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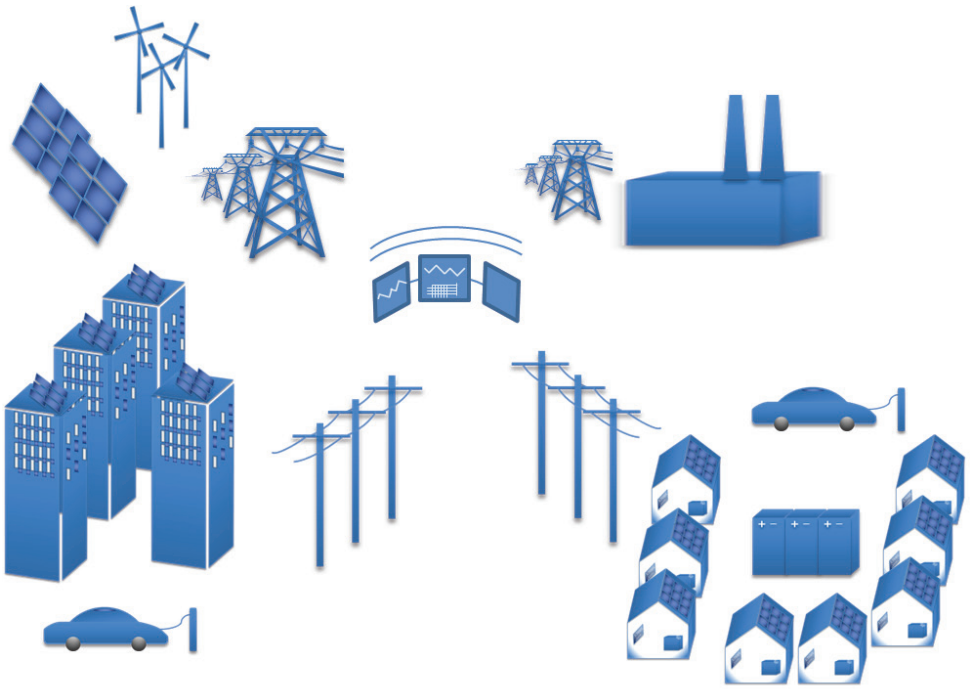
Leadership in ecoInnovation

Smart Grid in Canada 2011-2012



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This report provides a summary of smart grid development progress in Canada during 2011-2012. It is written for industry, government and research stakeholders in smart grid development.

Canada

M151-4/2012E

Citation:

Hiscock, Jennifer; Beauvais, David, Smart Grid in Canada 2011-2012, report # 2012-224 RP-ANU 411-SGPLAN, Natural Resources Canada, October 2012, 29 pp.

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Acknowledgements:

The editors of this report would like to acknowledge contributions from its Smart Grid Plan project partners to this annual report:

Lisa Dignard-Bailey, Director Integration of Distributed Energy & Renewables Group, NRCan CanmetENERGY

Ken Nakahara, Manager Smart Grid Networks, Ontario Ministry of Energy

Jon Norman, (former) Director of Transmission & Distribution Policy, Ontario Ministry of Energy

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INTRODUCTION

Smart grids represent the future of electricity and energy systems around the world. In Canada, smart grid design reflects a shift to more efficient network and resource use as systems become more flexible and adaptable to the energy supply and demand characteristics. CanmetENERGY studies the development of smart grid technologies and systems, and their relation to the institutional and market dynamics of electricity as it becomes more integrated with other energy systems. This report highlights the current status of smart grid progress in Canada in the 2011-12 timeframe, the activities that Canada's smart grid stakeholders are participating in, and the challenges and opportunities facing the industries engaged in the development of smart grids.

SMART GRID DEPLOYMENT

Smart grid deployment and progress is not a straightforward measurement of modern and new technology deployment. The very definition of smart grid requires a conversation because it is not a specific system design. A common way of describing smart grid is through applications that deliver services to operators and users of smart grid systems. In this report the applications, representing multiple component technologies, have been chosen because of their prevalence in the industry, their level of development, and their potential for impact on the system. Figure 1 maps these applications by their acronyms onto smart grid jurisdictions in Canada:

- Advanced metering (AMI)
- Time of Use rates or dynamic pricing (TOU)
- Wholesale demand response (DR)
- Direct load control (DLC)
- Fault detection, isolation and restoration (FDIR)
- Planned islanding (PI)
- Voltage and var (reactive power) control (VVC)

These applications are explained in Table 1 with the associated services they deliver. Not all of these applications have mature technologies in them, and many are still in development. In general smart grid includes technological evolutions in transmission networks, with the greater number of new applications deployed downstream in distribution networks or behind the meter with the customer. Even then, the distinction between transmission and distribution networks is becoming blurred in smart grid operations as distributed solutions are changing the way the whole power system operates.

Table 1: Smart grid applications described as developed or deployed in Canada

Application	Description of deployment
Advanced Metering (AMI)	Advanced metering is commonly referred to as advanced metering infrastructure (AMI). In Canada it generally supports automatic meter reading and interval metering. This infrastructure, through the smart meter, could also be used as a gateway for information exchanges with the customer. Depending on the local conditions, AMI could be used to support any or all of services such as outage and loss detection, direct load control, time-of-use rates, in-home displays and home energy management systems.
Time of use pricing (TOU) **Wholesale demand response (DR)** **Direct load control (DLC)**	As electricity systems become more congested in Canada, these applications allows load shifting and peak demand reduction, allowing for reduced spending for the utilities and the customers. These applications could be offered or delivered by a range of actors including utilities, aggregators or retailers. Time of use pricing rewards customers who shift their personal peak consumption from peak periods on the system with cheaper rates during off-peak periods on the system. Similarly demand response and direct load control programs pay a customer directly to shift their peak consumption of electricity. Demand response technologies include energy management systems, but also technologies such as storage which can minimize the disruption of a customer's activities while still decreasing their demand on the system.
Fault Detection, Isolation and Restoration (FDIR)	Sometimes referred to as fault location, isolation and service restoration (FLISR), this is the "self-healing" capacity of the grid. This application is usually network automation hardware for remote sensing and switching with outage management systems (OMS) and distribution management systems (DMS) as the software controls.
Planned islanding (PI)	Planned islanding takes advantage of distributed generation or storage as a way to create a "micro-grid" within a larger network that can be isolated and maintained during outages on the bulk power system. The distributed energy resources could also be used to reduce the peak demand in the area. At this point in Canada the deployment is rare, but standards are being developed to facilitate the transition to this functionality in specific contexts and locations across Canada.
Voltage and var (reactive power) control (VVC)	Voltage and reactive power (var) control uses substation automation and capacitors to flatten the voltage profile of a feeder, leading to energy conservation and loss reduction. VVC applications can also allow distribution networks to support greater amounts of variable power from renewable electricity generation such as wind and solar photovoltaic. VVC applications can be standalone installations at substations, or integrated into distribution management systems (DMS).

Figure 1 maps the major development and deployment of these applications across Canada. For each application, a pie chart indicator provides information as to the level of development or deployment in that jurisdiction. A 1/3 pie represents applications that are in major study projects or pilot stages, a 2/3 pie representing ongoing or partial deployment of an application across a jurisdiction, and a whole pie represents full deployment across a jurisdiction. For example, Ontario has full-scale deployment of smart meters across the province for its residential and commercial customers. BC will complete smart meter deployment across the

province by the end of 2012. A table of projects by utility[1] can be found on the CanmetENERGY website. The following image maps out the deployment activities across the jurisdictions in Canada.

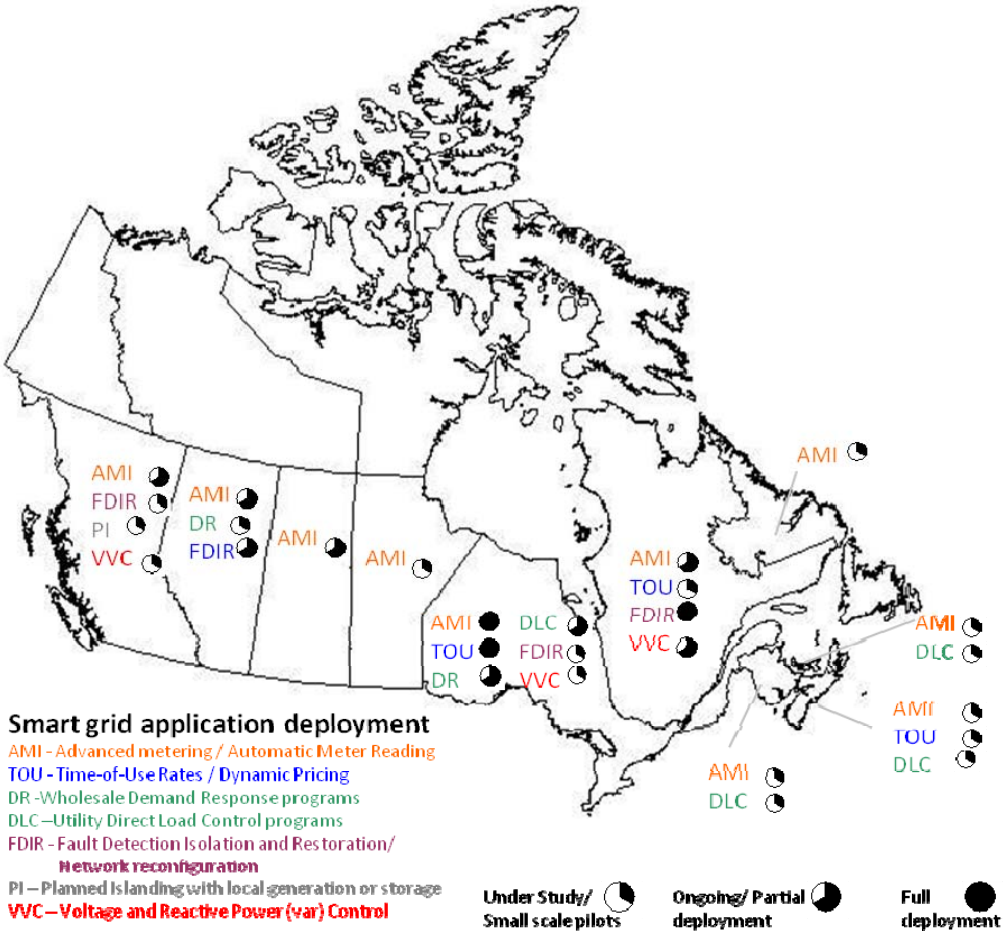

Figure 1: Smart grid deployment in Canada

It should be noted that smart grid development and deployment is not a singularly defined or linear pathway. Provinces, territories, and electricity jurisdictions will approach smart grid deployment and development differently as explained in the following section. The system designs for each jurisdiction will also be different depending on the existing infrastructure and characteristics. Each application is a unique deployment of technologies and design that requires a combination of control, communication and information management technologies. For example, Hydro-Québec has a fully deployed network reconfiguration on its distribution

[1]Smart grid projects by utility: http://canmetenergy.nrcan.gc.ca/renewables/smart-grid/publications/2987

network allowing for FDIR that differs in the hardware and software from the FDIR deployed by PowerStream in Ontario. As such, the number of projects in a province or territory does not necessarily represent one province or territory being farther ahead than another, and Figure 1 should be taken to represent application development or deployment, not a ranking of provinces and territories.

SMART GRID DEMONSTRATIONS

NRCan is leveraging its Clean Energy Fund to support $116.5M in smart grid demonstration projects, as shown in Figure 2. These projects showcase the latest in smart grid technologies in storage, demand response, controls and electric vehicle grid integration. These projects are funded for 4 years, with a 5 year monitoring commitment following the completion of the project.

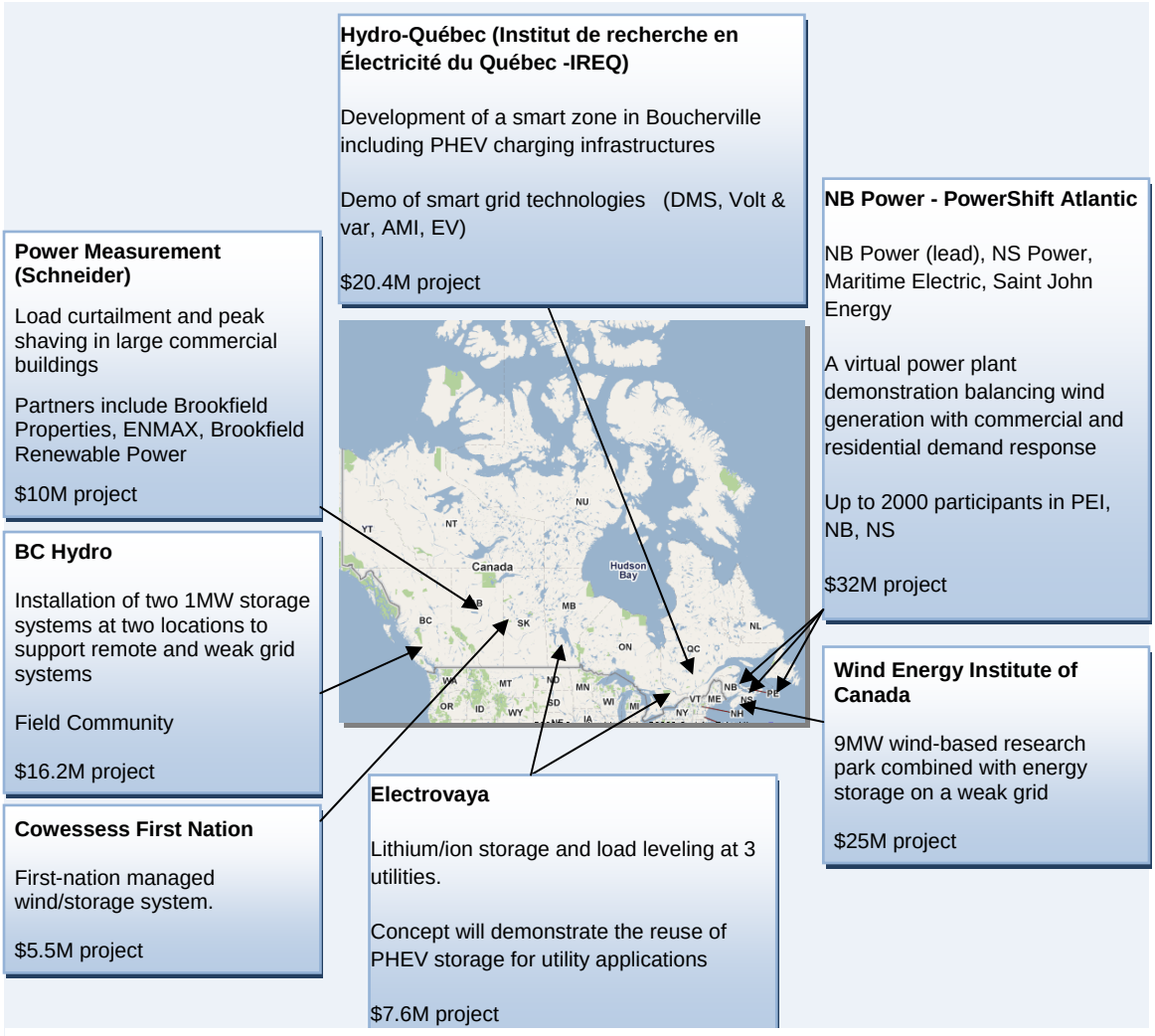

Figure 2: NRCan Clean Energy Fund smart grid demonstration project map

Project descriptions for these seven smart grid demonstrations can be found on the NRCan Clean Energy Fund website[2]. Highlights of the progress in these projects can be found in Appendix A – Smart Grid highlights.

NRCan's ecoEnergy Innovation Initiative projects are expected to be announced later in 2012 and it is anticipated that further investment and development in smart grid will be enabled through this new fund.

SUPPORTIVE STRUCTURES FOR SMART GRID

Each province and territory in Canada has its own approach to developing smart grid systems reflective of their energy resource base, market and regulatory structure, and policy drivers. Most jurisdictions have recognized benefits to the environment and the economy as major drivers for smart grid development. What differs is their approach to supporting the development of new markets and implementing the infrastructure to facilitate automated and integrated systems. Highlights of the 2011-12 jurisdictional support are included below.

Ontario announced its Smart Grid Fund[3] recipients on June 8, 2012. To date approximately $25M was awarded in this first round. A list 13 projects were approved under the following categories: behind the meter solutions, integrating distributed resources, regional integration, data management and grid automation. The purpose of fund is to increase innovation and economic development in smart grid related industries.

Ontario launched its Clean Energy & Economic Development Strategy[4] on April 12th, 2012. This was borne out of the Feed-In Tariff (FIT) review and centered on smart grid. This strategy and the activities generated from it will be supported in partnership by Ontario's Ministry of Energy and Ministry of Economic Development and Innovation. A Clean Energy Task Force[5] was mandated to broaden Ontario's energy focus and identify export opportunities. A major initiative from this strategy led to the announcement for the creation of an Ontario Clean Energy Institute[6]. The design of the Institute will be investigated in partnership MaRS[7]. It has received $500K from the government of Ontario and has 1 year to develop its mandate and metrics within a plan and model for its operation.

Figure 3: Ontario Minister of Energy Chris Bentley opens Future of Energy Summit 2012 and announces Smart Grid Fund recipients. (Photo courtesy of MaRS Discovery District)

[2] http://www.nrcan.gc.ca/energy/science/programs-funding/1514
[3] http://www.energy.gov.on.ca/en/smart-grid-fund/
[4] http://news.ontario.ca/mei/en/2012/04/expanding-ontarios-clean-energy-economy.html
[5] http://news.ontario.ca/mei/en/2012/04/members-of-the-ontario-clean-energy-task-force.html
[6] http://www.marsdd.com/2012/06/08/mars-clean-energy-institute/
[7] http://www.marsdd.com/

The regulator in Ontario, the Ontario Energy Board (OEB), released a Staff Discussion Paper[8] on November 8th, 2011 after consultation with its Smart Grid Working Group[9]. Responding to the Ontario Green Energy Act priorities and Ministry of Energy Directive to the Board, the OEB initiated a regulatory reform process and now requires utilities to have Smart Grid Plans and Regional Plans. The OEB is planning to adopt more performance based regulation as opposed to only cost-based regulation.

FUTURE OF ENERGY SUMMIT

MaRS Discovery hosted the Future of Energy Summit, June 2012 in Toronto. With both the Minister of Energy and Minister of Economic Development and Innovation as keynote speakers during the day, the event provided an opportunity for the province to draw attention to key smart grid initiatives: the Smart Grid Fund project announcement, the Clean Energy Institute announcement, and the Clean Energy Task Force work to develop Ontario's Clean Energy and Economic Development Strategy.

The conference focused on areas of data management, grid design, combining energy systems, emerging technologies and commercializing energy technologies. A major focus during the day was storage technologies, with 4 of the 5 panels talking specifically about storage and issues of integrating storage.

Outside the conference room, the Summit also drew attention to MaRS clients with new smart grid technologies and business models emerging to meet future markets and system demand.

In January 2011 the Alberta Utilities Commission released its influential "Alberta Smart Grid Inquiry[10]." The study provided information on smart grid and the Alberta context to inform policy and smart grid programs that would support the Provincial Energy Strategy[11]. The report concluded with five smart grid principles and recommendations to regulators, policy makers and utilities on developing and deploying smart grid.

ENMAX Energy is delivering a Micro Renewable Energy Program [12]for customers across Alberta that expands the utility product offering beyond standard commodities. Leveraging the strengths of the Climate Change and Emissions Management (CCEMC) Corporation, Climate Change Central (C3) and ENMAX, the program delivers immediate GHG reductions by reducing barriers to entry for

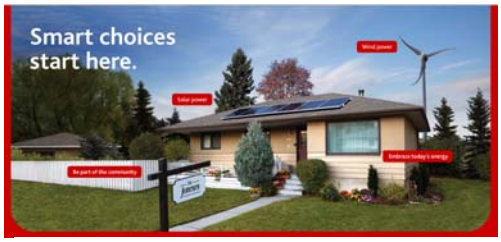

Figure 4: ENMAX Energy Micro Renewable Energy Program. (Source: ENMAX website www.generatechoice.ca)

[8] http://www.ontarioenergyboard.ca/OEB/_Documents/EB-2011-0004/EB-2011-0004_Staff_Discussion_Paper_20111108.pdf
[9] http://www.ontarioenergyboard.ca/OEB/Industry/Regulatory+Proceedings/Policy+Initiatives+and+Consultations/Energy+Issues+Relating+to+Smart+Grid/Smart+Grid+Working+Group
[10] http://www.auc.ab.ca/items-of-interest/special-inquiries/Documents/smart_grid/Alberta_Smart_Grid_Inquiry_final_report.pdf
[11] http://www.energy.alberta.ca/Initiatives/3082.asp
[12] http://www.generatechoice.ca

residential micro renewable technologies. ENMAX designed their customer engagement to in effect create 9000 residential ambassadors of renewable energy. The scale of this endeavor also stimulates a new industry for sub-trades and the renewable energy supply chain in the province.

British Columbia's Clean Energy Act in 2010[13] directed BC Hydro to install smart meters across the province by the end of 2012. In Québec, Hydro-Québec presented a business case for smart meters in the province and in fall 2012, received the required regulatory approval to proceed. In Saskatchewan, SaskPower is planning to deploy smart meters in the province by 2014.

British Columbia's BC Hydro launched an EV charging infrastructure demonstration project.[14] Building off of this project announcement, the utility plans to expand the project to 1000 charging stations across the province that are all grid aware. The project will test and demonstrate grid-aware capabilities and user control, while ensuring charging is from clean electricity resources.

Figure 5: BC Hydro EV charging station. (Source: BC Hydro website)

Figure 6: New Brunswick Premier David Alward delivers progress report for rebuilding energy sector. (Photo courtesy Government of New Brunswick)

New Brunswick Power and Siemens Canada have entered into a partnership[15] which includes the creation of a 10 year energy roadmap for the province. To complement the planning, Siemens has announced that it will establish a Smart Grid Centre of Competence in Fredericton.

Hydro-Québec's Voltage and var reactive power management (VVC) project proposal, CATVAR[16], was approved by the regulator. The deployment covers 130 distribution substations (2000 feeders) and will be completed in 2014. By the end of 2012, 15 substations will have VVC. At the project's completion 2 TWh of electricity will be saved annually. As Hydro-Québec's major distribution automation project, it stands almost completed with 85% of the 3600 automated switches now being installed to support network operation. In addition, Hydro-Québec's powered Circuit Électrique[17] is expanding with more institutional and private charging station available in the province. By the end of 2012, up to 150 stations will be available to EV owners.

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[13] http://www.leg.bc.ca/39th2nd/1st_read/gov17-1.htm
[14] http://www.bchydro.com/news/press_centre/press_releases/2011/vancouver_ev_charging_pilot.html
[15] http://www2.gnb.ca/content/gnb/en/news/news_release.2012.08.0775.html
[16] http://internet.regie-energie.qc.ca/Depot/WebPages/ProjectPhaseDetail.aspx?ProjectID=84&phase=1
[17] https://evnet.avinc.com/evportal/LecircuitElectrique/default.aspx

Table 2: Summary of Smart Grid Support Structures in Canada's jurisdictions

SMART GRID Highlights in Canada			
	Programs & technology deployment	**Stakeholder strategy, advice and government plans**	**Legislative and regulatory guidance**
Alberta	Interval (smart) metering of more than 60 % of energy consumed (>150 kW) Generate Choice, small solar and wind lease program for 9000 installations (ENMAX Energy)	Alberta Smart Grid Inquiry, prepared by Alberta Utility Commission (AUC) Wholesale DR Review to Alberta Electric System Operator (AESO)	
British Columbia	Smart Meters deployment by 2012		Part 5 of Clean Energy Act requires BC Hydro to implement smart meters and smart grid
New Brunswick		New Brunswick Smart Grid Summit, Report of Proceedings, Government of New Brunswick NB Power – Siemens agreement to develop 10 year roadmap for smart grid and build Centre of Competence for smart grid R&D.	
Nova Scotia		Renewable Electricity Plan, April 2010	
Ontario	Smart Meters deployed PeakSaver program Micro-FIT (Feed-in Tariff), distributed generation program $50M Smart Grid Fund to support pre-commercialization and capacity development for smart grid in Ontario Many demo sites (Hydro One, Toronto Hydro, Milton Hydro, PowerStream, Burlington, Hydro Ottawa, Chatham-Kent)	IESO 2nd Smart Grid Forum Report MaRS report on Smart Grid Innovation in Ontario Announcement of Clean Energy Institute to focus on storage and smart grid technologies in the beginning.	Green Energy and Economy Act Smart Metering Initiative Ontario Energy Board's Guidance for Smart Grid implementation (working group and reports) Privacy by Design, Information and Privacy Commissioner, Ontario

Quebec	Hydro-Québec VVO project's "Contrôle Asservi de la Tension et des VAR" (CATVAR) on 130 substation was approved and launched in 2012 Distribution automation program on 3600 switches and reclosers is 85% deployed Hydro-Québec's Smart meters project "Lecture à Distance" (LAD) was approved by the regulator in fall 2012		
Saskatchewan	Smart Meters deployed by 2014		
Canada	Clean Energy Fund ($146 M, 8 Smart Grid and storage projects) ecoEnergy Innovation Initiative ($97M, smart grid projects to be announced soon)	Smart Grids in the North American Context, policy leadership conference Report	Smart Grid Standards Roadmap for Canada

SMART GRID STANDARDS ROADMAP

The Canadian Task Force for Smart Grid Standards developed a roadmap that will support Canada's contribution to the development of smart grid standards in the North American and international networks. The Task Force was part of the Canadian National Committee (CNC) to the International Electrotechnical Commission (IEC). The Roadmap produced 17 recommendations, 3 of which are:

- The CNC/IEC should recommend the creation of a ***'Smart Grid Steering Committee'*** to coordinate and assist with the other recommendations contained in this *Roadmap*, work with other relevant standards policy bodies and technical committees, and periodically update the Roadmap.

- The CNC/IEC should support the creation of a Canadian technical **sub-committee for smart meters**, also encourage greater participation and support funding to other important technical committees.

- The CNC/IEC should recommend that Canadians stakeholders participate in the specification of Smart Grid cyber security requirements and standards within the US National Institute for Standards and Technology's (NIST) Smart Grid Interoperability Panel and **Cyber Security working group** to promote a harmonized North American approach to the extent possible.

SMART GRID AS A PAN-CANADIAN EFFORT

To facilitate opportunities for collaboration and coordination of effort across Canada, various organizations and groups are engaging stakeholders from across the country to develop tools and materials in support of smart grid development.

ENERGY MINES AND MINISTERS CONFERENCE

The Federal, Provincial and Territorial Energy and Mines Ministers meet annually at the Energy Mines and Ministers Conference (EMMC). The 2011 meeting in Kananaskis Alberta produced a series of areas of focus for ministries to collaborate on and produce recommendations for the following EMMC. Under the banner "Canada as a Global Energy Leader: Toward Greater Pan-Canadian Collaboration," one of the initial priorities for action leading to EMMC 2012 was smart grid. A Smart Grid Working Group was struck to deliver a document explaining smart grid and smart grid activities in Canada, and a synthesis report that proposed recommendations for collaboration on smart grid. Both will be released at the 2012 EMMC in PEI.

SMART GRID CANADA REPOSITORY

With support from NRCan, Smart Grid Canada designed and launched an online repository[18] to house the smart grid projects in Canada. This repository is intended not only to provide information on projects across the country, but also to provide support for designing future smart grid projects with various materials and networks available to future proponents. Projects are input and updated by the project leaders themselves, with other materials to be provided by the broader network of stakeholders in the smart grid industry.

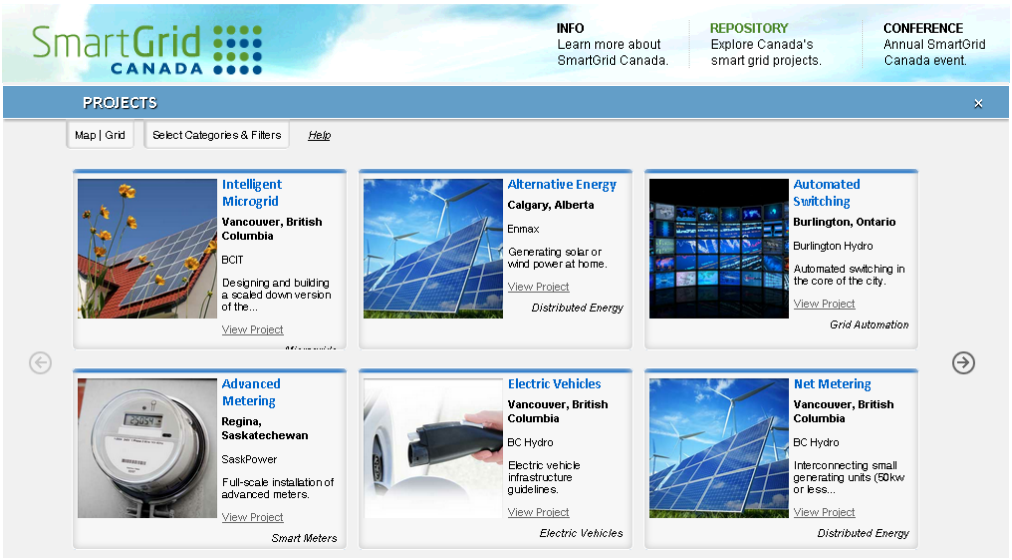

Figure 7: SmartGrid Canada smart grid project repository showing project details

[18] http://sgcanada.org/repository/

This repository was also a deliverable under the Canada-US Clean Energy Dialogue, as explained later in this report, in order to facilitate more collaboration on smart grid between our countries.

SmartGrid Canada is exploring pathways for future collaboration with the Repository with smart grid stakeholders provincially and internationally, including the Ontario Centres of Excellence, the US Smart Grid Information Clearing House, the European Joint Research Council and the International Smart Grid Action Network.

CANADA'S SMART GRID INDUSTRY

Canada's smart grid industry is building off of its strengths in science and technology, and its growing expertise in facilitating innovation. Many established companies are creating or expanding business lines to compete in this field. New start-ups attracted by supportive innovation environments and growing momentum in this field are emerging in the most active smart grid regions of the country. Clusters of technology companies can be found emerging in the following fields, with select start-ups highlighted in Table 3. Further information can be found on companies innovating in these fields from the MaRS Discovery District Innovation Showcase website[19] and report, Start-ups and the Smart Grid[20].

Table 3: Selection of smart grid start-ups in Canada

Company Name and Location	Innovation description	Funding Program/ Business Support	Project Partners
Advanced Metering			
Ecobee **Toronto Ontario**	Smart in-office displays with web based energy management system	Ontario Smart Grid Fund	Direct Energy Markham
Demand Response, Storage & Ancillary Services			
ENBALA **Vancouver BC Toronto Ontario**	The ENBALA Power Network manages the way electrical equipment uses power, giving the electricity system operator new ways to balance and provide quality to the electricity system.	MaRS, Ontario Smart Grid Fund	

[19] http://futureofenergy.marsdd.com/innovation-showcase/
[20] http://www.marsdd.com/news-insights/mars-reports/smartgrid-innovation/

MMB Research Inc. **Toronto Ontario**	RapidSE is a drop-in, automated ZigBee Smart Energy platform that allows OEMs to leapfrog application development, save time and cost, and deliver to multiple markets simultaneously.	MaRS	
Hydrostor **Toronto Ontario**	Underwater compressed air energy storage	SDTC, IDF, OCE, MaRS	Toronto Hydro University of Windsor
Network Monitoring & Automation			
dTechs **Calgary Alberta** **Toronto Ontario**	Grid monitoring & analysis package with low-cost, mobile remote sensor devices	MaRS, Ontario Smart Grid Fund	Oakville Hydro Cooper Power Systems Broy Engineering DLM Consulting Cornerstone Graphic Systems Inc. Rogers Communications
Prolucid Technologies **Mississauga Ontario**	Prolucid's grid technology is an "intelligent" distribution solution which includes data collection, monitoring and control for substations, feeders and distributed generation.	MaRS, Ontario Smart Grid Fund	Toronto Hydro National Instruments

Demonstrations and technology development consortiums are providing opportunities for these industries to partner during the planning and implementation phases of projects. Important lessons will be learned through these partnerships that should be communicated to the broader community.

Critical to the growth of these smart grid companies is the partnership with utilities and access to technology, business and market development supports. Utilities and smart grid technology developers are using a range of communication mechanisms to reach their customers, stakeholders and potential partners. A number of videos are now available online for Canadian projects and products, a few examples of which are provided here. BC Hydro produced a number of videos showcasing smart grid technologies and projects. Their CEF energy storage project [21] and smart meter benefits [22] videos help customers and stakeholders understand the

[21] http://www.bchydro.com/news/press_centre/press_releases/2011/battery_project_golden_field.html
[22] http://www.bchydro.com/energy_in_bc/projects/smart_metering_infrastructure_program/benefits.html

new capabilities of the grid that they will be able to benefit from. CanmetENERGY and the Ontario Ministry of Energy partnered to produce smart grid videos[23] that showcase the leadership of local distribution companies and their regional partners in smart grid in Ontario.

Figure 8: Smart Grid videos showcase leadership of PowerStream and Veridian with local industry.

T&D MAGAZINE SMART GRID ROADSHOW

The development of smart grid products and services is happening at the confluence of four professional industry sectors: electricity, IT, buildings and high-tech. As smart grid visions become articulated in jurisdictions across Canada, stakeholders from each of these industries are challenged to develop markets by engaging customers, creating integrated solutions, and informing regulatory and policy change.

CanmetENERGY organized a panel for T&D Magazine's Smart Grid Roadshow that explored these dynamics by asking panelists whether smart grid is breeding collaboration or competition in Canada. The panelists highlighted projects where they were collaborating across sectors on projects that included:

- smart meter deployment and customer engagement,
- increasing distributed generation through utility financing for residents,
- demand response programs in commercial retail with the system operator and local utilities,
- knowledge management for industry and stakeholder engagement.

In general, panelists agreed that currently the strategy is collaboration, and that it's happening to various degrees, led usually (but not always) by the electricity sector players. In the future it is hoped that enough players will enter into the smart grid space that more competition between players will lead to even greater results.

[23] http://canmetenergy.nrcan.gc.ca/news/varennes/3131

SMARTGRID CANADA

SmartGrid Canada continues to grow its membership with the goal of becoming the pre-eminent organization that is dedicated to maximizing the value of the smart grid in Canada. It delivers nationally and internationally on this goal through its four priority areas shown in Figure 9. The second annual SmartGrid Canada Conference will be held in partnership with the Independent Electric System Operator (IESO) in Toronto, October 2012.

In the past year SmartGrid Canada has been active presenting and publishing reports on smart grid progress and issues in Canada, provincially, nationally and internationally, and convening and supporting smart grid industry partnerships. The Global Smart Grid Federation Report[24] was prepared by SmartGrid Canada, which presented energy markets and project summaries from Australia, Canada, Europe, Great Britain, Ireland, Japan, Korea and USA, along with insights on public policy and technology pathways.

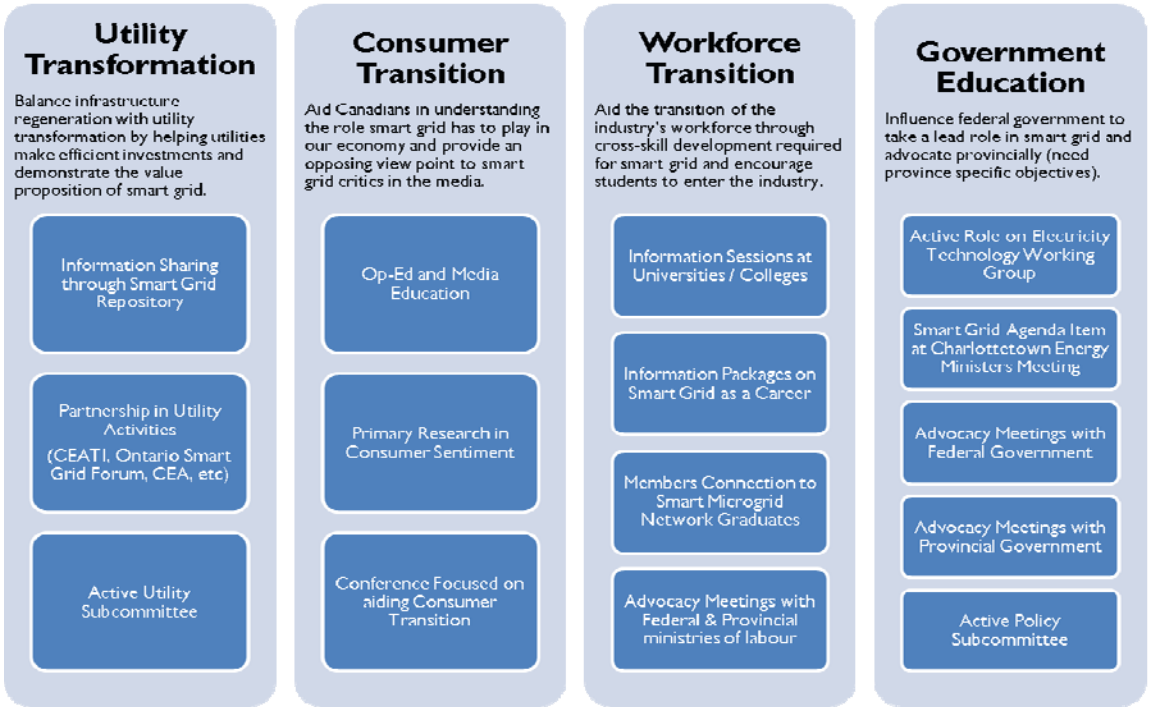

Figure 9: Four priority areas for SmartGrid Canada, courtesy SmartGrid Canada 2012

CANADIAN ELECTRICITY ASSOCIATION (CEA)

The CEA has long represented the voice of electricity business in Canada. As its members engage in smart grid projects, the CEA provides them with domestic and international industry outlooks, provides a forum for discussion of smart grid issues and engages government on issues to smart

[24] Published April 2012, retrieved from http://www.globalsmartgridfederation.org/documents/May31GSGF_report_digital_single.pdf

grid development. The CEA addresses key aspects of smart grid with the support of its working groups and committees in the following areas:

- CEA Metering Task Group: working with Measurement Canada to address many issues that have arisen from the widespread deployment of smart meters.
- EMF Task Group: tracking the radio frequency conversation across the country. Public officials across Canada have said that radio frequency from smart meters is not a public health concern.
- CEA Distribution Council: monitoring business, technology and customer trends closely, and serving as an industry forum for discussion.
- Other areas the CEA is actively engaged in include:
    - NIST Smart Grid Interoperability Panel 2.0 Business Plan
    - FERC / NERC concerns that smart technologies at the distribution level may collectively impact the bulk power system
    - Regulatory treatments of smart grid pilot projects

The CEA also released a discussion paper in 2010, "The smart grid: a pragmatic approach[25]." The paper discussed industry trends, presented a framework for smart grid capabilities, shared lessons learned from its members, and presented recommendations on a path forward for smart grid in Canada.

CENTRE FOR ENERGY ADVANCEMENT THROUGH TECHNOLOGICAL INNOVATION (CEATI)

Throughout 2011 and 2012, CEATI has been actively involved with smart grid initiatives through their Distribution Assets Life Cycle Management Interest Group (DALCM), their Power Quality Interest Group (PQIG), their Cyber Security Task Force (CSTF) and their Customer Energy Solutions Interest Group (CESIG). In early 2012, CEATI launched a Smart Grid Task Force (SGTF), which is a dedicated forum for electric utility professionals to share expertise and discuss experiences regarding Smart Grid technology deployments.

Through its webinar series, the SGTF has organized presentations and roundtable sessions on Distribution Management Systems, Integrated Volt/VAR Optimization and Distribution Sensing. Their upcoming annual meeting will focus on technical challenges associated with communications architecture, cyber security, asset management and cost-benefit analysis, distributed generation and energy storage integration, automation technology and the use of data analytics and IT in Smart Grid applications.

Other Smart Grid related projects CEATI has undertaken over the 2011/2012 period include:

- Secure Wireless Communication in the Electric Utility Industry
- Measurement and Verification of Demand Response Measures
- Low-Energy Climate Adapted Buildings and Technologies Study
- National Plug-in Electric Vehicle (PEV) Charging Infrastructure Deployment Guidelines
- Electric Vehicle Public Fast Charging Planning Framework

[25] http://www.electricity.ca/media/SmartGrid/SmartGridpaperEN.pdf

- Impact, Reliability and Operation of a Plug-in-Hybrid Electric Vehicle (PHEV)
- Energy Savings Potential Using Occupancy Sensors
- Distribution System Phasing using AMI and DSCADA Information-Phase II

CANADIAN MANUFACTURER'S ASSOCIATION (CMA)

The CMA is Canada's largest national industry and trade association. It runs the Energy Connections 2011-12 program, which aims to help companies throughout Ontario get involved in the growing energy sector. Through forums, workshops and tradeshows, the CMA engages its membership in effort to educate them about the energy industry and smart grid, accessing new markets with new business and supply chain opportunities. The CMA also advocates on behalf of its membership for Canadian supply chains supporting US markets.

RESEARCH NETWORKS

NSERC SMART MICROGRID NETWORK (NSMG-NET)

The NSERC Smart-Microgrid Research Network (NSMG-Net)[26] is a major five-year collaborative project between academia, industry, and government agencies. Established in 2010 with $4.6M in funding from NSERC and partner institutions, its goal is to advance knowledge in smart microgrids, vital building blocks in Canada's smart grid future.

Smart microgrids are self-contained electric power systems that are capable of providing power to its loads whether connected or disconnected from the larger bulk electric system. It has must potential, including enabling the increased adoption of renewable energy sources and thereby reducing greenhouse gas emissions; increasing system reliability and productivity through reductions in critical infrastructure outages; and opening cost savings through investment deferrals.

With the British Columbia Institute of Technology serving as the test-bed, ten professors and over 40 students will form the twelve research teams conducting NSMG-Net research. Additionally, eighteen (and counting) partner organizations are providing financial and in-kind support, providing material and advising on research directions.

NSMG-Net research will fall under three major themes:

1. Operation, Control, and Protection of Intelligent Microgrids
2. Intelligent Microgrid Planning, Optimization and Regulatory Issues
3. Intelligent Microgrid Communication and Information Technologies

The first theme is focused on developing power-related methodologies and technologies necessary to create and operate microgrids. Some issues that will be addressed in this theme are the control renewables in remote community microgrids; algorithms and communications necessary for power management; protection; and electric storage integration.

[26] http://www.smart-microgrid.ca/

In NSMG-Net's second theme, researchers are directing their attention to maximizing the benefit that can be realized from microgrid implementation. This work includes an exploration of ancillary services provisioned through microgrids; interactions between microgrids and the bulk electric system; demand response strategies; and performance metrics.

Research in the third theme is tasked with identifying and meeting the information and communication technology requirements of microgrids. Best practices for communication systems; quality of service requirements; integrated sensor networks; and data management are some of the many aspects that this theme will investigate.

Not only will Canada's scientific knowledgebase increase throughout the life of this project, but also the number of highly qualified personnel trained and ready to tackle the challenges of implementing Canada's smart grid.

SSHRC SMART GRID POLICY RESEARCH PARTNERSHIP

In April 2012 lead investigators Prof. James Meadowcroft[27] (Carleton University) and Prof. Ian Rowlands[28] (University of Waterloo) launched a national partnership for smart grid policy research and development. The partnership includes nine professors from five Canadian universities, working in conjunction with eight societal partners (from the utility, governmental, business and civil society sectors) and three collaborators at United States universities was formed earlier this year. This partnership is supported by the Social Sciences and Humanities Research Council of Canada through their 'Partnership Development Grants' competition, and extends until 2015.

Entitled 'Unlocking the potential of smart grids: a partnership to explore policy dimensions'[29], the partnership will build Canadian research capacity around the societal and policy dimensions of smart grids. In particular, it aims to:

- develop knowledge of the social, economic and political contexts of smart grid development in Canada;
- build an understanding of different societal perspectives on the emerging smart grid and of the controversies associated with its deployment;
- develop collaborative interactions among partner organizations and with other interested societal stakeholders to appreciate distinctive perspectives and concerns and to promote joint problem-solving in the smart grid realm; and
- analyze key public policy challenges related to smart grids, formulate alternative approaches, and provide tools for stakeholders and decision makers.

[27] jmeadowc@connect.carleton.ca
[28] irowlands@uwaterloo.ca
[29] https://uwaterloo.ca/sustainable-energy-policy/projects/unlocking-potential-smart-grids-partnership-explore-policy-dimensions

SMART GRID AS AN INTERNATIONAL EFFORT

The smart grid industry has a projected global value of $15-36 billion USD in the 2014 time frame.[30] For Canadian innovators in its universities, utilities and industries this represents a huge potential for market growth, economic growth and environmental benefit. To promote innovation and affordable costs for future electricity customers, countries are investing in opportunities to understand more about technologies being developed around the world, and international market opportunities. Activities include knowledge sharing, collaboration on R&D and demonstration projects and trade missions. Canada's federal and provincial governments support these activities through a number of mechanisms. International smart grid activities coordinated at a national level are listed here:

- International smart grid standards development (Standard Council of Canada, a crown corporation of the Industry Canada). This work was described in the sub-section on the Smart Grid Standards Roadmap for Canada.
- Asia-Pacific Economic Cooperation (APEC) workshops on regulatory approaches to smart grid, and research collaboration under the Energy Smart Communities Initiative (Natural Resources Canada – International Energy Division). http://esci-ksp.org/
- The Canada-US Clean Energy Dialogue (CED) is a collaborative mechanism to align our efforts on clean energy issues with the US, to reduce greenhouse gas emissions and address climate change. Provinces and stakeholders are engaged on smart grid issues primarily through the Electricity Grid Working Group (led by Natural Resources Canada - Electricity Resources Branch). www.climatechange.gc.ca
- The International Smart Grid Action Network (ISGAN) serves as a forum for cooperation and knowledge sharing between countries. It has now 6 major initiatives (called annexes) underway to facilitate learning, inform decision-making and promote collaboration across 22 countries. (Natural Resources Canada – CanmetENERGY). www.iea-isgan.org
- Canada science and technology agreements (Germany, Korea, China, India, Brazil, Israel) which have specific funding matched by both countries in the agreement to support partnerships between universities and industry (Natural Resources Canada, Department of Foreign Affairs and International Trade).

Highlights of Canadian contributions to these activities are included in the following sub-sections.

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[30] McKinsey (2010) "The smart grid opportunity for solutions providers," McKinsey on Smart Grid, Summer 2012. Retrieved Aug 2012 from: http://www.mckinsey.com/~/media/mckinsey/dotcom/client_service/EPNG/PDFs/McK%20on%20smart%20grids/MoSG_SolutionProviders_VF.ashx
Pike Research (2010) "Global Smart Grid Investment to Peak at $35.8 Billion in 2013." Retrieved Aug 2012 from: http://www.pikeresearch.com/newsroom/global-smart-grid-investment-to-peak-at-35-8-billion-in-2013

ASIA-PACIFIC ECONOMIC COOPERATION (APEC): REGULATORY APPROACHES TO SMART GRID INVESTMENT AND DEPLOYMENT

Interoperability standards have been recognized as an emerging regulatory issue for trade and investment in Asia-Pacific Economic Cooperation (APEC) countries. As such, in 2011 APEC Ministers and Leaders committed to remove unnecessary barriers to trade and investment in smart grid related to interoperability standards. In May 2012, Canada had the honour of hosting regulators and stakeholders from over 75 countries at the World Forum on Energy Regulation[31] in Quebec City. Following this event the APEC Subcommittee on Standards and Conformance held a workshop on Regulatory Approaches to Smart Grid Investment and Deployment[32].

During this workshop, prominent members of the regulatory and standards communities addressed issues of hype that often surround smart grid deployment. Smart grid "hype cycles" have been widely recognized[33] in jurisdictions world-wide and Canada jurisdictions are no exception. Regulatory, political and standards bodies hold key roles in communicating to customers and managing expectations for smart grid. In this respect it was framed as critical that the typical silos between technology and policy disciplines be broken down to avoid costly inefficiencies and unnecessary public unease with smart grid development.

Ms. Lise Duquette, chair of Canada's Energy and Utility Regulators (CAMPUT) delivered the first keynote address. She called for increased communication between regulators and standards makers in order to connect the standards issues of safety and performance to the regulatory issues of technology reliability, affordability, lifecycles and return on investment.

CANADA-US CLEAN ENERGY DIALOGUE (CED)

The Canada-US Clean Energy Dialogue[34] (CED) supports efforts to build a low-carbon economy in Canada and the USA. Three working groups deliver on the priorities of the Action Plan. Smart grid activities fall under the responsibilities of the Electricity Grid Working Group, with the relevant priority themes highlighted below:

1. Setting the Scene for Offshore Renewable Energy Technologies Deployment
2. **Advancing Smart Grid Technologies**
3. **Realizing the Potential of Power Storage Technologies**
4. Increasing Opportunities for Trade in Clean Electricity"

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[31] http://www.worldforumv.org/cms/

[32] Report on 2012 APEC workshop on Regulatory Approaches to Smart Grid Investment and Deployment: http://publications.apec.org/publication-detail.php?pub_id=1298

[33] For examples see: Canadian Electricity Association (2010) *Smart Grid: A pragmatic approach*. Retrieved September 2012 from: http://www.electricity.ca/media/SmartGrid/SmartGridpaperEN.pdf
See also: Price Waterhouse Coopers (2010) *Smart from the start: managing smart grid programs.* Retrieved September 2012 from: http://download.pwc.com/ie/pubs/smart_from_start.pdf

[34] http://www.climatechange.gc.ca/dialogue/

In the past year Canada contributed to the following smart grid initiatives under this working group:

- Smart Grid Policy Leadership Forum: in January 2011 government and industry leaders discussed key policy issues raised by the transition to a smart electric grid.
- Smart Grid Standards Task Force: created by NRCan to provide Canadian input into standardization efforts of the US National Institute of Standards and Technology (NIST).
- Foundation papers: created by the working group to examine policy and regulatory issues associated with energy storage, the smart grid and renewable portfolio standards.
- Smart Grid Repository: hosted by SmartGrid Canada, this repository complements the US Smart Grid Information Clearinghouse to facilitate shared knowledge between project partners.

In June 2012 the Canada-US Clean Energy Dialogue Action Plan II[35] was released. It calls more specifically for continued work in the following areas:

- Focus on collaboration through knowledge exchange, sharing best practices, particularly on consumer awareness and engagement through experiences such as Ontario's time-of-use pricing and the US Smart Grid Consumer Collaborative.
- Create common codes & standards between jurisdictions (NIST, Smart Grid Standards Roadmap).
- Fund smart grid R&D and demonstration projects domestically.

INTERNATIONAL SMART GRID ACTION NETWORK (ISGAN)

The International Smart Grid Action Network (ISGAN)[36] is an International Energy Agency (IEA) co-operative program on smart grids. Created by the Clean Energy Ministerial (CEM)[37] during its 2010 meeting, ISGAN reports annually on the deliverables that it was tasked with in its creation. Its 22 member countries produce and share knowledge through government-to-government collaboration on 6 Annexes of work. The Annexes focus on supporting smart grid practitioners with information and tools for project and policy design, analysis and implementation. Canada is actively participating in 3 of the Annexes (indicated by bold face font):

Annex 1: Inventory of policy drivers and technology projects
Annex 2: Case study of smart grid demonstration and pilots
Annex 3: Benefit & Cost evaluation and toolkits
Annex 4: Insights for decision-makers
Annex 5: Smart Grid International Research Facility Network (SIRFN)
Annex 6: Power Transmission and Distribution Systems

Canada's participation in these Annexes is driven by voluntary effort from smart grid stakeholders. The national experts representing Canada are from SmartGrid Canada,

[35] http://www.climatechange.gc.ca/dialogue/default.asp?lang=En&n=B0A0569E-1
[36] http://www.iea-isgan.org/
[37] http://www.cleanenergyministerial.org/

CanmetENERGY and Ontario Ministry of Energy for Annexes 1, 2 and 4 respectively. The Canadian effort is represented on the ISGAN steering committee by CanmetENERGY.

In the last year Canada produced the following materials under ISGAN to serve domestic and international audiences:

Annex 1: Inventory of Technology & Policy Drivers

- Policy Drivers: 1 survey for Canada (Ontario). Based on Ontario Ministry of Energy public documents.
- Technology Project Inventory: Canada provided a list of projects representing a range of applications.

Annex 2: Smart Grid Case Studies

- Three Case Studies from Canada:
  - A Self-Healing Grid - PowerStream automated feeders & SCADA system[38]
  - Distribution Automation - Hydro-Quebec automated & remote controlled switches
  - Smart Meter Deployment - Ontario smart meters & time-of-use

Annex 4: Tools for Smart Grid Decision Makers

- White Paper prepared by the US National Renewable Energy Laboratory (NREL) & CanmetENERGY "*Smart Grid contribution to variable renewable resource integration*"[39]
- Smart Grid Videos showcasing smart grid projects from Ontario distribution companies PowerStream[40] and Veridian,[41] communicating smart grid vision and benefits to the customer.

CANADIAN BILATERAL AGREEMENTS, COLLABORATION AND MISSIONS

Canada has agreements and relationships with several countries which provide increased opportunities for international trade and collaboration between smart grid stakeholders. A summary of recent agreements relative to smart grid are included here:

[38] http://canmetenergy.nrcan.gc.ca/renewables/smart-grid/publications/3138
[39] http://www.iea-isgan.org/b/Media/276
[40] http://canmetenergy.nrcan.gc.ca/videos/3122
[41] http://canmetenergy.nrcan.gc.ca/videos/3126

DEPARTMENT OF FOREIGN AFFAIRS AND INTERNATIONAL TRADE (DFAIT) SMART GRID MISSION

DFAIT lead a smart grid mission to China June 2012. The main objective of that mission was to introduce the strong capabilities of Canadian companies and institutions which are involved in various aspects of smart grid technologies to potential Chinese partners. The delegation was made up of twelve members from five Canadian provinces, SmartGrid Canada, universities, utilities, and companies.

Figure 10: DFAIT smart grid mission to China. (Photo courtesy of DFAIT.)

The mission recruited Canadian stakeholders that have developed technologies and/or engaged in research in a wide range of smart grid technologies such as demand response management, energy storage, EV integration and volt/var optimization, among others. The mission focused on business-to-business (B2B) matchmaking and discussions with the Chinese power sector to understand the growing Chinese market. The partnering seminar from the 1st day of the mission attracted more than 120 potential Chinese representatives from a variety of disciplines, which many of whom participated in the follow-up B2B matchmakings with our Canadian delegates

For DFAIT smart grid is a major focal point now. The 2012/13 business plan contains a similar mission to Europe to take place later on in the fall of 2012 and similar activities with Brazil/Chile and San Francisco/ San Diego by spring 2013. DFAIT continues to look for other areas to focus on relevant to smart grid through its missions and the "Going Global Innovation" Program[42] which provides innovation seed funding for future initiatives.

PROSPECTS FOR SMART GRID IN CANADA

Smart grid is more than a modernization of transmission and distribution network infrastructure. It represents infrastructural and institutional integration between the energy systems that Canadians depend on. Through strategic investments in relevant areas of smart grid technology and design, Canadians will be able to benefit from more efficient and sustainable energy systems.

This is an exciting time for Canadian industries engaged in smart grid! Opportunities for the alignment of public policy and business strategy are opening up across Canada's provinces and internationally. As such, Canada's strengths in research, science and technology can be supported in ways that facilitate the local transition to smart grid in Canada's provinces, and facilitate economic growth in the smart grid technology sectors through domestic and international market opportunities.

It is important that throughout this period stakeholders are informed and engaged. Shared smart grid visions need to be created and expectations managed. Without a close engagement between technology and policy development a number of messages can be confused and effort

[42] http://www.tradecommissioner.gc.ca/eng/funding/ggi/ggi.jsp

spent inefficiently. Important foundations are being laid in this respect, in the technical and regulatory infrastructure as provinces connect stakeholders in a strategy for smart grid.

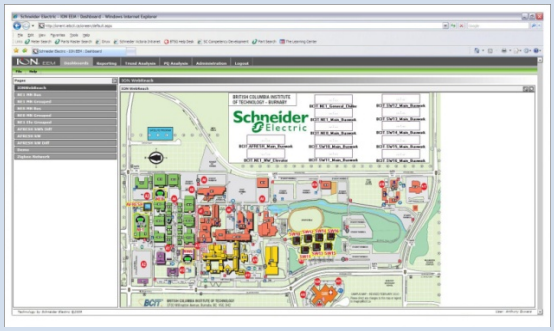
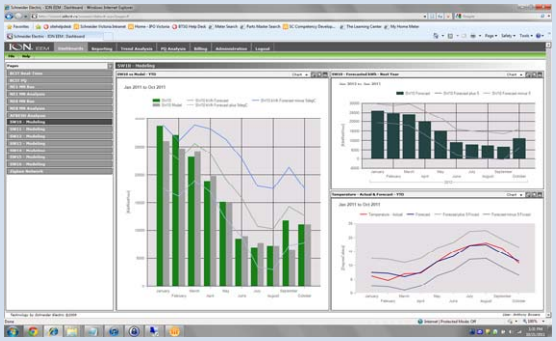
Canada is already contributing to the global growth in the smart grid market with technologies, infrastructure renewal and new energy markets and business models. The 2011 Clean Technology Report[43] estimated that the smart grid industry in Canada claimed $319 million in revenues in 2010, which is forecast to grow between $520 million to $2.1 billion by 2020. This represents some important trends and opportunities for building Canada's smart grid industry.

Moving forward it is important that Canada's smart grid stakeholders continue to coordinate efforts, particularly in areas of codes and standards development, discussions on energy and innovation policy and market mechanisms, knowledge sharing through case studies and cost-benefit analyses of smart grid investments, and collaboration on technology research, development and demonstration.

[43] Analytica Advisors (2010), The 2011 Canadian Clean Technology Industry Report. Ottawa.

APPENDIX A – SMART GRID HIGHLIGHTS

Table A-4: NRCan Clean Energy Fund Project Highlights

Project	Progress Highlights
Power Measurement Ltd. (Schneider) - Energy Management Business Intelligence Platform – Renewable Energy and Customer Use Capability Development and Demonstration  BCIT Campus meter locations. Image courtesy of Schneider Electric.  Consumption Forecasting Based on Temperature for BCIT. Image courtesy of Schneider Electric.	Power Management has released the new version of their SPM software which is now available in the market. The new software platform provides easy to implement user dashboards; it allows demonstration partners improved process modeling capabilities and better tools for energy management either through energy conservation or through demand response. "Asset Management" module has been completed, which allows dedicated meters to be assigned to major machinery in order to provide asset performance information and maintenance warnings. This has the ability to reduce costs related to poor performance, maintenance and repair, and potential equipment failure. Consumption forecasting model installed at BCIT site. Human interface gadgets designed for onsite generation and storage. The 5kW wind turbine installed at BCIT has also generated 13MWh of clean electricity.

BC Hydro – Energy Storage and Demand Response for Near-Capacity Substation

Project information video available online[44].

Illustration of battery service for substation and community. Image taken from BC Hydro project information video.

All permitting and planning completed, Golden substation has been upgraded in preparation for the battery installation with some work remaining on the distribution controls system.

The battery manufacturer called for a hold on the project until investigations into a fire with one of its batteries at another location could be completed. Additional safety reviews for project conducted leading to a replacement in battery modules with new safe design and revised specifications. Project will resume with equipment installation at the Field location, addressing any implications on this project accordingly.

Electrovaya – Utility Scale Electricity Demonstration using New and Repurposed Lithium Ion Automotive Batteries

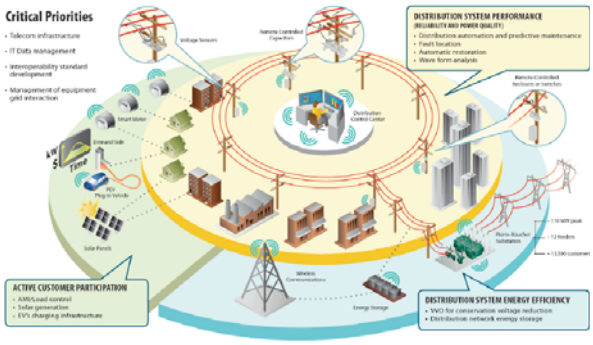
Electrovaya modules. Image retrieved from Electrovaya website[45].

Energy storage system design completed. Confirming site location to finalize design and begin manufacture. Models and preliminary software have been developed, and tests have been conducted on some of the system components at the high-voltage DC lab.

[44] http://www.bchydro.com/news/press_centre/press_releases/2011/battery_project_golden_field.html

[45] Retrieved July 2012 from http://www.electrovaya.com/products/other/modules.aspx

Hydro Québec – Interactive Smart Zone Demonstration



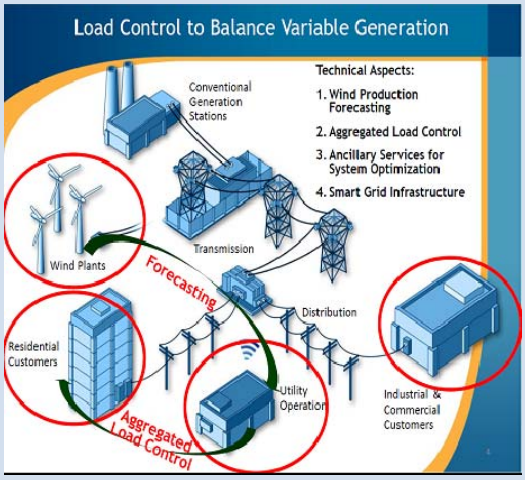
Hydro-Québec Smart Grid Zone. Image courtesy Hydro-Québec.

Measurement technology facilities within the distribution network have allowed Hydro-Québec to understand load behaviour and to calibrate voltage settings and reactive power settings. Voltage levels at various work stations are now controlled by these measurements throughout the network operating software via a dynamic voltage control system. As of February 2012 60% of the target (2% energy savings) have already been reached.

Electric vehicle charging stations were acquired in order to assess performance under real-world weather conditions and laboratory tests. Also, a simulation tool was developed, allowing Hydro-Québec to evaluate the impact of electric vehicle charging on the distribution network in terms of energy and power. Forty seven charging stations are installed and thirty electric vehicles are on the road.

A call for proposals for next-generation meters was issued. 5800 smart meters were installed as part of the advanced metering infrastructure (AMI). These meters will become the interface between the network and the customer and enable the gradual introduction of new features for energy management. A 'Meter Data Management System' (MDMS) has been implemented.

NB Power – PowerShift Atlantic



PowerShift Atlantic concept diagram. Image courtesy NB Power.

Wind farm in PowerShift Atlantic project. Image courtesy Michael Losier from [2010 Quest Canada ICES Conference presentation][4].

The PowerShift Atlantic Consortium, led by New Brunswick Power is demonstrating a smart grid application that enables load management for wind balancing. The solution developed is called a Virtual Power Plant (VPP).

A VPP has the ability to manage loads to provide all sorts of services to the power system. This Virtual Power Plants aims to provide "ancillary services" such as load following and spinning reserve.

New forecasting and estimation algorithms are being developed. Core component and interfaces for the VPP are now completed. The VPP is currently in the commissioning stage, with one VPP and two aggregators running and metrics, such as energy and dollars saved and GHG emissions reduced will be forthcoming in the following quarters and years.

A survey of residential participants in the program showed that 80% are very satisfied with their experience in the program.

Cowessess - Wind and Storage Demonstration in a First Nations Community

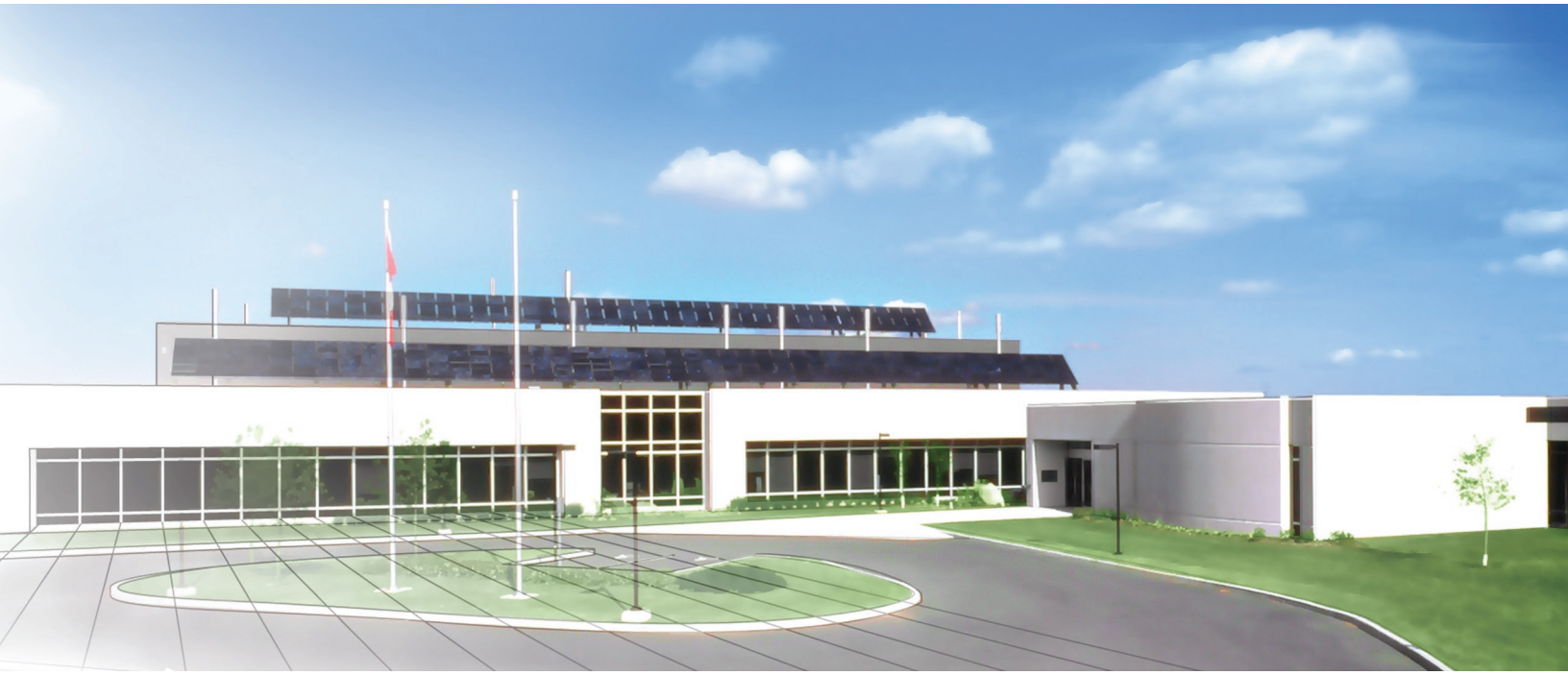
Cowessess First Nation, Enercon, SaskPower and NRCan are finalizing the details of this project. This project involves installing an 800-kW wind turbine and 1000-kWh lithium-ion battery storage system on Cowessess First Nation (CFN) land 2-km southeast of Regina, Saskatchewan. The intent is to demonstrate a wind-storage system that can harness wind power and provide a more continuous and predictable output for on-grid and perhaps off-grid applications. The successful demonstration would prove this system as a model for other First Nation's communities across Canada.

WEICan - 10 MW Wind Technology Research and Development Park

Conceptual image of WEICan's wind farm in PEI. Image retrieved from: http://www.nrcan.gc.ca/energy/science/programs-funding/2052

The Wind Energy Institute has installed and commissioned three of the five 2MW turbines for a total of 6MWe installed and commissioned as of March 31, 2012. As the turbines were commissioned in early 2012, they have generated 1.2MWh of electricity this year. The numbers for next year are expected to be higher. Since the turbines were installed in PEI, which uses primarily coal as its electricity generator, WEICan has estimated it has reduced CO_2 emissions by 628t using the NB Grid for its emissions factor.

LIST OF ACRONYMS	
AMI	Advanced Metering Infrastructure
APEC	Asia-Pacific Economic Cooperation
BCIT	BC Institute of Technology
CATVAR	Contrôle Asservi de la Tension et des VAR
CEA	Canadian Electricity Association
CEATI	Centre for Energy Advancement through Technological Innovation
CED	Canada-US Clean Energy Dialogue
CEF	Clean Energy Fund (NRCan)
CMA	Canadian Manufacturing Association
CNC	Canadian National Committee (to the IEC)
DFAIT	Department of Foreign Affairs and International Trade
DLC	Direct Load Control
DR	Demand Response
EMF	Electromagnetic Field
EMMC	Energy & Mines Ministers' Conference
EV	Electric Vehicle
FDIR	Fault Detection, Isolation and Restoration
FERC	Federal Energy Regulatory Commission
FIT	Feed-In Tariff
GHG	Greenhouse Gas
IDF	Innovation Demonstration Fund (from the Ontario Ministry of Economic Development and Innovation)
IEC	International Electrotechnical Commission
IESO	Independent Electricity System Operator (in Ontario)
ISGAN	International Smart Grid Action Network
IT	Information Technology
NERC	North American Electric Reliability Corporation
NIST	National Institute of Standards and Technology
NRCan	Natural Resources Canada
NSERC	Natural Sciences and Engineering Research Council
NSMG-Net	NSERC Smart-Microgrid Research Network
OCE	Ontario Centres of Excellence
OEB	Ontario Energy Board
PI	Planned Islanding
SDTC	Sustainable Development Technology Canada
SSHRC	Social Sciences and Humanities Research Council
TOU	Time-of-Use pricing
VPP	Virtual Power Plant
VVC	Voltage and VAR (reactive power) Control



CanmetENERGY

www.canmetenergy.nrcan.gc.ca