

STIMULATING INNOVATION ON BEHALF OF CANADA'S ELECTRICITY AND NATURAL GAS CONSUMERS

2015 UPDATE

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SECTION 1:

EXECUTIVE SUMMARY

As discussed in our [August 2014 report](#) innovation in the natural gas and electric utility industries promises benefits for customers in the form of improved reliability, energy cost savings, environmental benefits, and economic growth. An increased commitment to rate-payer funded innovation by utilities will support the testing and deployment of new technologies, products and services with associated business processes and models that deliver value to customers. The advances could include more efficient end-use equipment, low-emission customer-sited generation, energy storage, integrated gas/electricity solutions like micro combined heat and power, and a “smart energy network”¹ that integrates emerging technologies in a way that preserves the reliability and resiliency of the distribution system. Such innovations can provide cleaner and less expensive energy services to Canadian households and businesses while creating jobs, bolstering Canadian competitiveness, and promoting Canada’s position among global energy leaders.

Our 2014 report offered a framework to consider the roles for government, utilities and other private-sector entities in innovation. We examined the roles that Canada’s utilities and regulators can play to promote innovation, particularly where the public benefits from innovation are large enough to justify public funding and where the financial rewards for the private sector are not large enough to compensate for development risks. Ratepayer funding can be used to unlock and leverage funding from public and private sources that can be combined to ensure that customers benefit from research, development and deployment (RD&D) activities in the utility industry.

This 2015 Update presents regulatory and other current drivers of innovation in the electric and natural gas industries, and the challenges that will be faced by utilities (focusing on the distribution segment). Concentric presents several case studies organized into three distinct categories: (1) new innovation programs that have been announced within this past year, (2) new projects that have received funding, and (3) results of demonstration or other innovation efforts that have been recently completed. The case studies provide a deeper dive into specific financing sources, approaches and expected benefits from these programs or projects.

The innovation projects are sponsored by utilities and public entities that solicit, screen, select and fund energy-related R&D and innovation project proposals. Our research focused on jurisdictions – both in the United States and abroad – with histories of progressive approaches towards energy innovation and technology initiatives. It is evident that policymakers and regulators are taking an active interest in the role of innovation to address the daunting objectives of cleaner, more resilient, and cost-effective utility services. Many of the public and ratepayer-funded programs we cite remain in their formative stages, so the results are just starting to come in. Innovation by its nature is riskier than business as usual, so not all projects will be successful. Nonetheless, it will be important for policymakers, regulators and utilities to demonstrate tangible consumer benefits as these programs mature, even if substantial portions of these benefits spill over into the broader public domain.

SECTION 2:

2015 EMERGING INDUSTRY TRENDS

Whether viewed through the lens of cutting-edge product and service development or the imaginative retooling of companies' internal organizational and operating cost strategies, innovation drives competitiveness and inspires an atmosphere of workplace creativity. It's hard to imagine a company that would argue an innovative mind-set is not crucial to enterprise success.² – The Funding of Innovation in Canada

The focus of utility innovation at any particular point in time is driven by the major industry drivers. The current drivers include evolving regulatory models, economic goals, environmental and sustainability goals, market forces, and technology advances. Advancements in information technology and the ability to manage “big data” present both opportunities and challenges with respect to cyber security and the privacy of customer data. Safety also remains of paramount importance in both the natural gas and electricity industry.

In the electric industry, the “utility-of-the-future” concept has gained considerable momentum throughout the United States over the past year as the conversation has evolved from a relatively narrow focus on the increasing proliferation of roof-top solar and the impact of controversial “net metering” policies, to a broader discussion of whether electric distribution utilities will be transformed into grid “platforms” that enable the integration of all forms of distributed electricity energy resources (defined broadly to include distributed generation, storage, energy efficiency and microgrids) and provide transactional services to customers and third-parties. Interest in the utility-of-the-future is being driven by many of the same industry drivers, including goals to reduce the environmental footprint and improve end-to-end efficiency in the energy sector. Information and emerging energy technologies are key enablers as the cost of distributed and renewable generation are becoming more competitive and there is a concomitant need to monitor and control flows on the distribution network to be able to accommodate more of these resources while maintaining power quality and reliability. Energy storage, as it becomes more economical, is a potential contributor to the overall efficiency of the electric system by improving load factors throughout the supply chain and on customer premises.

The natural gas industry will contribute to a more efficient energy future as electricity and natural gas infrastructures and markets become increasingly integrated throughout the supply chain and include retail markets. Equipment manufacturers are responding to evolving market needs by developing more efficient natural gas end-use equipment that can take advantage of the current affordability of natural gas across North America. The potential efficiency benefits are becoming increasingly apparent to commercial and industrial customers that are candidates for combined heat and power (CHP) applications. There are other potential benefits of innovation that focus on the natural gas distribution network including enhancements to safety, reductions in methane emissions, and more efficient pipeline inspection and repair processes. As in the electric industry, there are opportunities to improve asset management, maintenance, and asset replacement processes through new data, systems and processes.

One of the building blocks of this new future is customer engagement and interest in new energy products and services that may be provided either by the utility or by third parties or by both

working together as partners. This requires innovation and testing of new business models and new roles to be served by regulated distribution utilities. Ultimately, the ability to achieve the promises of this technology-driven future will depend on the ability of all stakeholders, including utilities, regulators, governments, and unregulated third party vendors to provide what customers want and value. This value includes the imperative that reliability, resiliency, security and safety of electric and natural gas distribution networks be maintained throughout any transition in business models and regulatory frameworks.

REGULATORY AND GOVERNMENT INITIATIVES

Not surprisingly, governments and regulators that are focused on utility-of-the-future business models recognize the importance of innovation in the utility sector and are including demonstration projects that will be funded by customers as an integral component of new regulatory frameworks. The imperative to move beyond “business as usual” utility models frames their discussion. This interest is prompted by major investments that will be required to add functionality to the distribution networks and by a recognition that these investments will not produce the desired efficiency gains if customers are not engaged. Innovation efforts by a utility enable it to evaluate emerging technologies and make informed investment decisions regarding those technologies.^{3,4} Customer engagement is particularly important where the efficiency gains derive from “distributed energy resources” or “DERs” that include energy efficiency, demand response, acceptance of time-varying rate structures, distributed generation, and customer-sited energy storage.

The interest in new business models and regulatory frameworks in the United States follows the lead being set in the United Kingdom by the Office of Gas and Electricity Markets (“Ofgem”). Ofgem has implemented its latest iteration of incentive-based ratemaking (termed the Revenue = Incentives + Innovation + Outputs, or “RIIO,” model) for gas and electric transmission and distribution companies, and the most recent framework includes new elements to foster innovation.⁵ Ofgem recognized that even within the new incentive-based ratemaking framework, “research, development, trials and demonstration projects - the earlier stages of the innovation cycle - are speculative in nature and yield uncertain commercial returns.”⁶ Ofgem noted that the innovation stimulus is intended to “kick start” a cultural change at utilities.⁷ Innovation funding is provided by customers since they will benefit from innovations.⁸

Interest in the utility-of-the-future has gained considerable steam in the United States over this past year. Three states are proceeding to consider changes in business models and regulatory frameworks in a comprehensive manner: California, Massachusetts and New York. Notably, each of these states has either made a major commitment to innovation and customer-funded demonstration projects or is working on a process for doing so. New York has received the most attention over the past year and is thus the subject of one of the case studies. As discussed in the case study, New York is particularly interested in testing new business models and for utilities to work collaboratively with third parties to engage customers as an integral element of its ambitious “Renewing the Energy Vision” or “REV” policy proceeding.

Two other states are addressing many of the same issues: Hawaii and Minnesota. Hawaii is a unique case because of its archipelago cluster and the fact that it is not connected to a broader regional or super-regional energy infrastructure.

The Canadian jurisdictions have not yet generated as much attention with respect to utility-of-the-future, but many are engaged in smart grid development and more targeted activities. Ontario's Smart Grid Fund, sponsored by the Ontario Minister of Energy, is a case in point, as is Alberta's Energy and Environment Solutions and Innovates - Technology Futures programs. Ontario reorganized the broader role of innovation in the Ontario Energy Board's recently adopted "Renewed Regulatory Framework for Electric Distributors" where it found:

The Board's incentive regulation approach to rate-setting creates incentives for distributors to innovate in order to operate within the price cap while continuing to meet the needs and expectations of their customers. The Board will further consider incentives directed at innovation to address system and customer requirements. While this work should consider the Board's current policies as set out in the Report of the Board on the Regulatory Treatment of Infrastructure Investment for Ontario's Electricity Transmitter and Distributors, the Board expects that new approaches may be required.⁹

Canada's innovation model has tended to rely as much, if not more, on RD&D programs that are sponsored by national agencies. Natural Resources Canada (NRC) and Sustainable Development Technology Canada (SDTC) are both active in promoting and funding energy innovation projects. The Atlantic Canada Opportunities Agency is active on a regional basis.

While our research update does not attempt to add up the total electric and gas sector related funding for innovation, the number and scope of programs suggest these levels are increasing, in response to the drivers we mention at the outset.

SECTION 3:
SELECTED CASE STUDIES

In this update, the following case studies were selected to illustrate new programs, increases in funding for existing programs, or newly funded projects.

RD&D Programs

1. New York Renewing the Energy Vision (“REV”) Demonstration Projects
2. Ofgem Network Innovation Competitions (“NICs”) for Electricity
3. Ofgem Network Innovation Competitions (“NICs”) for Gas
4. U.S. Department of Energy Natural Gas Modernization Initiative

RD&D Projects

1. Energy Efficient Data Centre Interconnect
2. Energy Storage Innovation for Electric Vehicles In Ontario
3. Innovative and Cost-Effective In-Line Leak Detection Tool for Gas Pipelines

RD&D Results

1. Economical Dispatch Of Combined Cooling, Heating And Power (“CCHP”) Systems With Emissions Constraints, And Thermal Load Following Capability
2. Customer-led Network Revolution (“CLNR”) Project

Funding mechanisms for the case studies are specific to each program. Ratepayer funding supports the programs cited for the New York Public Service Commission, Ofgem (UK), the U.S. Department of Energy (partially with the FERC levy on pipelines), the California Energy Commission and the Province of Ontario (50% born by ratepayers). Government funding also supports the programs of the DOE, Sustainable Development Technology Canada (“SDTC”), and the Province of Ontario. Third party co-funding is also utilized by Ofgem, the California Energy Commission, the Province of Ontario, and the SDTC programs.

Program Sponsor	Funding Mechanism		
	Ratepayer Funded	Government Funded	Third Party Co-funded
New York Public Service Commission ¹			
Ofgem			
U.S. Department of Energy			
California Energy Commission			
Province of Ontario			
Sustainable Development Technology Canada			

¹ Third party co-funding is aspirational.

CASE STUDIES:

RECENT RD&D PROGRAMS

PROGRAM CASE STUDY 1:

NEW YORK RENEWING THE ENERGY VISION (“REV”) DEMONSTRATION PROJECTS

- Sponsored by the New York Public Service Commission (“NYPSC”)
- Funding – The annual revenue requirement impact of ratepayer-funded demonstration projects is capped at 0.5% of annual delivery revenues

Problem Being Addressed

The NYPSC is of the view that the success of its REV initiative depends to a significant degree on the ability of utilities to work together with third party “energy entrepreneurs” to develop new business models. Demonstration projects are expected to help inform investment decisions with respect to these new functions and test the customer responsiveness to new products and services, including pricing and delivery aspects. They may also be relied on to test the application of new technologies that appear ready to be deployed but would benefit from a demonstration project before they are implemented at scale across the utility service area. Customer engagement is a key objective and necessary in order to achieve the Commission’s vision of a proliferation of customer-sited distributed energy resources.

Approach

As specified in a February 26, 2015 “Track 1” Order in the REV policy proceeding, each of the four investor-owned utilities are required to file demonstration projects by July 1, 2015 and may supplement these initial filings after that date with new proposals.¹⁰ The Commission has specified eight criteria by which it will evaluate utility proposals:

- Demonstrating Innovation – Diversity of projects in the demonstration portfolio;
- Value Distribution – Allocation of project benefits among customers, utilities and third parties;
- Partnerships – Between utilities and third parties;
- Customer Engagement – Response to DERs across the spectrum of customers;
- Market Solutions – Enabling participants to propose solutions through competitive solicitations;
- Developing Competitive Markets – Testing rules that will further the development of new markets;
- Cyber Security – Developing data security standards and protocols; and
- Scalability – The ability to accelerate development at scale.¹¹

Anticipated Value

Ideally, it is desired that these new business models will result in new and substantial transaction fee-based revenue streams for both third parties and the utilities, and thus help finance utility investments that will be required to add new functions to be performed by the utility as the Distribution System Platform (“DSP”).

PROGRAM CASE STUDY 2:

NETWORK INNOVATION COMPETITIONS (“NICs”) FOR ELECTRICITY¹²

- Sponsored by the UK Office of Gas and Electricity Markets (“Ofgem”)
- Funding - The Electric NIC will run annually from April 2013 – March 2023 and a maximum of £27m (\$50 million Canadian) will be available each year for the purposes of the competition. A further £3m will be set aside each year for the Successful Delivery Reward. Network Licensees may apply for this once they have successfully completed their Project.

Problem Being Addressed

A Network Licensee is the holder of an Electricity Transmission Licence, i.e., the National Electricity Transmission System Operator (NETSO), a Transmission Owner (TO) or an Offshore Transmission Owner (OFTO). There are also eight Distribution Network Operators (DNOs): Electricity North West; ESB Networks; Northern Ireland Electricity; Northern Powergrid; SP Energy Networks; SSE Power Distribution; UK Power Networks and Western Power Distribution.

The National Electricity Transmission System (NETS) is facing a number of challenges over the coming years. These include:

- Managing the technical challenges associated with an increasing level of intermittent generation connecting to the NETS;
- Managing the increasing impact of distributed resources and active demand on the NETS; and
- New sources of generation connecting to the network in areas far from consumption centres.

These challenges will directly affect the way transmission companies plan and manage their businesses. Network Licensees will need to innovate in the way they design, plan, and operate their networks. The Electricity NIC is designed to help stimulate this innovation and encourage Network Licensees to undertake trials to address these challenges in the most cost-effective way. Network operators will gain understanding from these trials, which they will then be able to apply to the specific challenges they face. This could potentially bring environmental benefits and cost savings to electricity customers in the future.

Approach

As part of the RIIO price controls introduced in 2012, Ofgem established a Network Innovation Stimulus. Electric transmitters were eligible beginning in 2013; distributors are eligible beginning in 2015. The innovation stimulus consists of three measures:

- A Network Innovation Competition (NIC) – An annual competition to fund selected flagship innovative Projects that could deliver low carbon and environmental benefits to customers.
- A Network Innovation Allowance (NIA) – To fund smaller innovation projects that can deliver benefits to customers as part of a RIIIO-Network Licensees price control settlement. The NIA is a set annual allowance that each RIIIO-Network Licensee receives to fund small-scale innovative projects as part of their price control settlement. The NIA will fund smaller scale RD&D projects and can cover all types of innovation, including commercial, technological and operational. A fixed annual regulatory allowance was established between 0.5 and 1.0 percent of allowed annual revenue for each year of the planning period.
- An Innovation Roll-out Mechanism (IRM) – To fund the roll-out of proven innovations which will contribute to the development in Great Britain (GB) of a low carbon energy sector or broader environmental benefits.

The Network Innovation Stimulus includes two annual Network Innovation Competitions (NICs), one for electricity transmission and distribution companies, and one for gas network companies. Companies compete for funding for the research, development and demonstration of new technologies, operating and commercial arrangements. Network Licensees are encouraged to collaborate with each other and “Project Partners”. Project Partners are able to contribute external funding to a project but are only eligible to lead bids for funding through a Network Licensee.

An interesting feature we see from completed projects under Ofgem innovation funding is the “close down report”. Examples are cited in Attachment A for the Low Carbon London project and the Customer-Led Revolution project. The purpose of these reports is to fully document the outcomes of projects and to share this knowledge with other utilities so they can apply new learning to their “business as usual” activities.

Anticipated Value

All electricity customers fund Electricity NIC projects. A key feature of the NIC is the requirement that learning gained through projects is disseminated in order that customers gain significant return on their funding through the broad roll-out of successful projects and the subsequent delivery of network savings and/or carbon and environmental benefits. Even where projects are deemed unsuccessful, Network Licensees will gain valuable knowledge that could result in future network savings. The project selection criteria used to screen projects suggest the anticipated benefits:

1. A NIC project must have the potential to have a direct impact on a Network Licensee’s network or on the operations of the GB System Operator and involve the development or demonstration of at least one of the following:
 - a. A specific piece of new (i.e. unproven in GB) equipment (including control and/or communications systems and/or software);
 - b. A specific novel arrangement or application of existing electricity transmission equipment (including control and communications systems software);
 - c. A specific novel operational practice directly related to the operation of the electricity transmission system; or

d. A specific novel commercial arrangement.

In addition to meeting one or more of the requirements above, a Network Licensee must also demonstrate that their project meets all the following criteria:

2. Accelerates the development of a low carbon energy sector and/or delivers environmental benefits while having the potential to deliver net financial benefits to existing and/or future network customers;
3. Delivers value for money for electricity customers;
4. Creates knowledge that can be shared across energy networks in Great Britain or create opportunities for roll-out across a significant proportion of Great Britain networks;
5. Is innovative (i.e., not business as usual) and has an unproven business case where the innovation risk warrants a limited development or demonstration project to demonstrate its effectiveness.

Status

On 9 August 2013, Network Licensees submitted three projects to be considered for funding through the Electricity NIC. Ofgem selected two of these projects for funding:

Project Awarded Funding	Network Licensee	Funding Awarded
Multi Terminal Test Environment for HVDC Systems	Scottish Hydro Electric Transmission Limited	£11.3m
Visualization of Real Time System Dynamics using Enhanced Monitoring	SP Transmission Limited	£6.5m

On 25 July 2014, electricity Transmission Licensees submitted four projects to be considered for funding through the Electricity NIC. Ofgem selected three of these projects for funding.

Project Awarded Funding	Network Licensee	Funding Awarded
Enhanced Frequency Control Capability	National Grid Electricity Transmission Plc	£6.9m
Modular Approach to Substation Construction	Scottish Hydro Electric Transmission Limited	£2.8m
Offshore Cable Repair Vessel and Universal Joint	TC Ormonde OFTO Limited	£9.0m

PROGRAM CASE STUDY 3:

NETWORK INNOVATION COMPETITIONS (“NICs”) FOR GAS¹³

- Sponsored by the UK Office of Gas and Electricity Markets (“Ofgem”)
- Funding – The Gas NIC will run annually from April 2013 – March 2021 and a maximum of £18m (\$33.3 million Canadian) will be available each year for the purposes of the competition. A further £2m will be set aside each year as an incentive reward to successful projects.

Problem Being Addressed

There are four gas distribution companies operating in Britain: National Grid Gas (NGG), Scotia Gas Network (SGN), Northern Gas Networks (NGN) and Wales & West Utilities (WWU). National Grid is the sole owner of the gas transmission network in the UK. UK’s gas transmission and distribution companies face a number of challenges over the coming years.

These include:

- Playing a role in delivering the low carbon economy and the objectives of the UK Carbon Plan
- Reducing the overall carbon footprint of the gas transportation businesses
- Enabling alternative and/or renewable sources of gas to connect to the network.
- Adapting the networks to cope with the impact of climate change

These challenges will affect the gas distribution and transmission networks and the way the Network Licensees plan and manage their businesses. Network Licensees will need to innovate in the way they design, plan, build and operate their networks.

Approach

As part of the RIIO price controls introduced in 2012, Ofgem established a Network Innovation Stimulus. The innovation stimulus consists of three measures:

- A Network Innovation Competition (NIC) – An annual competition to fund selected flagship innovative projects that could deliver low carbon and environmental benefits to customers.
- A Network Innovation Allowance (NIA) – To fund smaller innovation projects that can deliver benefits to customers as part of a RIIO-Network Licensees price control settlement. The NIA is a set annual allowance that each RIIO-Network Licensee receives to fund small-scale innovative projects as part of their price control settlement. The NIA will fund smaller scale RD&D projects and can cover all types of innovation, including commercial, technological and operational. The NIA is a set annual allowance that allows Network Licensees a funding opportunity of 0.7% of revenue to be spent on innovation projects, 90% of which can be recovered through the incentive mechanism.
- An Innovation Roll-out Mechanism (IRM) – To fund the roll-out of proven innovations which will contribute to the development in Great Britain (GB) of a low carbon energy sector or broader environmental benefits.

As with the electric program, under the Network Innovation Competitions (NICs) companies compete for funding for the research, development and demonstration of new technologies, operating and commercial arrangements. The Gas NIC is designed to encourage Network Licensees to undertake trials to address these challenges in the most cost-effective way. Network Licensees will gain understanding from these trials, which they will then be able to apply to the specific challenges they face. This could potentially bring benefits and cost savings to consumers in the future.

Network Licensees are encouraged to collaborate with each other and project partners. Project partners are able to contribute external funding to a project but are only eligible to lead bids for funding through a Network Licensee.

Anticipated Value

Customers of the gas network fund the Gas NIC projects. Therefore, a key feature of the NIC is the requirement that learning gained through projects is disseminated. This is to ensure that customers gain significant return on their funding through the broad rollout of the funded projects. This return includes the delivery of network savings and/or carbon and environmental benefits. Even where the funded projects are deemed unsuccessful at the end of the project life, Network Licensees will gain valuable knowledge that could result in future savings. The project selection criteria used to screen projects suggest the anticipated benefits:

1. A NIC project must have the potential to have a direct impact on a Network Licensee's network or the operations of a GB System Operator and involve the development or demonstration of at least one of the following:
 - a. A specific piece of new (i.e. unproven in GB) equipment (including control and communication systems and/or software);
 - b. A specific novel arrangement or application of existing gas transmission and/or distribution equipment (including control and communication systems software);
 - c. A specific novel operational practice directly related to the operation of the gas transportation system; or
 - d. A specific novel commercial arrangement.

In addition to meeting one or more of the preceding requirements, a Network Licensee must also demonstrate that the project meets the following ISP criteria:

2. Accelerates the development of a low carbon energy sector and/or delivers environmental benefits while having the potential to deliver net financial benefits to existing and/or future network customers;
3. Delivers value for money for gas customers;
4. Creates knowledge that can be shared across energy networks in Great Britain or create opportunities for roll-out across a significant proportion of GB networks;
5. Is innovative (i.e. not business as usual) and has an unproven business case where the innovation risk warrants a limited development or demonstration project to demonstrate its effectiveness.

Status

In the first year of the competition, six submissions requested funding for a total of £26.31m. From these, four projects were selected for funding by an expert panel, for £15.12m, of the available £18m. This funding will be recovered in rates beginning with the April, 2014 rate year. In addition to the NIC funding, the Network Licensees and a range of partners will invest an additional £4.72m in funding.

Project (Location)	Funding Awarded
BioSNG Demonstration Plant (Swindon) A project to construct a demonstration plant investigating the techno-economic feasibility of the thermal gasification of waste to produce pipeline quality renewable gas. Submitted by National Grid Gas Distribution	£1.8m
Low Carbon Gas Preheating (North East) A project to test new and emerging pre-heating technologies and associated operating systems. Submitted by Northern Gas Networks	£4.8m
Opening up the Gas Market (Oban) A project to establish whether gas which sits outside the British standards could be used safely and efficiently. Submitted by Scotland Gas Networks (SGN)	£1.8m
Robotics (South East) A project to develop new robotic technologies that operate inside live gas networks, in order to repair leaking joints, manage the risk of pipe fracture in larger diameter pipes, and repair and replace pipeline assets. Submitted by Southern Gas Networks	£6.5m

In the second year of funding, eligible Network Licensees submitted two projects in July 2014 to be considered for funding through the NIC. In this year's decision Ofgem selected one of these projects for funding.

Project Awarded Funding	Network Licensee	Funding Awarded
In Line Robotic Inspection of High-Pressure Installations	National Grid Gas Transmission	£5.6m

PROGRAM CASE STUDY 4:

NATURAL GAS MODERNIZATION INITIATIVE¹⁴

- Sponsored by the U.S. Department of Energy (“DOE”)
- Funding - Initial funding includes \$15m for the DOE to develop and demonstrate more cost-effective technologies to detect losses from natural gas transmission and distribution systems. An additional \$10m is proposed to quantify emissions from natural gas infrastructure in coordination with the Environmental Protection Agency. DOE will also work with the Federal Energy Regulatory Commission (FERC) to develop regulatory incentives for natural gas infrastructure modernization investments.

Problem Being Addressed

Methane emissions accounted for nearly 10 percent of U.S. greenhouse gas emissions in 2012, of which nearly 30 percent came from the production, transmission and distribution of oil and natural gas. U.S. oil production is at the highest level in nearly 30 years, and the U.S. is also now the largest natural gas producer in the world. Emissions from the oil and gas sector are down 16 percent since 1990. However, emissions from the oil and gas sector are projected to rise more than 25 percent by 2025 without additional steps to lower them. The Obama Administration is committed to taking responsible steps to address climate change, and as part of that effort, announced a new goal to cut methane emissions from the oil and gas sector by 40 – 45 percent from 2012 levels by 2025, and a set of actions to put the U.S. on a path to achieve this ambitious goal.

Approach

The Administration announced on January 14, 2015 it is undertaking a series of steps encompassing standards and cooperative engagement with states, tribes and industry toward meeting the 2025 goal. This cross-agency effort envisions a harmonized approach that considers the roles of FERC, state utility commissions and environmental agencies, and industry. Administration actions include:

- Propose and set common sense standards for methane and ozone-forming emissions from new and modified sources
- New guidelines to reduce volatile organic compounds
- Consider enhancing leak detection and emissions reporting
- Lead by example on public lands
- Reduce methane emissions while improving pipeline safety
- Drive technology to reduce natural gas losses and improve emissions quantification
- Release a Quadrennial Energy Review (QER)

There is one initiative that is directly applicable to the utilities sector:

- Modernize Natural Gas Transmission and Distribution Infrastructure, whereby DOE will continue to take steps to encourage reduced emissions, particularly from natural gas transmission and distribution, including:

- Issuing energy efficiency standards for natural gas and air compressors;
- Advancing research and development to bring down the cost of detecting leaks;
- Working with FERC to modernize natural gas infrastructure; and
- Partnering with NARUC and local distribution companies to accelerate pipeline repair and replacement at the local level.

Anticipated Value

A strategy for cutting methane emissions from the oil and gas sector is an important component of efforts to address climate change. Reducing methane emissions means capturing valuable fuel that is otherwise wasted while reducing harmful pollutants. Achieving the Administration's goal would save up to 180 billion cubic feet of natural gas in 2025, enough to heat more than 2 million homes for a year and support businesses that manufacture and sell cost-effective technologies to identify, quantify, and reduce methane emissions.

Status

The Initiative builds on prior policies designed to reduce methane emissions. One dimension of the Initiative has progressed at FERC:

- In November 2014 FERC issued a proposed policy statement and sought comments regarding potential mechanisms for interstate natural gas pipelines to recover the costs of modernizing their facilities and infrastructure to enhance the efficient and safe operations of their systems. The Commission issued the policy statement in an effort to address these costs and to ensure that existing Commission ratemaking policies do not unnecessarily inhibit interstate natural gas pipelines' ability to expedite needed or required upgrades and improvements, such as replacing old and inefficient compressors and leak-prone pipelines. After review of the comments on the proposed policy statement, the Commission on April 16, 2015 established a policy allowing interstate natural gas pipelines to recover certain capital expenditures made to modernize system infrastructure through a surcharge mechanism, subject to conditions intended to ensure that the resulting rates are just and reasonable and protect natural gas consumers from excessive costs.¹⁵

CASE STUDIES:

RECENT RD&D PROJECTS

PROJECT CASE STUDY 1:

ENERGY EFFICIENT DATA CENTRE INTERCONNECT

Sponsored by:

- Sustainable Development Technology Canada (SDTC)
- National Resource Council of Canada
- Ranovus, Inc.
- Funding – \$4.25 million from SDTC – out of a total project value of \$14.3 million

Problem Being Addressed

When users post photos or update statuses on major social networks, or when they use the cloud to back up their data, they create digital traffic within data centres around the world. The energy required for data centres is huge — accounting for two percent of the world’s electricity consumption and 1.5 percent of the global carbon footprint — and it continues to grow at a rapid rate. Today, there are no power-efficient, cost-effective and scalable solutions to support impending future bandwidth requirements.

Approach

Ranovus brings together technologies, including a state-of-the-art quantum dot laser and silicon photonics, to streamline the way data flows through a data centre. The resulting 100 Gb/s transceiver module can be integrated into a data centre, reducing its cost of doing business eight-fold and its power consumption four-fold.

Anticipated Value

Power-efficient, cost-effective and scalable solutions to support impending future bandwidth requirements.

PROJECT CASE STUDY 2:

ENERGY STORAGE INNOVATION FOR ELECTRIC VEHICLES IN ONTARIO¹⁶

Sponsored by:

- Ontario’s Smart Grid Fund
- Ontario Ministry of Energy
- Funding - In the second round of funding in 2014, 17 projects were awarded a total of CA\$23.7 million (US\$20.8 million) across a range of projects for energy storage, microgrids, behind the meter, grid automation and data analytics. The province’s funding will be matched by \$54 million in funding from the energy sector. Ontario’s initial \$14.1 million resulted in more than \$100 million in private investment.

Problem Being Addressed

The arrival of electric vehicles is bringing new challenges to utilities in managing their impact on the grid. Ryerson University's Centre for Urban Energy plans to demonstrate a pole-mounted energy storage system to facilitate EV integration and improve grid stability and reliability on Toronto Hydro's network.

Approach

In the project, a modular storage solution from the local storage company eCamion will be combined with a smart controller, developed by Ryerson, which communicates with downstream smart meters of connected residences. The objective is to develop and demonstrate the solution to show the integration of smart meters, electric vehicle chargers and improved system reliability.

Anticipated Value

The project is regarded as an important demonstration of the promise of storage at the edge of the grid. Toronto Hydro, as the local utility, should benefit by way of reduced cost of infrastructure upgrade, reduced energy costs, reduced usage during peak hours, enhanced grid reliability and increased power flexibility. In addition, the project will showcase eCamion's technology, which is going to be pursued for worldwide commercialization.

PROJECT CASE STUDY 3:

INNOVATIVE AND COST-EFFECTIVE IN-LINE LEAK DETECTION TOOL FOR GAS PIPELINES

Sponsored by:

- Sustainable Development Technology Canada (SDTC)
- Pure Technologies Alliance Pipeline Ltd.
- Plains Midstream Canada
- City of Calgary
- Funding - \$1 million from SDTC – out of a total project value of \$3 million

Problem Being Addressed

Identifies suspected small gas pipeline leaks before they can grow and create ruptures.

Approach

Tests the ability to transfer a "SmartBall" technology that is already used for water and oil pipelines to the natural gas industry. The SmartBall relies on acoustic leak detection at a high resolution that identifies leaks and their location and communicates back to the operator.

Anticipated Value

Faster leak detection and location reported back to the pipeline operator, avoiding leaks and associated release of methane.

CASE STUDIES:

RECENT RD&D RESULTS

RESULTS CASE STUDY 1:

ECONOMICAL DISPATCH OF COMBINED COOLING, HEATING AND POWER (“CCHP”) SYSTEMS WITH EMISSIONS CONSTRAINTS AND THERMAL LOAD FOLLOWING CAPABILITY¹⁷

- Sponsored by the California Energy Commission (Final Project Report issued July 2014)
- Funding – Modest cost (about \$400,000), since the project heavily leverages previous investment and uses significant previously developed expertise and resources

Problem Being Addressed

Most commercial and industrial electrical loads are highly dynamic and typically not synchronized with local heating and cooling demands. These dynamics, together with utility tariff and rate structures, often make CCHP systems less cost-effective and less attractive to end users. There are advancements being made in smaller CCHP technologies, but several regulatory, market, and technology barriers remain. These include continuing improvement in the cost of smaller CCHP equipment, awareness of the CCHP options among commercial and small industrial customers, and environmental and zoning issues. This particular study focuses on the fact that the cooling and heating or “thermal” load profile for many customers does not follow the electricity load. The economics of CCHP will be improved through the use of algorithms that optimize the dispatch of the CCHP equipment reflecting thermal loads, electricity loads, and any environmental constraints. Electric utility tariff designs including the ability to sell excess power to the grid or take advantage of demand response programs also contribute to the economics. Lower delivered gas prices also improve the economics.

Approach

The project simulated the thermal and electrical load profiles of several commercial and industrial customers and tested the economic impact different economic control and dispatch strategies based on gas and electric utility tariff structures. Using these control strategies applied to a Capstone C65 microturbine generator, building types, and utility rate models, the project examined various generator characteristics.

Anticipated Value

CCHP technology results in significant energy efficiency improvements and associated lower customer costs while also producing meaningful reductions in greenhouse gas emissions. It will help address the barriers to smaller CCHP applications that is an underserved market that has great potential as a source of electric capacity if barriers can be addressed. The project sponsors estimated that the potential contribution to capacity in the United states was approximately 100 GW.

Results

The project developed control algorithms that would optimize the CCHP dispatch given economic objectives and environmental emissions constraints. The models were subjected to dynamic CCHP load demands and other sources of variation.

RESULTS CASE STUDY 2:

CUSTOMER-LED NETWORK REVOLUTION (CLNR) PROJECT

- Sponsored by Northern Powergrid Northeast
- Funding – The project investment of £31 million is funded by the Low Carbon Networks Fund (approximately 90%) and a mandatory contribution by Northern Powergrid Northeast (approximately 10%). Supplemental funding is also contributed by third-party participants in the project, including customer contributions.

Problem Being Addressed

The transition to a “low carbon economy” will be challenging from a:

- (1) technological perspective (connecting and integrating new distributed energy resources to a grid that was not designed with this in mind while monitoring and controlling the impact on the reliability of the network),
- (2) customer engagement perspective (required to attract participation) and
- (3) financial perspective (maintaining the affordability of energy and related services).

The CLNR is a comprehensive demonstration project that tests technological and customer engagement approaches with the goal of identifying efficient and affordable paths forward to transition to the low carbon economy. The project set out to determine whether customers could be flexible in the ways they use and generate electricity and how distributors can support the reduction in customer energy costs and the carbon footprint.

Approach

The CLNR project was a four-year effort to test a broad range of “utility-of-the-future” concepts in an integrated manner involving approximately 13,000 customers and distributed generators and obtain learning from the efforts. The project required significant efforts to engage a broad cross-section of customers by customer class, size and income levels and attract their active participation with distributed resources, innovative tariffs and load response, with appropriate customer protections related to marketing and data privacy. It explored new commercial arrangements among third-party suppliers, distributors, and customers. The project involved the significant investments in equipment including customer and grid storage technologies, customer “smart energy systems”, load controllable end-user appliances, and several network technologies including monitoring equipment, voltage control, and other control technologies. Significant compensation was provided to three contractors: British Gas (energy retailer partner), EA Technology Limited (network competencies), and Durham and Newcastle Universities (data analyses). As noted above, external funding was also provided by third parties and customer contributions for installation of

certain customer equipment (solar PV, heat pumps, smart meters, and electric vehicle charging points).

Results

The project produced extensive learning across a range of outcomes including estimation of load and generation profiles to assist with system planning, measurement of the value of a more flexible network and customer load flexibility, and testing of network control solutions either to address network constraints or to operate the solutions (once installed) on a real-time basis.

Anticipated Value

Northern Powergrid Northeast estimated the value of learning at upwards of £5 billion from implementation at scale derived from four categories: capital cost savings to enhance the network, customer benefits, reduced carbon emissions, and generation capital cost savings from lower peak demands.

SECTION 4:

CONCLUSIONS

The emphasis on innovation in the electric and natural gas industries has increased over the past year as the industry seeks to leverage advances in information and communications technologies, distributed energy resource technologies, and other technologies that allow utilities to perform their responsibilities more efficiently. A second major trend is the push by regulators for changes in the business model and role of the utility that requires a much greater understanding about how third parties and utilities can work together to deliver new products and services and about what it will take to engage customers in these opportunities. In both cases, there is a critical role for regulators to serve to fund utility innovation through customer rates while ensuring these investments satisfy the public interest. Ratepayer-funded projects serve as an important resource, in addition to investment by government, industry and third-party sources. Customers are the ultimate beneficiaries of these innovation projects and, in many cases, they would not be performed by unregulated market participants.

Many of the public and ratepayer-funded programs we cite remain in their formative stages, so results from these efforts remain more anticipated than demonstrated. Innovation by its nature is riskier than business as usual, so not all projects will be successful. Nonetheless, it will be important for policymakers, regulators and utilities to demonstrate tangible consumer benefits as these programs mature, even if substantial portions of these benefits spill over into the broader public domain.

An update to our research on utility related innovation programs from which the case studies have been selected is provided in Attachment A.

ATTACHMENT A:

SURVEY OF INNOVATION EFFORTS

The following table summarizes Concentric’s research into new programs, expansion of existing programs or selected projects identified since our 2014 report.

NEW GOVERNMENT AND REGULATORY AGENCY PROGRAMS

Location	Program	Purpose	Status
Department of Energy (EERE-AMO Office)	Natural Gas Modernization Initiative	Launch a collaborative effort with industry to evaluate and scope high impact manufacturing R&D to improve natural gas system efficiency and reduce leaks with the goal of establishing an advanced manufacturing initiative.	DOE plans to hold a technical workshop to identify the most pressing opportunities in the natural gas system and to focus the technical community on the development of relevant solutions to these challenges.
European Commission	LIFE Programme: Private Finance for Energy Efficiency (PF4EE)	Aims to increase private financing for investments in energy efficiency enhancing projects. Its objective is to support member states in making progress in view of the EU's agreed targets for energy efficiency.	The European Investment Bank is currently accepting proposals and will approve 10-15 from diverse member states.
Hawaii	JumpSmart Maui program, a collaboration between New Energy and Industrial Technology Development Organization (NEDO) – a Japanese organization – and Hawaii	Incorporate smart grid, renewable energy and electric vehicle solutions on Maui, funded through a \$30 million investment by NEDO. The project will also enable Maui to become more energy efficient, create a more stable energy infrastructure to help lower residential energy bills, and attract high-tech projects to generate job growth.	Since its inception in 2011, Hitachi’s JumpSmart Maui initiative, Haleakala Solar, has completed the installation of residential charging stations and is under contract to construct a number of new charging station projects in 2015.
Massachusetts	RD&D funding as part of Utility Grid Modernization Filings	RD&D efforts to focus on testing, piloting and deployment of new and emerging technologies to meet grid modernization objectives.	Proposed RD&D projects to be included in Grid Modernization filings for the three investor-owned electric utilities required by August 1 st , including a proposed funding mechanism.

Location	Program	Purpose	Status
New York	Advanced Grid Innovation Laboratory for Energy (AGILE)	Build a facility devoted to energy technology innovation and the rapid deployment of smart-grid technology to modernize New York's electric grid. The research will aid utilities in making their transmission and generation operations more efficient and to help integrate renewable energy resources into the power grid.	Project announced in late March 2015.
New York	Demonstration projects to support Renewing the Energy Vision ("REV") business model transformation policy initiative	Prepare the utilities to serve as the Distributed System Platform ("DSP"), test new business models, and inform the Commission and stakeholders concerning how best to engage customers to consider DERs and new products and services that will be enabled by REV.	Utility-proposed demonstration project filings due by July 1, 2015.
New York	NYSERDA – "NY Prize"	\$40 million energy competition aimed at spurring new business models and partnerships to modernize the state's electric grid.	Currently seeking proposals from communities to study the feasibility of microgrids. NYSERDA will accept 25-30 communities for the next phase of the project.
UK (Ofgem)	Network Innovation Competitions ("NICs") for Electricity	Competition amongst electricity transmission and distribution companies for innovation stimulus funding to support the R&D and demonstration of new technologies, operating and commercial arrangements.	NICs for electricity completed its second round of funding in July 2014, selecting three of the four proposals submitted
UK (Ofgem)	Network Innovation Competitions ("NICs") for Gas	Competition amongst gas network companies for innovation stimulus to fund the R&D and demonstration of new technologies, operating and commercial arrangements.	NICs for gas completed its second year in July 2014, selecting one of two projects considered for funding.

NEW RD&D PROJECTS

Jurisdiction (Sponsor)	Project	Description	Objectives
Alberta	In-Line Leak Detection Tool for Gas Pipelines	Acoustic line detection tool.	Provide quick detection and location of small leaks.
British Columbia	Rechargeable Zinc Air Fuel Cell	Testing of fuel cell made from abundant resources (zinc and air).	Potential microgrid energy storage technology.
California (PG&E)	PG&E 3D Toolbox	Develop "smart pigs" to assess the condition of natural gas pipelines for dents, cracks and corrosion on the outside of gas pipelines.	Give PG&E real-time information about the condition of pipeline surfaces and speed up the assessment process.
California (PG&E)	PG&E Innovative Leak Detection Technology	Under a pilot program, the leak detection tool mobilizes large numbers of PG&E gas workers concentrating on repairs in a specific area.	Finds and repairs natural gas leaks faster and more efficiently.
Canada	Innovative and Cost-Effective In-Line Leak Detection Tool for Gas Pipelines	Tests the ability to transfer "SmartBall" technology, already used for water and oil pipelines, to the natural gas industry.	Avoids leaks and associated methane release through faster leak detection technology.
Department of Energy (DOE)	Consortium for the Advanced Simulation of Light Water Reactors (CASL)	Renewed funding for the energy innovation hub that develops advanced computing capabilities to serve as a virtual version of existing, operating nuclear reactors.	Enable the role of nuclear energy and advance research in a dependable, low-carbon energy source.
DOE Fuel Cell Technologies Office (FCTO)	Gas Technology Institute	Assess the technical and economic feasibility of thermal compression for cost-effective pressurization of hydrogen to 700 bars for hydrogen fueling stations.	To support innovations in fuel cell and hydrogen fuel technologies.
Ontario	Energy Efficient Data Centre	Application of Quantum Dot Laser and Silicon Photonics to streamline data flows.	Reduce cost and energy usage of data centres.
Ontario	EV Technology Interoperability	Integrate the building energy management system, EV applications, advanced energy storage, solar generated energy and a distribution automation applications	Assess the impact of storage between a grid infrastructure and commercial customer valuation perspective.

Jurisdiction (Sponsor)	Project	Description	Objectives
		network to expand opportunities for customer control, enable conservation and allow for high penetrations of renewable generation.	
Ontario	Gallium Nitride Power Devices for High-Efficiency Industrial Battery Chargers	Testing of charging efficiency of lower weight electric vehicle batteries.	Reduce power losses and generation of waste heat during the charging process.
Ontario	Ryerson University's Centre for Urban Energy's Pole-mounted Storage	Modular storage solution will be combined with a smart controller, which communicates with downstream smart meters of connected residences.	Develop and demonstrate a pole-mounted energy storage system to facilitate EV integration and improve grid stability and reliability on Toronto Hydro's network.
Ontario	Storage for EV Charging Station Management (Toronto Hydro)	Install energy storage systems to solve issues caused by the sudden connect/disconnect of EVs and system congestion.	Demonstrate how its system can mitigate issues including peak management, peak charging management, infrastructure deferment, harmonics and voltage and frequency regulation.
Québec	SIMLOC: Fault Locating on Underground Distribution Lines	Hydro-Québec developed a system for locating damage along underground lines and at cable joints.	Shortens and standardizes the time it takes to locate a fault as well as reduces the risk of damaging the cables or other equipment.

RESULTS OF RECENT INNOVATION PROJECTS

Jurisdiction (Sponsor)	Project	Description	Results
California (CEC)	Dispatch of Load Following Small-Sized CHP Subject to Economic and Environmental Costs	Test ability to address market barriers to small-scale CHP.	Developed and tested new control algorithms
California (CEC)	Solid State Batteries for Grid-Scale Energy Storage	Demonstration of Lithium Batteries up to 10 kWh.	Validated process for producing grid-scale batteries. Tested 10 kWh battery pack.
Ofgem (UK)	Low Carbon London	Evaluate impact of low carbon technologies on London's electricity distribution network.	Achieved significant cost-sharing benefits of approximately £14m with customers and met all of its reward criteria. Led directly to the reduction of capital investment plans by £43m.
Ofgem (UK)	Customer-Led Network Revolution	Trial customer and network flexibility techniques to deliver greater capacity at a lower cost.	Produced insights and knowledge with net benefits estimated in the range £5b to £26b from 2020 to 2050.

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