deloitte.com)

Jan Peeters
Olameter (olameter.com)

Chris Reid
Energent (energent.com)

Martin Rovers
Better Place (betterplace.com)

Geoffrey Salter
Aztech Inc. (aztechinc.com)

Steve Taylor
The SPI Group
(thespigroup.com)

Losel Tethong
Accenture (accenture.com)

Linda Wainewright
The TEAM LTD
(theteamltd.com)

Richard Wunderlich
Siemens (siemens.com)

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*alternate

EXECUTIVE SUMMARY

The electrical system in Ontario is going through a profound transition as the province changes the way it generates, manages, consumes and values its electricity.

In less than two years, more than 25,000 homeowners, farmers, schools, and businesses have signed on to develop renewable energy projects, large and small, each generating power for the grid. Many are up and running, reducing Ontario's greenhouse-gas emissions and other pollutants. Ontario has installed the most wind energy capacity in Canada, and as the country's leading solar market is now home to the world's largest solar photovoltaic (PV) facility.

The province is also the first jurisdiction in North America to equip every home and small business with a smart meter, enabling the widespread introduction of time-of-use (TOU) pricing that better reflects the true cost of power generation.[1] As more consumers shift their patterns of consumption to take advantage of lower off-peak power rates, this will lead to more efficient use of existing grid infrastructure and generating assets. At the same time, more large commercial and industrial facilities are lowering their peak-time power use by participating in demand-response programs, reducing the need (and costs to ratepayers) of building new generation.

Meanwhile, the first wave of electric vehicles will soon begin plugging into household power outlets. Over the coming years, electric vehicle charging stations are expected to dot the landscape to support market growth and satisfy driver demand for convenience and increased mobility.

These changes are part of a global trend that Ontario is leading – and propelled by. The province is among several jurisdictions around the world that have recognized the need to modernize their electricity systems to fully capture the economic and environmental benefits of this transition.

Consumers want assurances they can safely charge their vehicles and reliably connect their rooftop solar panels to the grid. They want more control over their energy bills. They want to make sure they can enjoy the features and benefits that will come with a new generation of "smart" appliances. They also want to know that the electricity services they rely on every day – in the home or at work – are reliable and making the most efficient use of publicly-funded infrastructure.

This has focused a spotlight on the smart grid, a term used to describe a reliable and fast-adapting electrical grid that combines the use of computing and communications technologies to safely manage the two-way flow of electricity and automate many aspects of operation. The smart grid is ultimately about using megabytes of data to move megawatts of electricity more efficiently and affordably. In the medical world, it would be what Magnetic Resonance Imaging (MRI) is to an X-ray – more advanced, versatile, safe, and beneficial for those who rely on it.

[1] This excludes condominiums and multi-unit buildings.

Today's electricity system is aging and in need of renewal. Built well before the digital era, our 20th century grid was designed for the simple one-way delivery of power from large generators to consumers. Its designers did not anticipate the need to accommodate the future charging of millions of electric vehicles, the variable generation of thousands of wind turbines, or the electricity from tens of thousands of rooftop solar systems scattered across the province. Some grid automation and renewal has happened, but the majority of investment is still to come. There is a need for more coordination to make sure these future investments are made responsibly and in the best interests of residential, commercial, institutional and industrial ratepayers.

The Ontario Smart Grid Forum (the 'Forum') was convened in 2008 in recognition of the need to establish a vision for the smart grid and begin facilitating its development. In early 2009, the Forum published its first report, which articulated a vision, reviewed the level of smart-grid development activity in Ontario and around the world, and made recommendations on how various stakeholders in the electricity sector should proceed with grid modernization.

This document, the Forum's second report, assesses the status of those earlier recommendations, identifies what barriers remain to their implementation, and highlights the considerable progress that its members – representing utilities, government, public agencies, academia and the private sector – have made to date.

The Forum, for example, created a detailed Smart Home Roadmap that shows consumers how development of the smart grid over the next five, 10 and 20 years will enable exciting new technologies and services for the home. This roadmap will inform policymaking over the coming years so the many benefits of the smart home can be fully realized.

The Forum and its private-sector partners defined several smart grid "success metrics" that will be essential to measuring progress as the province's electricity system is modernized. In collaboration with government, it defined high-level smart grid principles that are being used to guide development and rulemaking (see Appendix A). Members of the Forum also formally recognized smart grid privacy principles that will be crucial to building consumer confidence in the smart grid. Customers need to know that their personal information will be protected.

While much has been accomplished, this report is also very much an action plan. It lays out the next steps – in the form of several new recommendations – that are needed along the path to grid modernization.

What's clear is that *the smart grid is happening in Ontario*.

Since the Forum's first report, the government has passed legislation that mandates smart grid development. Some utilities, often with assistance from the Ontario Centres of Excellence and the National Science and Engineering Research Council, are already participating in important pilot projects. Many have automated parts of their networks. The province's universities and private sector are deeply engaged in smart grid research and development. Meanwhile, the electricity mix is changing as more individual Ontarians and commercial properties connect their own sources of renewable generation to the grid.

Modernization efforts are clearly well underway. And the government's Long-Term Energy Plan will continue to drive this transition over the coming 20 years. The plan recognizes that customer choice is expanding, and that the broad array of new energy products and services entering the market – and which consumers increasingly demand – are driving smart grid investments.

Yet much work remains. More effective and co-ordinated efforts are needed to accelerate progress. In particular, clarity is needed around the roles and responsibilities of private sector companies as they introduce new products and services made possible by the smart grid.

The report also aims to highlight gaps that have emerged and ensure that the province can take full advantage of certain smart grid technologies, such as distributed energy storage. Also, new private-sector entrants want assurances of a level playing field, such as getting the same access to electricity customers and smart meter data that Ontario's local distribution companies (LDCs) now collect. Once these, and other issues are resolved, consumers will be able to fully benefit from innovation and competition in the energy sector.

The various pieces of the smart grid will also have to be carefully integrated. As the smart grid evolves, more information will flow through it and more points of vulnerability will emerge. Utilities will have to manage this information overload, implement new security measures, and institute new privacy policies that prevent the personal information of customers from falling into the wrong hands. Industry standards, however, are still emerging during these formative years of the smart grid. This presents more investment risk.

To address these and other challenges, the Forum makes the following recommendations:

Privacy and Security

- 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.
- The Ontario Information and Privacy Commissioner should begin tracking smart grid-related consumer complaints with respect to how utilities and third parties use their information.

Third-Party Access

- 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.
- 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.

Consumer Engagement

- 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 facilitate timely development.
- The interactions between LDCs and third-party service providers in each area of the smart grid value chain, including support for electric vehicles, 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.
- The role that aggregators can play in delivering benefits to consumers via the smart grid should be investigated and, where appropriate, specific recommendations should be developed to facilitate their participation in the market. The Forum and its Corporate Partners Committee will work with industry to address this issue.
- Gaps in knowledge specific to the development of the smart grid in Ontario should be identified and, where applicable, research should be advocated aimed at filling those gaps. The Forum will work closely with industry to identify and close knowledge gaps.
- The Ontario Ministry of Energy should conduct an annual smart grid consumer engagement survey to gain insight into how smart grid products/services are benefiting consumers and influencing consumption behaviour. The results of this survey should be shared with industry.

Electric Vehicle (EV) Integration

- The Ontario Ministry of Transportation should track the registration of electric vehicles and ensure that necessary information is provided to the electricity industry in a meaningful and timely manner. Where necessary, legislation and regulatory changes that facilitate this information exchange and protect consumer privacy should be made.
- The source of accurate and timely information about the installation of Level 2 and higher charging stations should be identified and made available to assure the safe and reliable operation of LDC networks. The Forum will work with the automotive and electricity sectors to identify and recommend the appropriate parties and mechanisms for supplying this information.

Storage Integration

- The Ontario Power Authority (OPA) and Independent Electricity System Operator (IESO), in consultation with industry and the Ontario Energy Board (OEB), should jointly develop a framework to promote the integration of distributed energy storage with the grid where it is cost-effective.

Standards

- 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.

Innovation & Economic Development

- A new task force should be established to foster smart grid innovation, technology commercialization and related economic development opportunities, capitalizing on the province's public infrastructure investment in grid modernization. The task force, facilitated by the Forum but not exclusive to its members, would seek the active participation of public- and private-sector organizations in a position to help Ontario realize the broader economic development potential, including export opportunities, related to the smart grid over the longer term.

Measuring Smart Grid Success

- 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.

The Forum estimates that over the next five years public investment will total about $390 million annually, an amount already factored into electricity price increases projected under Ontario's Long-Term Energy Plan (which also includes identified investments in many areas beyond just the smart grid). Investments will be devoted to grid automation, monitoring, communications, research, pilot projects and the integration of more distributed renewable energy on the grid. All investments will be reviewed thoroughly and ultimately must be approved by the Ontario Energy Board. This regulatory process makes sure that such investments deliver value to electricity ratepayers.

These are exciting times. Ontario's electricity system is truly in transition. The pace of change is unprecedented in many ways. This makes the adaptive, flexible and dynamic features of the smart grid even more important as we manage this change. But the smart grid can't be carelessly rushed. It must be properly planned, its development must be coordinated, and the technologies chosen to build it must be based on open standards that future-proof the investments we make today.

Only then will the full potential of the smart grid be realized for Ontarians.

SECTION 1: REALIZING THE SMART GRID

The Independent Electricity System Operator (IESO) launched the Ontario Smart Grid Forum in March 2008 as a broad-based industry dialogue aimed at developing a smart grid vision for the province, and to offer the provincial government advice and insight as it develops smart grid policy. The idea was to build on Ontario's Smart Metering Initiative and complement the renewal already taking place in the transmission and generation sectors by taking advantage of advances in information technology.

From the outset the Forum, chaired by IESO President and Chief Executive Officer Paul Murphy, had broad representation from Ontario's electricity sector. Utility members of the Forum included Burlington Hydro, Hydro One, Hydro Ottawa, Niagara-on-the-Lake Hydro, Toronto Hydro, and Veridian Connections. Non-utility members included the Ontario Centres of Excellence (OCE), the Building Owners and Managers Association (BOMA), the University of Waterloo (representing academia), and the Ontario Power Authority (OPA) [2]. The Ontario Ministry of Energy and the Ontario Energy Board (OEB) participated as observers. Monthly meetings during the year, which involved extensive consultation with industry experts, culminated in the February 2009 release of the Forum's first report, "Enabling Tomorrow's Electricity System."

The report described what a smart grid in Ontario might look like, how it should evolve, potential barriers to its development, opportunities it represented, and what actions were needed to capture those opportunities. It also identified various smart grid-related activities already taking place in the province. The Forum found that the level of smart grid investment was insufficient and that there was no comprehensive provincial plan in place to coordinate such investments. It recognized that alignment, from the start, with security and technology standards would be crucial to such a plan.

The Forum also looked at what the smart grid would mean to electricity consumers by providing greater visibility and control over energy use and enabling the widespread adoption of electric vehicles, "smart" appliances, energy management services, and distributed forms of generation, such as rooftop solar photovoltaic panels. The 2009 report made several recommendations with an eye to assuring the rapid but orderly development of a smart grid that would bring measurable benefits to electricity consumers and help the province achieve its economic and environmental goals.

A day after its release, Ontario Premier Dalton McGuinty spoke of the importance of a smart grid to the province's future. "A smart grid opens up a whole new world of convenience, new jobs and green electricity," he said. "Our province will be greener, stronger, and in a much better position to compete and win against the rest of the world."[3]

[2] The Chair of a Corporate Partners Committee, established in 2010, was also made a member of the Forum. Some utilities, while not members of the Forum, did actively participate in the Forum's Working Group.

[3] Comments were made in a speech by Ontario Premier Dalton McGuinty to the Ottawa Chamber of Commerce on Feb. 5, 2009.

Three weeks later, the government tabled Bill 150, the *Green Energy and Green Economy Act 2009* (GEGEA), which included a specific mandate for smart grid development. The bill was passed into law on May 14, 2009, and established a firm base from which to push forward on smart grid policies and programs.

There has been considerable progress since publication of the 2009 report, including action taken on several Forum recommendations. Below is a discussion of those activities as they relate to the Forum, the provincial government (including agencies) and electric utilities.

Progress of Forum

Since its first report, the Forum has continued to keep abreast of smart grid trends, technologies, research, and standards while maintaining a frequent dialogue with government, the private sector and academia. Expert presentations to the Forum covered a variety of evolving topics, including electric vehicle (EV) charging stations, plug-in electric vehicles, home energy management, third-party access to smart meter data, and protection of consumer privacy. During this period the Forum met 22 times.[4]

In late 2009, the Forum began exploring the idea of expanding its collaborative approach more formally to the private sector. This exercise resulted in the creation of a Corporate Partners Committee that is composed of members of the Ontario Energy Association and other corporate entities that consider the smart grid strategic to their business. The committee, which held its inaugural meeting in June 2010, represents a wide range of interests in the smart grid ecosystem, including manufacturers of battery-powered vehicles, technology providers and providers of energy aggregation services. One task assigned to the Corporate Partners Committee was to define several "success metrics" that could be used over the short- or long-term to highlight year-over-year progress of smart grid development, as well as the rate at which services and products enabled by smart grid technologies are being adopted (see: "Measuring Smart Grid Success" on page 18).

Much work was also done by the Forum, in collaboration with the Ontario Ministry of Energy, to develop high-level principles and objectives that will inform the crafting of smart grid policies and selection of technologies over the coming years. After extensive discussion, the following 10 Smart Grid Principles were identified: *Efficiency, Customer Value, Coordination, Interoperability, Security, Privacy, Safety, Economic Development, Environmental Benefits,* and *Reliability*. In addition, 14 specific objectives were identified that fall under the banners of *customer control, power system flexibility* and *adaptive infrastructure* – the three broad smart grid objectives recognized under the GEGEA.[5] In November 2010, the Minister of Energy recognized these principles and specific objectives through an Order in Council, a significant milestone that laid the foundation for smart grid development in the province and set the stage for broader industry participation. The Ontario Energy Board is using these principles and objectives to define a regulatory process that will guide utilities as they develop and come forward with their respective smart grid plans.

[4] A separate Working Group, created to undertake research and support the main Forum, met just as frequently. Between August and September 2010 a Working Group subgroup met weekly to update smart grid investment estimates.

[5] See **Appendix A** for a more detailed description of the 10 Smart Grid Principles and 14 specific objectives.

Another Forum initiative was development of a Smart Home Roadmap. The roadmap addresses a recommendation in the Forum's first report that the province consult with industry stakeholders to develop smart grid educational materials for the public. These materials are intended to explain how smart meters, time-of-use rates, in-home devices, smart appliances, and other smart grid technologies can bring more control, choice and value to residential electricity consumers and operational benefits to the grid. This is captured in the roadmap's vision statement: *"Smart homes will improve the lives of Ontarians. Served by a marketplace that provides the tools, information, and incentives, consumers will be easily able to make intelligent energy choices that are in their interest. In the process, they will provide valued services to the electricity grid and benefit society."*

By 2015, the roadmap sees smart home technology embedded in most household appliances and devices, allowing consumers to collect real-time information related to their energy use and automatically respond to price signals in the market. Non-utility, third-party energy services are expected to be broadly available at this time. The level of sophistication of the smart home is seen to rise considerably by 2030, when smart homes, appliances, electric cars, and distributed generation will be capable of seamless and secure interaction, embodying the two-way flow and management of electricity envisioned in a mature smart grid.

Protecting consumer privacy will be increasingly crucial as this intelligent grid matures over the decades into a massive, interactive, information-gathering network. The Forum met with Ontario's Information and Privacy Commissioner in spring 2010 to discuss privacy and the smart grid. The Commissioner talked about *Privacy by Design*, a concept she developed, which emphasizes the need to embrace a culture of privacy and embed privacy-enhancing technologies into the early design specifications of information technology, business practices, physical environments and infrastructure. Following discussions with the Commissioner, seven foundational principles at the heart of *Privacy by Design* were formally recognized by the Forum in June 2010 to emphasize continuing commitment to privacy protection.

More recently, the Forum has discussed the potential of establishing partnerships with other jurisdictions and national organizations to share knowledge and align efforts as new smart grid standards and technologies emerge. Members of the Forum continue to work through a number of issues, such as the degree to which third parties can access smart meter data, the respective roles and responsibilities of government and industry as the smart grid evolves, and the need to drive competition by increasing market openness. These and other topics will steer Forum activities in 2011.

Progress of Government and Agencies

The Ontario government and its various energy sector agencies are on track to meeting several recommendations from the Forum's 2009 report, though there is still much work to do. One key recommendation was for the Ministry of Energy to facilitate development of Ontario's smart grid "through legislation, regulation or other available means that clarify authorities, establish requirements, or create incentives… to accelerate the deployment or enhance the functioning of smart grid technologies."

The most substantive move in that direction was the introduction of the *Green Energy and Green Economy Act 2009* (GEGEA). The legislation created a specific mandate to develop a smart grid, implicitly recognizing the need to modernize Ontario's aging electricity system. It put focus on three objectives: giving electricity consumers more control over, and information about, their energy use as a way to encourage conservation and off-peak consumption; making the grid flexible enough to accommodate increased use of renewable energy sources and clean energy technologies on the distribution system; and creating a modern grid infrastructure that can adapt as new energy-saving and system-control technologies emerge.

The GEGEA laid the foundation for the Feed-in Tariff (FIT) Program, launched in October 2009 by the OPA to spur development of renewable energy projects, attract private investment and stimulate the creation of jobs. However, LDCs have been challenged in trying to keep up with the high levels of demand, highlighting the need to accelerate investment in grid renewal and expansion. The opportunity is ripe to introduce smart grid features and functionality to the grid as equipment is modified, replaced or added.

There were several Forum recommendations aimed at fostering specific aspects of smart grid development, including demand-response programs and home-energy management devices and services. These were addressed generally through the GEGEA, but also reinforced through ministerial directive. In March 2010, for example, the Minister of Energy directed the OEB to establish new conservation and demand-response targets for LDCs over the next four years, building on programs already developed by the OPA. The targets must be met as a condition of licence, and help create a market for new smart grid technologies as conservation and demand management (CDM) programs are implemented. In November, the Minister also directed the OEB to use high-level smart grid principles and specific objectives, established in collaboration with the Forum, to develop guidance for regulated companies as they move to develop and implement their smart grid plans.

Ontario has led the continent with the deployment of smart meters, which are an essential part of the larger smart grid vision. The devices allow utilities to collect timely and accurate information on the electricity use of their customers and charge electricity rates, based on time of use, that more truly reflect the cost of generation. With access to this information, customers are better equipped to choose how and when they consume electricity; energy retailers can offer new services tailored to customer needs and lifestyles; and LDCs can improve customer service, reduce costs and use their assets more efficiently.

Nearly every home and small business in the province now has a smart meter. But there still remain thousands of condominium complexes and other multi-unit buildings without per-unit smart metering. The government passed the *Energy Consumer Protection Act 2010* to clarify the rules for property developers, landlords and tenants. As a result, more Ontarians are expected to have greater access to conservation programs and pricing structures enabled by smart meter technology.

The Forum recommended that home energy management systems be thoroughly researched and demonstrated and that information gathered be shared across the industry. It also was recommended that more research be done, in consultation with industry and consumers, to clarify the technical, regulatory and institutional issues associated with micro-grids, energy storage and other smart grid technologies. The Ontario Centres of Excellence (OCE) continues to play a pivotal role in this regard. Since the Forum's first report, the OCE's total portfolio of smart grid-related projects has grown to 23 from 14 and now represents an investment of $24 million, with $8.7 million of that coming directly from the OCE. Another $3 million, which must be matched by project partners, will come this year with the introduction of a new OCE Smart Grid Research and Innovation Fund focused on transformative innovations.

In its 2009 Ontario Budget, the government also allocated $50 million for the creation of a Smart Grid Fund to support advancement of smart grid technologies through demonstration projects. The Ministry of Energy issued a call for information about prospective projects in January 2011. The Fund was launched in spring 2011 with initial projects expected to be funded as early as August. It is likely some projects will address the integration of electric vehicles with the grid. The government's vision is to have one out of every 20 vehicles in Ontario be electrically powered by 2020. This target is backed by several incentives aimed at boosting electric vehicle adoption.

The OEB and the province's electricity sector agencies have also made some important progress since the Forum's inaugural report. The OEB, for example, issued filing requirements to distribution and transmission utilities wishing to investigate and test smart grid technologies on their systems. Utilities that wish to recover costs from these activities must submit detailed reports to the OEB and share results. In January, the OEB announced it would begin consulting with utilities and other industry stakeholders on the future regulatory treatment of smart grid infrastructure investments. This is on track to addressing several Forum recommendations related to utility investment in smart grid technologies, research and demonstration.

As mentioned, the OPA continues to administer several programs that influence and inform smart grid development, including the FiT and microFiT, demand-response, and other initiatives designed to encourage conservation and the efficient use of electricity. It is also assessing the smart grid's growing role in the government's Long-Term Energy Plan. The IESO is investigating the use of smart grid technologies for providing regulation services, which help balance the total system by matching supply and demand on a second-by-second basis. It has also pushed ahead on a plan to centralize the forecasting of variable generation, specifically wind energy, and is taking other measures to assure the reliable and safe integration of renewable energy with the grid.

The smart grid is clearly a priority for the government. The province's 20-year Long-Term Energy Plan, issued in November 2010, emphasized the smart grid's strategic importance, describing it as "an essential element of Ontario's clean energy future."

Progress of Utilities and Broader Community

LDCs have been busy over the past two years deploying smart meters to the remainder of their customer base to fulfill a government commitment to reach all homes (outside of multi-unit buildings) and small businesses by the end of 2010. That target was reached. More than 4.5 million smart meters have been installed, and roughly half are now feeding customer usage data to a central Meter Data Management and Repository (MDM/R) system. IBM Canada operates the system under the oversight of the IESO. The repository is what provides LDCs with the hourly energy consumption of their customers, who can then be billed based on the time of day electricity is consumed and at the corresponding rate set by the OEB. As of the end of 2010, utilities have switched approximately 1.6 million customers to time-of-use billing[6] and are on track to converting the entire customer base.

Beyond smart meters, the pace of smart grid development among LDCs and Hydro One varies across the province. There are 81 LDCs in Ontario that represent $14 billion in assets and 10,000 jobs.[7] Larger utilities, along with a few small- and mid-sized LDCs, are active with pilot projects and/or preparing to put more comprehensive smart grid spending plans in front of the OEB this year for review and approval. Some of the larger LDCs with dense urban centres are in the midst of major infrastructure re-investment and have already filed smart grid spending plans with the OEB for review and approval. By and large, small- and mid-sized LDCs have been more tentative in their smart grid plans in light of the socio-economic conditions of the communities they serve. Investment priorities and service offerings depend heavily on the local economy, industry makeup, geography, asset condition, system design, customer expectations and the expectations of municipal shareholders. In this regard, groups such as the Electricity Distributors Association can play a vital role in sharing the experiences of successful pilot projects and smart grid deployments to the benefit of all LDCs. Alliances, collaboration and the exchange of knowledge are proving vital as the smart grid vision unfolds. Some utilities are finding the value of not only reaching out to other utilities, but also to like-minded organizations and non-electricity sector partners, such as automakers and universities/colleges, who share an interest in smart grid developments.

At the project and deployment level, utilities have moved cautiously as they wait for the OEB to establish specific rules that will more clearly guide smart grid activities and investments. In the words of one Forum member: "The heavy lifting is still to come." Still, since the Forum's first report a variety of innovative pilot projects have commenced or are in advanced stages of planning. Utilities, generally, are eager to better understand how to reliably and safely integrate new energy storage, vehicle charging, grid-monitoring and digital automation – to name a few – into grid operations.

Energy management and peak time demand-response is another area of focus. A five-utility pilot project commissioned by the OPA in 2010, for example, equipped 130 homes and small businesses across Ontario with smart thermostats, smart plugs and in-home displays that allowed customers to monitor and manage their energy use inside or remotely via access to an online portal. The technologies also enabled participation in demand-response programs, which represent a future opportunity for home and business owners. The small and large utilities involved in the project – Cambridge and North Dumfries Hydro, Hydro One (Owen Sound), Kitchener-Wilmot Hydro, Toronto Hydro and Waterloo North Hydro – will use the information collected from the pilot to design future energy-management offerings for their customers.

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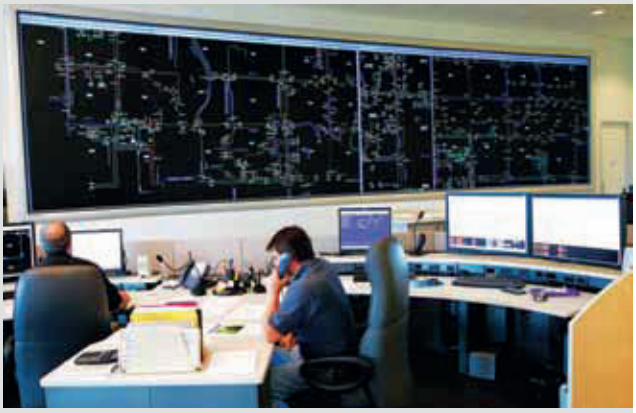
[6] Ontario Energy Board, "Monitoring Report, Smart Meter Deployment and TOU Pricing – Dec. 2010"

[7] Electricity Distributors Association, 2009 Annual Report

THE ONTARIO SMART GRID: TWO CASE STUDIES

The Beginnings of a Self-Healing Grid

PowerStream, a large LDC that serves 11 communities north of Toronto, is testing a new software system that, when fully implemented, will demonstrate a real application of a self-healing grid. "It's the ability of the grid to detect a fault, isolate it, initiate switching and reconfigure the system so only the minimum number of customers are affected," explained John Mulrooney, the utility's director of smart grid technologies. The technology is being piloted on two transformer stations in Richmond Hill. Normally, when sensors detect a fault an operator in the control room must manually open and close switches to minimize the impact on service. PowerStream wants to fully automate that process, using the speed of computers to dramatically reduce the length of outages and customers exposed to them.



During the first stage of the project the software, after detecting a fault, will notify a control room operator and give him or her instructions for taking manual corrective action. The second stage lets the system take corrective action, though only with operator approval. "The ultimate is the third stage, where the system would detect the fault and invoke the operating sequence to restore the system on its own," said Mulrooney. PowerStream is still at the first stage. "After another year we'll probably let the system go automatic." There are generally two types of outages for a utility: momentary outages are typically under a minute, while sustained outages are longer. "The impact of this technology on us as a utility is huge. All of a sudden, what were previously sustained outages will now, if they happen, be momentary in nature."

Electric Vehicles and the Grid

Among pilot projects, there are several focused on studying the impact that electric vehicles will have on local distribution systems, particularly in densely populated communities where initial demand for the vehicles is expected. One of the most advanced projects is a partnership between Toronto Hydro-Electric System and Mercedes-Benz Canada launched in November 2010. The pilot project, called the *Toronto Hydro smart Experience*, is letting 15 Toronto Hydro customers drive a Mercedes-Benz 'Smart Fortwo electric-drive' vehicle over four years. Each customer will be equipped with a charging station and power meter, and given free charging and maintenance services for the duration of the project. The utility and its partners, including environmental organization Pollution Probe, will study driving habits, charging patterns, and vehicle performance in an urban setting. The data collected from this project will guide the utility's smart grid investments by helping it anticipate the future impacts of vehicle charging on its local system.

The public is clearly excited about these emerging technologies. Customer response to the program was 10 times higher than expected, despite the fact that participants had to commit to paying $545 a month to lease the vehicles. "A thousand people put their money down to sign up for only 15 cars," said Ivano Labricciosa, the utility's vice-president of asset management. Associated with this project, Toronto Hydro is working on ways to better manage electric vehicle charging loads and improve the customer charging experience. Different chargers are being put through vigorous testing, and there are efforts to embed the same intelligence found in smart meters inside charging stations and neighbourhood transformers so that power flows can be closely monitored and managed. "The vehicle is the end load that can be the tipping point," Labricciosa explained. "Every utility wants visibility into those power flows so a part of the system doesn't go 'pop!' when someone plugs in their car."

Toronto Hydro's pilot project is complemented by several other utility and non-utility initiatives focused on electric vehicles and related infrastructure. The Toronto Atmospheric Fund's EV300 Initiative, for example, is working with private and public vehicle fleet operators to put 300 plug-in electric vehicles on Greater Toronto Area roads by 2014 to monitor and evaluate their performance. The goal is to establish best practices and gather information that can inform policy-making and municipal planning.

Photo: Greg Reekie/Toronto Hydro

Better Place, an electric vehicle service provider based in California, is working with several Ontario utilities to demonstrate a "smart" EV charging network that was launched in March. It has also opened an electric vehicle education and demonstration centre in downtown Toronto. Plug 'N Drive Ontario and EC3 Initiative are two groups also collaborating with industry and utilities to better understand and facilitate the introduction of electric vehicles and enabling smart grid technologies.

Smart grid technologies, such as lighting and heating, ventilating, and air conditioning (HVAC) automation systems, are also being tested and deployed in many of the province's largest commercial buildings under the stewardship of the Building Owners and Managers Association (BOMA), which in Ontario includes affiliates BOMA Toronto and BOMA Ottawa. In October 2010, BOMA Toronto announced it would collaborate with Natural Resources Canada (CanmetENERGY) on a study that will simulate demand-response activities in 20 downtown Toronto office buildings. Researchers will study the potential for demand-response under a number of control sequences, including zone temperature reset, chilled water reset, and modification of lighting levels. The information gathered will provide input on the design of municipal and provincial demand-response programs.

Projects funded through the Ontario Centres of Excellence, and the OPA's Conservation Fund and Technology Development Fund, are also contributing to our understanding of smart grid technologies in a variety of settings, as well as the challenges – and opportunities – of more widespread deployment. The province's new Smart Grid Fund is expected to accelerate more demonstration and deployment, and as the OEB brings more clarity to regulations, the Forum expects 2011 will see the launch of much larger pilot projects and more routine utility deployment of smart grid technologies.

North American Trends

In a North American context, Ontario is clearly ahead in some areas of the smart grid and clean energy development. The GEGEA, the OPA's Feed-in Tariff (FIT) program, and the fact that all homes and small businesses have smart meters are examples of where Ontario leads the continental pack. Evidence of this leadership came in March, when General Electric announced plans to build a $40-million smart grid innovation centre at its existing site in Markham. The centre, according to the company, will be a "destination for companies and countries seeking to upgrade their energy systems."

But the province is in no way the only jurisdiction on the move, and several countries, U.S. states and provinces are gathering momentum. It is evidence that the smart grid isn't a passing fad. Just as telecommunications companies with analog landlines had no choice but to embrace digital technologies to stay competitive in the Internet age, utilities must embrace digital automation, advanced communications and computing, and business intelligence tools to meet the growing needs and higher expectations of 21st century electricity consumers and the demands of a modern economy. That other jurisdictions are waking up to the opportunities of the smart grid is a validation of Ontario's early leadership.

South of the border, for example, the U.S. government allocated $11 billion (U.S.) for smart grid development, including upgrades and expansion to transmission infrastructure, as part of the American Recovery and Reinvestment Act of 2009. Of that stimulus money, $4.5 billion was earmarked for the U.S. Department of Energy for investment in smart grid-related research, technology demonstration and worker training.[8] This excludes state and utility spending. It is estimated that 21 million smart meters have been installed in the United States as of the end of 2010, and more than 90 utilities have plans to deploy about 58 million more.[9] California's Pacific Gas and Electric Company, one of the largest electric and natural gas utilities on the continent, alone has installed more than 7.5 million smart meters since 2006. In addition, U.S. stimulus money is already funding hundreds of smart grid projects that will demonstrate energy storage, electric vehicle charging, home-energy management, and smart building technologies.

[8] American Recovery and Reinvestment Act of 2009: Key Energy Provisions," client alert from New York law firm Dewey & LeBoeuf LLP, Feb. 16, 2009

[9] Smart Grid Deployment Tracker," Pike Research (Q3, 2010)

Ontario may be Canada's smart grid pioneer, but several provinces have projects underway or planned in areas such as advanced metering, system monitoring, network automation and demand response. This year, British Columbia will follow Ontario's lead by beginning implementation of a province-wide smart metering program that the utility has called a "foundational step" on the path to modernizing B.C.'s electricity system. Deployment of smart meters and in-home displays will represent the lion's share of a $1-billion smart grid investment the utility plans to make over the next four years.

A sign that the smart grid is no longer just a distant vision, multinational industrial and technology giants such as Cisco Systems, General Electric, Google, IBM, Intel, Microsoft and Siemens are developing or already marketing a range of smart grid products – ranging from ruggedized switching gear for core grid communications, to advanced digital sensors for system monitoring and automation, to home-energy management devices and software that empower consumers. Verizon Communications, one of the largest telecommunications companies in the United States, launched a pilot program in January that will offer some of its customers in New Jersey a chance to manage their home energy use as part of a broader package of home automation and security services. It's not just a North American trend. One estimate is that global spending since 2008 on smart grid products and services will reach $200 billion (U.S.) by 2015. An investment of nearly $36 billion is expected in 2013 alone.[10]

The Forum believes Ontario, while it has captured some important early leads, cannot let itself fall behind if it wishes to capture the economic potential, environmental gains and societal benefits that will come with smart grid planning, investment, and deployment. The province is not alone in this pursuit. And just as we could not have anticipated fully the enormous opportunities to come with the arrival of digital technology, two-way broadband communications, and the Internet, the enabling infrastructure that will usher in a modern, interactive, and more decentralized electricity system will bring benefits that today we may not foresee.

Measuring Smart Grid Success

Statement of Purpose: "Measure the progress of development of the smart grid in the Province of Ontario and ensure that the intended benefits yielded from it are realized by consumers, industry and society in general." **– Corporate Partners Committee**

Early in the second half of 2010, the Forum's newly formed Corporate Partners Committee (CPC) highlighted the importance of measuring the success of smart grid activities and quantifiable impacts of investment as Ontario modernizes its electricity system. The CPC was assigned the task of crafting key success metrics that would allow government, industry and the regulator to track progress, including the rate at which consumers are adopting specific smart grid-enabled products and services. The committee worked diligently to identify near- and longer-term metrics. Several data points were recommended that fall under one of four broad metric categories.

[10] Smart Grid Technologies," Pike Research (Q4, 2009)

Success Metrics

Metric: The degree to which residential and small business customers are using smart meter information to make decisions on their electricity use

- The percentage of premises capable of receiving information from their smart meter
- The percentage of customers opting to make decisions based on their smart meter data
- Measurable electricity savings by customer class by region
- Evidence of load-shifting

Metric: The degree to which customers, including commercial and industrial customers, are taking advantage of the smart grid through associated technology and service offerings

- Level of participation in demand-side management programs, measured by number of participants and power load
- The number of different ancillary services in which customers are participating
- The number of active participants in distributed generation and megawatts generated

Metric: Overall performance of the smart grid and its support for new products and services, including electric vehicles

- The duration and frequency of electricity outages and number of customers affected
- Showing carbon content of electricity on an hourly basis
- Transmission and distribution system load factors
- The penetration of plug-in electric vehicles in the province, broken down by LDC and Hydro One operating territory

Longer-term

- Measurement of power quality, such as voltage regulation, on the grid
- Average number of days, from the point of initial request, that it takes a utility to "energize" a Level 2 (or higher) electric vehicle charging station

Metric: Level of contribution of the broader electricity sector to the Ontario economy.

- Number of jobs created

Longer-term

- Value of Ontario export of smart grid products and technology
- Percentage of rate-regulated smart grid investments, government grants/incentives relative to private investment

Forum members agreed that it was important to collect and publish as many of the near-term metrics as possible, which would establish early benchmarks to which future years can be compared. Some of those are listed here (see: "Benchmark Metrics" on this page). It should be emphasized that this is just a starting point. The Forum and its Corporate Partners Committee will endeavour to identify new success metrics over the coming months and years, including those related to economic development.

Benchmark Metrics - TOU rollout		
	December 31, 2009	**December 31, 2010**
Total retail customers in Ontario (all classes)	4,748,577	{Data not available at time of publication}
Smart Meters Installed	3,361,910	4,569,976
Smart Meters Enrolled in the MDM/R	484,505	2,215,260
Retail Customers (all classes) on Time-of-Use rates	196,753	1,628,896
Retail Customers (all classes) on Time-of-Use rates as a percentage of 2009 customer base	4.1%	34.3%

Sources: *OEB Distributors Yearbook, 2009 and OEB quarterly TOU progress reports*

Benchmark Metrics - Reliability				
	2006	**2007**	**2008**	**2009**
System Average Interruption Duration Index (SAIDI)[11]	8.8	4.27	7.1	3.96
System Average Interruption Frequency Index (SAIFI)[12]	2.66	2.42	2.62	2.11
Customer Average Interruption Duration Index (CAIDI)[13]	3.31	1.77	2.71	1.87

Source: *OEB Distributors Yearbook, 2009*

Recommendation:

- 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.

[11] **SAIDI** is the average forced sustained interruption duration per customer served per year (measured in hours). Calculation is: "Total Customer Hours of Interruptions" divided by "Total Number of Customers"

[12] **SAIFI** is the average number of forced sustained interruptions experienced per customer served per year (measured in outages). Calculation is: "Total Customer Interruptions" divided by "Total Number of Customers"

[13] **CAIDI** is the average forced sustained interruption duration experienced by interrupted customers per year (measured in hours). Calculation is: SAIDI divided by SAIFI.

SECTION 2: NEXT STEPS AND CHALLENGES

The Forum has identified six broad issues that will need to be addressed over the coming year and beyond to overcome potential barriers that risk slowing down or sidelining smart grid development efforts. These are discussed below, along with associated recommendations on how to move forward:

1) Privacy/Security

The smart grid, to describe it simply, is all about collecting, transmitting, sharing, analyzing and acting on information in a way that increases the value of electricity to customers and improves operation of the electricity system. Over time, that information will be gathered by a growing network of sophisticated sensors and digital devices, transmitted through a variety of two-way communications protocols, and both analyzed and acted on using specialized applications and advanced computing tools. All of this offers an unprecedented ability to monitor and manage the 24-hour-a-day operation of the grid and associated services. It also, however, creates a mountain of data – much of it personal to the consumer – that can be misused or abused, and introduces dramatically more points of cyber vulnerability on the system.

In the smart home of the future, for example, smart meters and smart appliances could keep a running log of activities within the household. The organization and analysis of that data has the potential to tell much about a person or family. "This kind of information can be combined with other data, such as work location and hours, and family status, to derive all kinds of assumptions that may be of interest to insurers, marketers, social service workers, and criminals," according to Ontario's Information and Privacy Commissioner, who calls privacy a "sleeper issue" for the smart grid.[14] Fortunately it's a manageable issue, and there are many lessons to be learned from the banking, healthcare and retail sectors.

The Forum believes utilities, regulators, equipment vendors and service providers need to embed privacy principles into the early design of new smart grid technologies and services. Privacy is one of the 10 high-level smart grid principles developed in consultation with the Forum and now recognized by government directive. The Privacy Commissioner's seven foundational *Privacy by Design* principles have also been formally recognized by the Forum. Consumers need to know that their personal information is protected. Otherwise, they may lose confidence in smart grid efforts.

Security, another smart grid principle, is essential to protecting consumer privacy and is integral to many aspects of grid operation. Electricity generation and delivery is the lifeblood of our economy, our institutions and our daily lives, and for this reason, securing this infrastructure has always been a priority. But the communications and computing layers of the smart grid increase the risk of cyber attacks on the electricity system. As a result, cyber security is critical to preventing attackers or malicious software from accessing networks, software and devices in a way that could destabilize grid operations. Common tools, such as firewalls, intrusion detection software, encryption and access controls, will become increasingly important to Ontario utilities over the coming years, as well as new standards around smart grid security. The Forum, with help from its Corporate Partners Committee, will continue to monitor developments in the areas of both privacy and security.

[14] "Smart Grid Privacy 101: A Primer for Regulators," Ann Cavoukian, Ontario Information and Privacy Commissioner, published Oct. 25, 2010.

Recommendations:

- 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.
- The Ontario Information and Privacy Commissioner should begin tracking smart grid-related consumer complaints with respect to how utilities and third parties use their information.

2) Third-Party Access

Lack of competition could be a barrier to smart grid development. The Forum's Corporate Partners Committee raised this as a top concern. As much as the quantity and granularity of customer data has privacy implications for the smart grid, it also raises questions about data ownership, access and sharing. Unlicensed third-party service providers, for example, want access to customer smart meter data so they can design and commercialize new energy products and services for residential, business and industrial consumers.

The OEB introduced rules in 2002 that allow licensed retailers access to electricity usage data with a customer's approval. It will soon consider the practical issues surrounding the opening up of access to hourly smart metering and real-time data to licensed retailers, but this won't deal with access by unlicensed providers who are offering a growing array of energy management services. The needs of all new entrants must be adequately addressed to promote smart grid innovation. More work should be done, therefore, to lower the barriers that currently limit access, keeping in mind that a one-size-fits-all approach will not be sufficient.

Many questions remain. Who should be required to have an OEB licence? If unlicensed third-party service providers – Google, for instance – are granted permission by a customer to access his/her hourly or real-time consumption data, what recourse does the customer have if that information is not properly used? How can access be revoked? Are there different levels of access? Is some sort of industry oversight needed?

Another outstanding issue: Who bears any added costs required to securely open up and standardize access to smart meter data while ensuring customer privacy? Current policy provides a user pay model. However this may not be practical in the future. Is it the utility, through the general rate base, or the third-party service provider, through its own customers? In this regard, regulatory guidance will be essential.

These questions need to be answered to assure smart grid activities in Ontario create Customer Value, a smart grid principle. Just as the Internet has challenged the traditional domains of telecommunications, media, and entertainment, the emergence of the smart grid will open up the grid to competition and increased innovation. This will blur the traditional roles and responsibilities in the electricity market and potentially create tension between regulated utilities and a diversity of new entrants. They include aggregators of demand-response capacity, suppliers of energy-storage services, providers of EV charging packages, and energy retailers offering customized, incentive-based electricity "plans".

Recommendations:

- 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.
- 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.

3) Engaging The Consumer

Electricity consumers need to have confidence that products and services delivered through a modernized electricity system will be reliable, secure, privacy friendly, and deliver enough benefits to make utility, industrial, commercial and household investments in new smart grid technologies worthwhile. But consumers, first, need to be aware of these benefits and how their concerns are being addressed (see: "Smart Grid Investment and Benefits" on page 29). This will require a shared and sustained effort to engage consumers through outreach and education.

What, for example, does the smart home really mean to households? Who will explain how the various pieces of the smart home fit together – e.g. in-home displays, smart appliances, smart thermostats, online energy management portals, rooftop solar panels, electric vehicle and charging system, etc.? What kind of services do they make possible? How can these products and services be used to reduce environmental impacts, better manage household costs, or create a more efficient and reliable grid for the benefit of all Ontarians? No individual stakeholder has sole responsibility for answering these questions, though the Forum has created a Smart Home Roadmap to help guide future discussions and policymaking. The role of government, LDCs, third-party service providers and product manufacturers will be determined largely by their own strategic interests and "place" within the smart grid ecosystem. Still, attempts should be made to coordinate outreach and education efforts to avoid confusing the consumer with mixed messages.

The Difference Between Smart Meters and Smart Homes:

More than four million smart meters have been installed across the province and the number of customers on time-of-use (TOU) rates is growing quickly. The Smart Metering Initiative has been a very specific public infrastructure investment aimed at bringing the benefits of smart metering to the consumer. Public utilities have made these investments guided by specific policy and regulation.

In contrast, it will be electricity consumers and the choices they make, which largely guide development of the smart home. Utilities will still play an important role as an enabler of customer choice. However, most investments in the smart home will come from consumers, not their regulated distribution companies. In other words, investments in smart home functionality will be largely market-driven, but at the same time encouraged and guided by policy and regulation.

Engaging the consumer also means creating the policies, regulations, pricing structures and incentives that will encourage competition and the kind of innovative products that electricity customers will want. Sending the right price signals will be important. The spread between off-peak and peak rates under Ontario's time-of-use program, for example, may not be sufficient at the moment to stimulate consumer investment in new appliances, wall plugs, home-area networks, and gateways that can communicate their status of operation to a smart meter or in-home display.

These technologies give consumers the ability to monitor and control their in-home electricity use (or generation), often remotely through mobile devices. But the ability to manage energy use is not a reason alone to purchase such products and services. They are not like cable services that offer entertainment, or Internet services that deliver high-speed access to news, online shopping, social networking, music and movies. Nor are they like wireless phone products that offer the freedom of mobile communications and connectivity.

Customer Value is a smart grid principle. The value that comes with controlling energy use will, to a significant degree, be financial in nature. If the monetary incentives for exercising that control – such as shifting power consumption to off-peak times – do not justify the cost of the enabling technology, then consumers already dealing with the global trend of higher energy prices will lose interest. Likewise, there will be fewer developers and service providers coming to market with innovative products.

Recommendations:

- 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 facilitate timely development.
- The interactions between LDCs and third-party service providers in each area of the smart grid value chain, including support for electric vehicles, 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.
- The role that aggregators can play in delivering benefits to consumers via the smart grid should be investigated and, where appropriate, specific recommendations should be developed to facilitate their participation in the market. The Forum and its Corporate Partners Committee will work with industry to address this issue.
- Gaps in knowledge specific to the development of the smart grid in Ontario should be identified and, where applicable, research should be advocated aimed at filling those gaps. The Forum will work closely with industry to identify and close knowledge gaps.
- The Ontario Ministry of Energy should conduct an annual smart grid consumer engagement survey to gain insight into how smart grid products/services are benefiting consumers and influencing consumption behaviour. The results of this survey should be shared with industry.

4) Electric Vehicle (EV) Integration

Plug-in electric vehicles – both pure-electric and hybrid-electric – have captured the imagination of consumers but also raised questions about their future impact on the grid. Nearly every major automaker and several new market entrants have plans to introduce electric vehicle models over the coming few years. Some already have. In Canada, both General Motors and Nissan are expected to commercially launch plug-in vehicles later in 2011, while Tesla Motors is already selling its luxury Roadster model in Ontario. Ford Motor, Mitsubishi and others are not far behind. There are several electric vehicle pilot projects underway in Ontario, mostly in densely populated urban markets. They include the Toronto Atmospheric Fund EV300 Initiative, the Better Place demonstration, and the Toronto Hydro smart Experience project in partnership with Mercedes-Benz Canada. A small number of EV charging stations dotting southern Ontario cities support these studies.

The Ontario government's vision is to see one out of every 20 cars on the province's roads powered, to some degree, with electricity by 2020. The Forum, presented with research from the University of Waterloo's Sustainable Energy Institute, heard that it will be three to five years before electric vehicles begin to have a meaningful impact on the grid, as even strong demand for vehicles will be limited by market supply.[15] But some stress points could present themselves earlier if high-density clusters of EV ownership emerge in certain neighbourhoods; if charging takes place during periods of peak electricity demand; or if Level 2 or higher charging stations put unexpectedly large loads on parts of the distribution network that are already strained. When an electric car is charging, it is like adding another house on the block. Two neighbours in a community who purchase electric vehicles could cause a blackout on their street if they decide to plug in at the same time on a summer afternoon. This risk and other challenges were also highlighted by a group of Canadian and U.S. power grid operators (IRC) in a comprehensive 2010 report.[16]

Utilities want to avoid being caught off guard to assure their customers get consistently reliable service. Such concerns are warranted. New research from McKinsey, the global consultancy, found that electric vehicles could represent between five and 16 per cent of new auto sales by 2015 in large urban areas, such as New York and Paris.[17] The largest cities in southern Ontario may experience similar adoption rates in certain communities. "Region-specific or neighbourhood-specific 'maps' of vehicle purchases and demand for charging stations need to be developed," according to the University of Waterloo research team. The Forum believes the information for such maps could be collected, in part, by the Ministry of Transportation at the point of vehicle registration and made available to utilities for system planning purposes.

The Forum recommended in its first report that a "task force" be set up to spearhead development of an electric vehicle strategy for Ontario. The intention was to broker the marriage of electric and transportation infrastructures, and assure the province is well positioned to capture potential economic benefits, such as attracting investment for EV manufacturing. While little of this has materialized, in reflection, it may prove more important in the near-term to clarify the potential role of LDCs and third-party service providers along the electric vehicle value chain, and work to reduce barriers to investment, system planning and EV adoption.

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[15] "Towards an Ontario Action Plan for Plug-In-Electric Vehicles (PEVs)," a presentation by Claudio Canizares and Jatin Nathwani, Waterloo Institute of Sustainable Energy, University of Waterloo (September 7, 2010)

[16] "Assessment of Plug-In Electric Vehicle Integration with ISO/RTO Systems," ISO/RTO Council (IRC), published March 2010

[17] "The Fast Lane to the Adoption of Electric Vehicles," McKinsey Quarterly, February 2011

From the perspective of Environmental Benefits, a smart grid principle, electric vehicles make tremendous sense for a province such as Ontario. The emission-free electricity from hydroelectric and nuclear stations, and increasingly renewable generation such as wind and solar, represents most of the province's supply. With the closure of all coal-fired power stations by the end of 2014, the electricity mix will become even cleaner. Not only is an electric vehicle charged and driven in Ontario greener than one in a coal-dependent jurisdiction, it emits dramatically less pollution and greenhouse gases than a vehicle that burns gasoline.

Recommendations:

- The Ontario Ministry of Transportation should track the registration of electric vehicles and ensure that necessary information is provided to the electricity industry in a meaningful and timely manner. Where necessary, legislation and regulatory changes that facilitate this information exchange and protect consumer privacy should be made.
- The source of accurate and timely information about the installation of Level 2 and higher charging stations should be identified and made available to assure the safe and reliable operation of LDC networks. The Forum will work with the automotive and electricity sectors to identify and recommend the appropriate parties and mechanisms for supplying this information.

5) Storage Integration

Low-cost and plentiful energy storage has been called the "holy grail" of the electricity system. Renewable energy facilities (such as wind farms) or nuclear power plants sometimes generate electricity when the province and surrounding markets can't take it or don't need it. Energy storage lets us capture that electricity and dispatch it to the grid when we demand it most. Storage can be used to smooth out the often unpredictable fluctuations of solar and wind resources, bringing added stability to the electricity system. It can ease points of congestion in transmission and distribution networks by temporarily absorbing surges and excess power flow, allowing for the deferral of expensive system upgrades. It can regulate voltage levels on the grid to maintain power quality. And, for electricity users, storage can also function as backup power in the event of blackouts. As part of the smart grid, energy storage is a kind of insurance policy – it brings flexibility, reliability and predictability to many aspects of system operation, and as an enabler of renewables can help us become less dependent on fossil fuels and achieve other environmental benefits.

There are many different types of energy storage, each suited to a specific type of application. Historically, however, they have all shared a common trait: a very high price tag. This is beginning to change. Advances in battery, flywheel, compressed-air and fuel cell technologies, as well as new and creative approaches to pumped storage, are lowering the cost of energy storage. Innovation around "process" storage – a way of intelligently managing loads in the commercial and industrial sectors to mimic the functions of storage – presents another promising option. At the same time, forecast higher electricity prices will improve the economics of these technologies and approaches.

Electric vehicles and the idea of "smart charging" are also changing the discussion. The vehicles themselves, while plugged into the grid, can potentially be programmed to act as a load during periods of lower demand and as a source of supply during times of highest demand. EV batteries can also have a second life beyond the vehicle. A project in downtown Toronto, led by Electrovaya Inc. with support from NRCan, HydroOne, Manitoba Hydro, Ryerson University and OCE is currently exploring the potential of using old lithium-ion batteries from electric vehicles for a variety of smart grid applications. Down the road, this could represent a welcome financial perk for owners of electric cars.

In Ontario, progress in the deployment of energy storage has been minimal and more efforts are required to encourage it. Regulated and some contracted generation receive the same amount per kilowatt-hour whether or not a facility produces power at 3 a.m., when demand is lowest, or 6 p.m., when demand is at its highest. If contract payments were designed to be higher or lower based on when electricity is most needed and capture the value that storage can offer the electricity system, this might make storage economically attractive for investors.

Some research, development and demonstration is happening. OCE, in partnership with utilities and academic institutions, is working with a number of Ontario-based energy storage companies with tremendous worldwide potential. One, for example, has developed a way to store energy by pumping compressed air into ruggedized balloon-like structures under water. Another has invented a low-cost flywheel technology that dramatically outperforms market rivals. There are plans to test both innovations and others on LDC systems. But more support is needed, and the Forum believes that without a comprehensive framework the province will miss the opportunities that energy storage can deliver to a modern grid. Through its Long-Term Energy Plan, the Ontario government has committed to continuing to investigate the potential for new storage technologies.

Recommendation:

- The Ontario Power Authority (OPA) and Independent Electricity System Operator, in consultation with industry and the Ontario Energy Board (OEB), should jointly develop a framework to promote the integration of distributed energy storage with the grid where it is cost-effective.

6) Standards

As the smart grid develops, technical, operational and process standards become increasingly important to its various pieces, as well as the advanced communications systems that connect them. The Forum's Corporate Partners Committee emphasized the need for Ontario utilities to embrace and seek development of North American-wide standards and codes for smart grid infrastructure and technologies. Open, broadly accepted standards will encourage third-party innovation, promote competition, give confidence to investors, and could ultimately lead to more affordable, reliable and interoperable products for new market entrants and electricity consumers. This can be a challenge for jurisdictions such as Ontario. By taking an early lead on smart grid development, they risk making large infrastructure investments before standards have sufficiently matured.

Standards will be especially important in the area of information management. The amount of grid-related data that will be collected, used and shared over the coming decade is going to skyrocket as the electricity system gets smarter. Utilities will be capable of keeping a 24-hour electronic eye on equipment status, power quality, power flows, and temperatures at various points in the grid and by the second, minute, or hour. In a residential and business context, the amount of electricity consumed or generated in a given time interval will be gathered from the smart home or building, appliances within it, and vehicles connected to it. Much of this data must be kept highly secure and confidential, but all of it will need to be managed. Some have warned of a coming "data deluge." One conservative estimate is that utilities will collect 900 per cent more data over the next decade.[18] Clearly, data collection will no longer be just about billing the customer.

But this data, on its own often holds little value unless it can be turned into information that can assist decision making, whether it be for infrastructure planning, policy development, system optimization, marketing, maintenance purposes, or the design of new services. In the words of one large utility and Forum member: "We're increasingly data rich but information poor at this stage." This is unexplored territory for many utilities – large and small – and regulated investments will need to be carefully coordinated and reflect widely accepted industry standards for data exchange. Different information management systems must be capable of processing the same types of information and securely sharing data across multiple stakeholders. This will require the delicate act of integrating what have historically been silos of closely held information. "It's an area I think we underestimate," said another Forum member.

Principles guiding smart grid development in Ontario – specifically the principles of *Coordination* and *Interoperability* – will assure that the province's utilities and broader industry align with procurement and deployment efforts across the continent. *Economic Development, Safety, Security* and *Privacy* principles also depend heavily on the development and adoption of industry standards. In October 2010, the U.S. National Institute of Standards and Technology identified five "foundational" smart grid standards that address data and information exchange (across networks, devices, and control centres), substation automation, communications and cyber security. The U.S. Federal Energy Regulatory Commission is now giving thought to establishing industry rules around these standards. In Canada, several Forum organizations are participating in the Canadian National Committee of the International Electrotechnical Commission (IEC), an effort being led by the Standards Council of Canada. An interim report on recommended standards is expected later in 2011. The Forum will continue to monitor these activities and assess implications for Ontario.

Recommendation:

- 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.

[18] "The Data Revolution: How Intelligent Hardware Will Drive the $34 Billion Smart Grid," Lux Research, January 2011

SECTION 3: SMART GRID INVESTMENT AND BENEFITS

Meeting the needs of electricity consumers and realizing the many benefits that come with a modern electricity system are driving public investment in the smart grid. Such investment is critical to expanding customer choice, giving energy consumers more control and enabling public participation in the electricity market.

In the Forum's first report it was concluded that required smart grid investments, while difficult to quantify, would represent an average public-sector utility investment of about $320 million annually over the initial five years of deployment. This preliminary projection was incremental to the business-as-usual costs associated with planned system renewal and expansion required to accommodate new supply. In other words, "smart grid" spending must add intelligence and new functionality to the electricity system. In the Ontario context, it excludes the cost of distributed renewable energy sources, such as those contracted through the FIT program, and investments made as part of the province's Smart Metering Initiative, which is nearly complete.

The Forum decided that a more detailed update to smart grid investment projections was needed. Members spent considerable time over the past year isolating what they believed would be smart grid spending. It is a tricky exercise, as over time smart grid capability increasingly becomes a common, built-in feature in equipment purchases. The line between old and new blurs as emerging standards influence design and reduce costs, gradually erasing the "premium" often associated with smart grid technologies. "As these technologies mature and as production volumes increase, the marginal costs of smart grid technologies have the potential to decline rapidly," the industry-funded Electric Power Research Institute (EPRI) explained in a recent report on smart grid costs and benefits.[19] The cost of smart meters, for example, has fallen dramatically over the past five years. The price gap between an old electromechanical meter and a smart meter has almost closed, yet a smart meter is so much more advanced and functional. "As we replace aging grid infrastructure, and as I buy pieces to do that," said one Forum member, "it is going to be harder to determine what the incremental cost is going to be, particularly as more standardization happens."

With that caveat, the Forum's Working Group developed a new, more detailed cost projection extrapolated from the spending plans of four Ontario utilities – Hydro One, Hydro Ottawa, PowerStream, and Toronto Hydro, which together represent more than half of the province's electricity customer base. It was concluded that public spending on the smart grid over the next five years would amount to about $390 million per year, an investment already factored into electricity price increases projected under Ontario's Long-Term Energy Plan. This investment is aimed at *enhancing the efficiency of the distribution grid* and using smart grid technologies to *enable the connection of distributed generation*, such as wind and solar, in a more intelligent, cost-effective way.

The time is ripe to make such investments. A significant portion of transmission and distribution infrastructure across Canada is decades old, built to serve a national population of what was then 20 million. The system is now in desperate need of renewal and expansion in a country with rising energy demands and a population expected to surpass 40 million by 2025. As a result of underinvestment in infrastructure since the 1980s, the Conference Board of Canada estimates the non-generation part of the grid will require

[19] "Estimating the Costs and Benefits of the Smart Grid – A Preliminary Estimate of the Investment Requirements for a Fully Functioning Smart Grid," report from the Electric Power Research Institute (EPRI), Mar. 29, 2011.

an average annual investment of about $5 billion over the next 20 years to maintain grid reliability and long-term affordability.[20] Ontario is doing its part. But this is more than simply renewing and maintaining the grid of yesterday; it's about investing in a smart grid of tomorrow that will deliver more economic value over the long term. "Increasing levels of distributed generation use, smart grid developments, and changing electricity requirements will all affect future distribution investments," the Conference Board acknowledges. EPRI, which calculates that U.S. smart grid investments could reach $479 billion (U.S.), estimates that every $1 invested toward a fully functional smart grid has the potential to return roughly $4 in benefits.[21]

Ontario is aiming to achieve similar returns, as well as capture the economic development opportunities and jobs that will come from smart grid activities and investments. The province is already well underway to modernizing its electricity system. The Forum believes it is crucial to build on that momentum and the investments made to date.

It is important to note that LDCs, transmission utilities, the OPA and the IESO are required to submit detailed cost-benefit analyses of their spending plans to the OEB, which will only approve investments that are in the best interest of ratepayers. Some of the principles and criteria to be considered in this analysis are set out in the Minister's smart grid directive and their application is currently the subject of a public consultation process being carried out by the OEB.[22]

Below is a brief breakdown of both investment categories, as well as a discussion of the many benefits they're expected to bring to electricity consumers:

1) Enhancing the Grid

The Forum estimates that adding intelligence and new functionality to the grid will require an average annual investment by public utilities of $193 million over the next five years. This investment will be spread across six categories: *distribution*, *transmission*, *communications*, *consumer technologies*, *electric vehicles* and *innovation.*

Nearly three-quarters of investment is going toward adding automation and "smart" features to various parts of the LDC *distribution* network, which is the part of the electricity system that directly connects to households and businesses. Spending includes the purchase and installation of sensors, control systems, self-healing switches and line monitoring tools that can make this part of the grid more reliable, resilient and responsive. Similar technologies are also being brought to Hydro One's *transmission* system – the backbone of our provincial grid – though the annual investment is expected to be much smaller.

In addition, utilities are continuing to invest in two-way, high-speed *communications* technologies that improve interaction between the various parts of the electricity system – from generation to transmission to local distribution to the end customer via smart meters. Robust communications is essential for adding automation and intelligence to the grid, as it allows for the near real-time collection and sharing of information about grid performance, electricity supply, and customer demand for decision making.

[20] "Canada's Electricity Infrastructure: Building a Case for Investment," published by the Conference Board of Canada, April 7, 2011.

[21] EPRI report and press release, March 29, 2011. "Factoring in a wide range of new technologies, applications and consumer benefits the investment needed to implement a fully functional smart grid ranges from $338 billion to $476 billion and can result in benefits between $1.3 trillion and $2 trillion," according to EPRI.

[22] See also, Ontario Energy Board consultation, "Developing Guidance for the Implementation of Smart Grid in Ontario" (EB-2011-0004)

LDCs are also investing in the demonstration and study of various *consumer technologies* that bring the benefits of the smart grid directly to homes and businesses. These include in-home displays, smart appliances, advanced thermostats, automated lighting systems, and other energy management devices that make up the "smart home" or "smart building." Electric vehicles and associated infrastructure are another area of focus – though this spending is expected to account for a relatively small portion of the projected incremental capital expenditures over the next few years until consumer adoption of electric vehicles reaches a critical mass. In the meantime, Ontario utilities are endeavouring to better understand how the proliferation of electric vehicles could impact the distribution system and overall system reliability. Investment in pilot projects are offering insight into consumer charging patterns and giving utilities the information they need to properly enhance the grid as electric vehicles become more prevalent in our communities.

Finally, utilities are participating as partners in a number of research and development projects that are largely funded through relevant private sector and government organizations, such as the Ontario Centres of Excellence and the National Science and Engineering Research Council. Utilities, as operators of Ontario's publicly owned electricity system infrastructure, bring invaluable expertise to the table that can guide innovation around energy storage, distributed generation, energy management, electric transportation and other smart grid-related technologies. But their investment in this area, relative to spending on infrastructure, will be small.

Customer Benefits:

Electricity customers get more ***reliable service*** when the grid is better equipped to detect, isolate and fix equipment failures, system stress points, or security threats. Increased automation, enhanced monitoring, and advanced communications means a local blackout typically caused by a fallen tree, faulty transformer or lightning strike can be entirely averted or dramatically shortened because of the speed at which the grid can take action to heal itself. Businesses and consumers, as a result, experience minimal – if any – impact and enjoy the uninterrupted, ***high-quality power*** they've come to expect in a digital economy. This will become increasingly important as more electric vehicles start plugging into the grid.

There is a meaningful ***improvement in customer service*** as well. Utilities often depend on electricity customers to report a service problem before responding to outages or equipment malfunctions. Even then, they often don't know where the problem lies in the network. Repair crews must be dispatched in trucks to search for the problem, which is an inefficient use of resources. A smart grid can detect the problem so quickly that a crew can be on the scene before customers realize there's a problem.

Consumers and businesses also get ***more value for ratepayer dollars.*** Through better monitoring and automation, LDCs can operate the system more efficiently – that is, they can make smarter decisions about how assets are used and deployed to meet the demands and expectations of customers. The result is reduced operational and maintenance costs, as well as the potential to defer expenditure on system upgrades and expansion.

Finally, smart grid investments in this category are giving customers ***more control and choice.*** Consumers will have an unprecedented ability to participate directly in the electricity marketplace and have access to a broad array of new products and services expected to emerge as the smart grid develops. Many of these products will give consumers greater control over how and when they use electricity. Consumers will be empowered to conserve or alter consumption patterns in a way that lowers their total energy costs or shields against future price increases. They can also potentially benefit financially through direct participation in the market, such as through demand-response programs, which pay consumers to reduce their electricity consumption during defined periods. Likewise, owners of electric vehicles will be able to participate in future demand-response and energy storage programs.

All of these investments bring immense ***environmental and health benefits*** to consumers. A grid that can operate more efficiently means less wasted energy and reduced use of fossil fuels. A grid that empowers consumers with the tools to control their energy use encourages energy conservation and smarter decision making. A grid that can safely accommodate growth in electric vehicle adoption can help to dramatically reduce greenhouse gas emissions and smog-causing pollution from the transportation sector, leading to cleaner air and better public health.

Ultimately, all the benefits described contribute to a ***smarter, stronger economy***.

2) Enabling Distributed Generation

Slightly more than half of projected annual spending ($198 million) is associated with augmenting distribution networks with additional intelligence and equipment that will permit the more efficient connection of solar, wind and other distributed sources of clean power generation. These investments reflect the obligation of utilities under the GEGEA to safely accommodate the connection of renewable-energy projects, which have increased substantially since the launch of the FIT and microFIT programs.

Empowered by these programs, citizens are taking control of their energy future by choosing to participate in Ontario's electricity market. Their eagerness over the past 18 months to install solar PV systems on rooftops, erect wind turbines, and generate electricity from animal and agricultural waste has exceeded expectations and is accelerating the need for LDCs to reinforce their distribution networks. In the course of making these upgrades, there will be an opportunity to add smart grid functionality to equipment and systems.

The Forum's first report was released prior to the passage of the GEGEA and introduction of the FIT and microFIT programs, and as result, adequate information was not available to forecast projected investment in the smart grid as a result of embedded generation.

Customer Benefits:

Adding intelligence to the grid to enable the connection of distributed generation brings several benefits. Smart upgrades to distribution systems are more cost-effective than investments in traditional upgrades, such as additional wires and poles, which would otherwise be required.

Electricity customers, increasingly, are no longer just consumers of electricity. They are able to take ***greater control over their energy future*** by becoming generators of clean power.

As a result, the growing investments consumers are making in solar, wind, biomass/biogas and hydro projects are ***creating jobs and boosting the economy***.

And given the opportunity to put more green power on the grid, Ontarians are improving air quality in the province and ***reducing their collective carbon footprint***.

Recommendation:

- A new task force should be established to foster smart grid innovation, technology commercialization and related economic development opportunities, capitalizing on the province's public infrastructure investment in grid modernization. The task force, facilitated by the Forum but not exclusive to its members, would seek the active participation of public- and private-sector organizations in a position to help Ontario realize the broader economic development potential, including export opportunities, related to the smart grid over the longer term.

Conclusion

The smart grid is not an end in itself. There is no measure by which to verify its arrival. The smart grid will be developed to meet the unique needs of the consumers, businesses, and industries it serves. It is constantly evolving, becoming more efficient, automated, adaptable, robust, secure – and "smarter." What the smart grid does represent is a dramatically new phase of development for the electricity system, one that will bring environmental and economic benefits for decades to come.

As this report makes clear, *the smart grid is happening now*. Ontario, generally, has done a good job of laying the foundation. Indeed, there are other jurisdictions envious of the province's progress. And this progress, to a large extent, is being driven by market demand. More consumers want tools that will help them better manage their energy spending. They want more choice of tools. Consumers want reliable service. Whether for environmental or financial reasons, more want to participate in the market by generating green power. This is all enabled by the smart grid. It is driving smart grid investment.

The challenge now is to make the right kind of grid investments to keep up with that demand. There is much work to do, and much more room for improvement. The recommendations listed throughout this report are aimed at lowering barriers to smart grid development. These recommendations should guide our next steps. In the meantime, the Forum will continue over the next year to monitor developments, facilitate discussion, and report back on progress.

Ontario is clearly on the path to bringing the benefits of the smart grid to consumers. The investments being made today and over the coming years will unlock enormous opportunities for the future. They will spur innovation, bring more choices to consumers, and contribute to a cleaner environment.

Ultimately, they will help strengthen Ontario's productivity and competitiveness in the 21st century.

RECOMMENDATIONS:

Privacy and Security

- 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.
- The Ontario Information and Privacy Commissioner should begin tracking smart grid-related consumer complaints with respect to how utilities and third parties use their information.

Third-Party Access

- 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.
- 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.

Consumer Engagement

- 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 facilitate timely development.
- The interactions between LDCs and third-party service providers in each area of the smart grid value chain, including support for electric vehicles, 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.
- The role that aggregators can play in delivering benefits to consumers via the smart grid should be investigated and, where appropriate, specific recommendations should be developed to facilitate their participation in the market. The Forum and its Corporate Partners Committee will work with industry to address this issue.
- Gaps in knowledge specific to the development of the smart grid in Ontario should be identified and, where applicable, research should be advocated aimed at filling those gaps. The Forum will work closely with industry to identify and close knowledge gaps.
- The Ontario Ministry of Energy should conduct an annual smart grid consumer engagement survey to gain insight into how smart grid products/services are benefiting consumers and influencing consumption behaviour. The results of this survey should be shared with industry.

Electric Vehicle (EV) Integration

- The Ontario Ministry of Transportation should track the registration of electric vehicles and ensure that necessary information is provided to the electricity industry in a meaningful and timely manner. Where necessary, legislation and regulatory changes that facilitate this information exchange and protect consumer privacy should be made.
- The source of accurate and timely information about the installation of Level 2 and higher charging stations should be identified and made available to assure the safe and reliable operation of LDC networks. The Forum will work with the automotive and electricity sectors to identify and recommend the appropriate parties and mechanisms for supplying this information.

Storage Integration

- The Ontario Power Authority (OPA) and Independent Electricity System Operator (IESO), in consultation with industry and the Ontario Energy Board (OEB), should jointly develop a framework to promote the integration of distributed energy storage with the grid where it is cost-effective.

Standards

- 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.

Innovation & Economic Development

- A new task force should be established to foster smart grid innovation, technology commercialization and related economic development opportunities, capitalizing on the province's public infrastructure investment in grid modernization. The task force, facilitated by the Forum but not exclusive to its members, would seek the active participation of public- and private-sector organizations in a position to help Ontario realize the broader economic development potential, including export opportunities, related to the smart grid over the longer term.

Measuring Smart Grid Success

- 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.

Appendix 'A' - Ontario's Smart Grid Objectives

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 licensed, regulated utilities in the province of Ontario.

GENERAL OBJECTIVES TO BE CONSIDERED BY THE OEB IN EVALUATING SMART GRID ACTIVITIES 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.

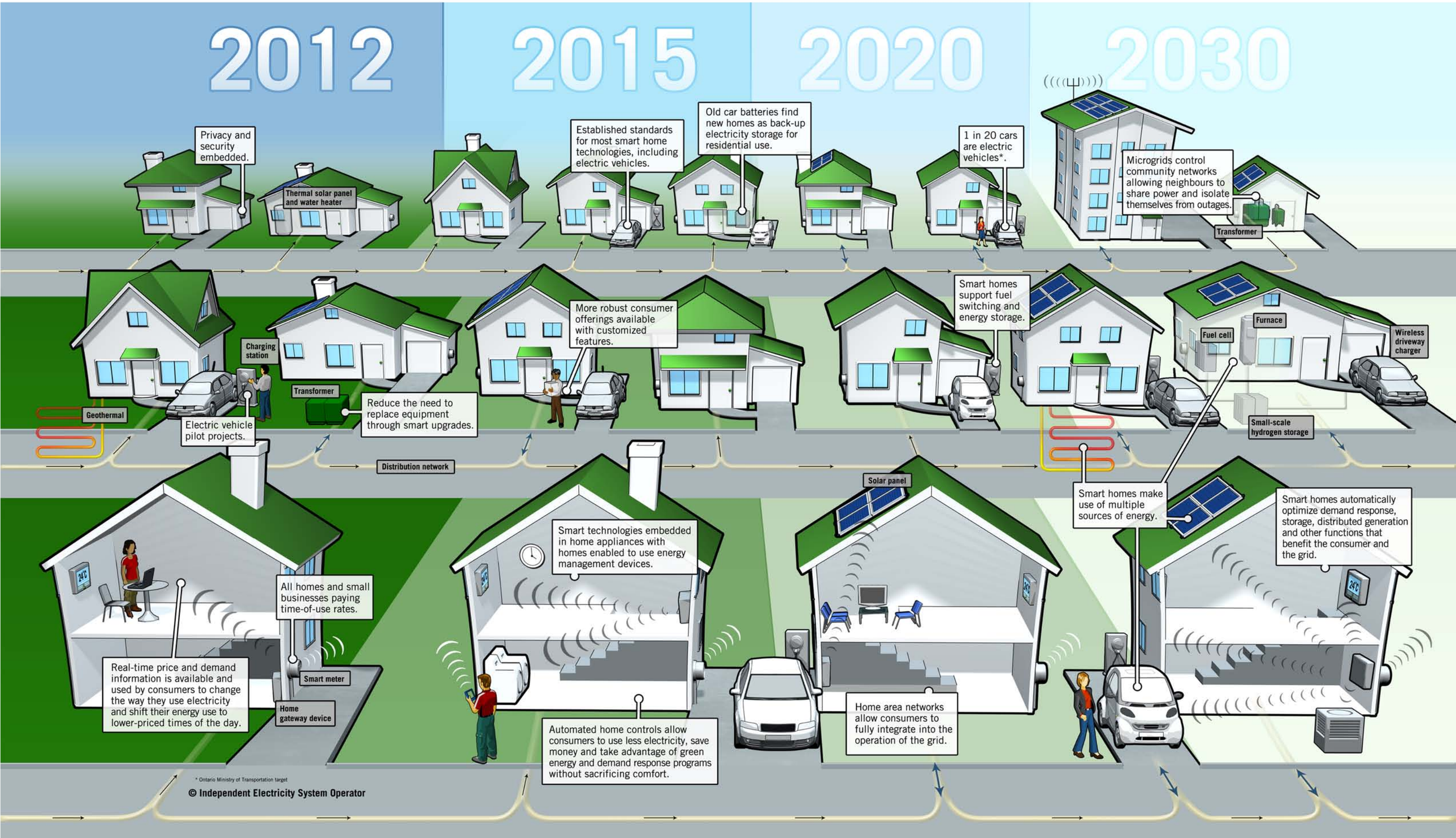
FORWARD COMPATIBILITY: Protect against technology lock-in to minimize stranded assets and investments and incorporate principles of modularity, scalability and extensibility into smart grid planning.

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 model.

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.

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)

Ontario Smart Home Roadmap



* Ontario Ministry of Transportation target

To contact a Forum member, please call the Independent Electricity System Operator:

655 Bay Street, Suite 410
P.O. Box 1
Toronto, ON M5G 2K4
www.ieso.ca
Phone: 905.403.6900
Toll-free: 1.888.448.7777
E-mail: customer.relations@ieso.ca
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