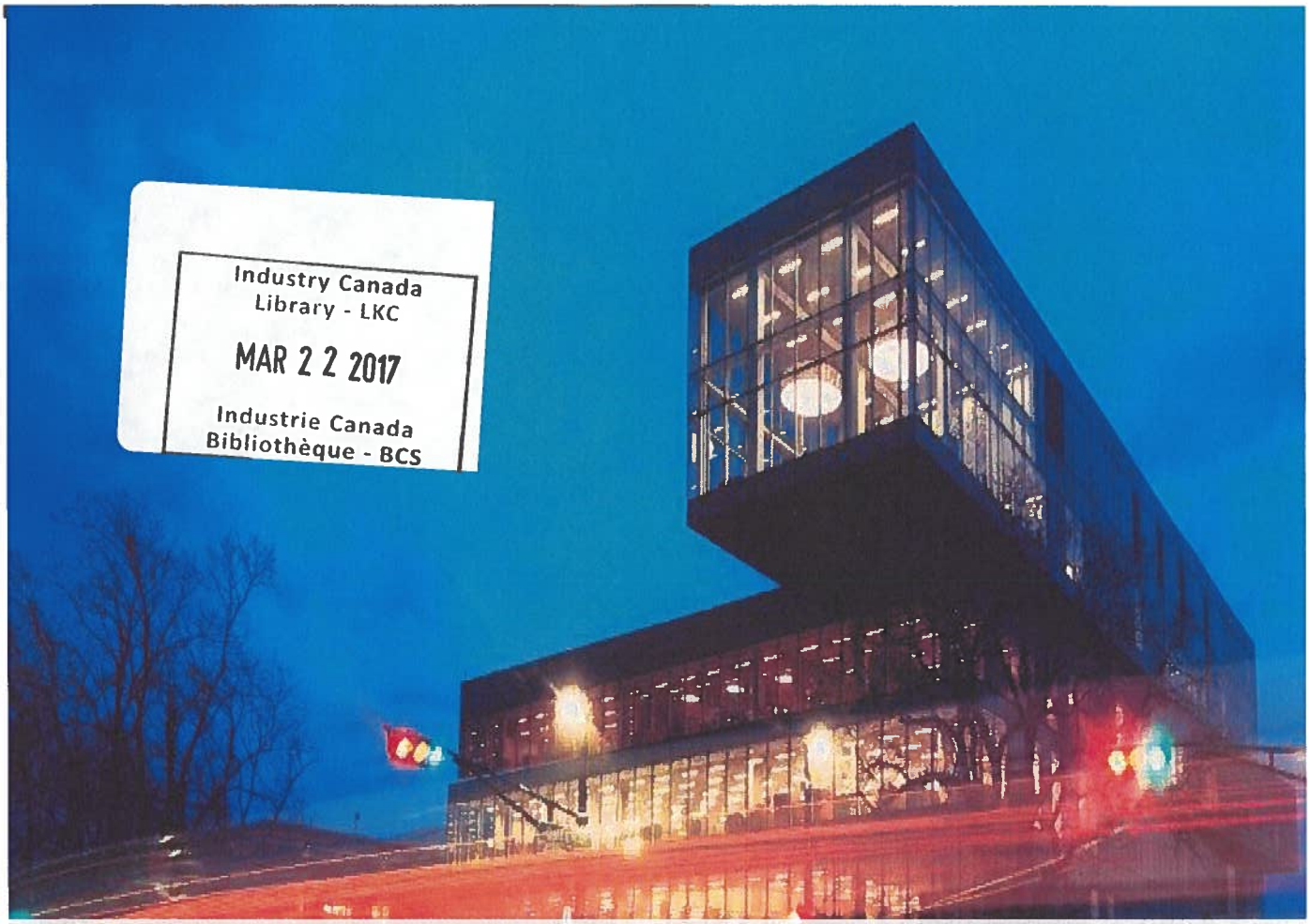
Innovation, Science and Economic Development Canada

Innovation, Sciences et Développement économique Canada



INSIGHTS

A Special Edition on the Innovation Agenda

2017, Volume 1

Strategic Policy Sector

Canada

FOREWORD

This special edition of ISED Insights is dedicated to exploring topics related to the Inclusive Innovation Agenda. The Government of Canada announced the Innovation Agenda as a means to build Canada as a global centre for innovation by focusing on people, technology, and companies. This edition of Insights consists of five articles that bring together work and research being done on innovation and related subjects across the department.

The first article, prepared by Spectrum, Information Technologies and Telecommunications Sector, focuses on the subject of 5G, which denotes the 5th generation of wireless communication systems. It describes 5G as a technological advance that will create enormous opportunities for innovative and creative firms, as it enables a new hyper-connected digital world that will constitute the most critical building block of Canada's digital society for the next decade. This article also highlights the important role of the Government in supporting 5G developments by evolving the regulatory and policy environment, supporting commercialization, and bringing together stakeholders to leverage strengths across Canada.

The second article, authored by colleagues at the Canadian Intellectual Property Office (CIPO), discusses innovation in climate change mitigation technologies in Canada. It explains that climate change mitigation technology is a rapidly growing sector linked to key government priorities surrounding clean technologies and sustainable growth in its transition to a low-carbon economy. In response, CIPO has undertaken a study in collaboration with other government departments and organizations that investigates Canada's innovative advantage in the areas of climate change mitigation technology.

The third article, which was produced by the Science and Innovation Sector, outlines the Fundamental Science Review that was announced in Budget 2016. It established a panel of experts drawn from a range of disciplines and experience to explore how federal funding could be optimized to sustain and strengthen Canada's scientific excellence. More precisely, the Fundamental Science Review will identify any imbalances in government support for fundamental research in Canada and make recommendations to remedy them. At the conclusion of the review, the advisory panel will produce a report that provides the federal government with advice on how to strengthen Canada's international standing in fundamental science and ensure that Canada's scientists have the tools, training and support needed to excel globally.

The fourth article, prepared by the Industry Sector, discusses clusters, their role in fostering innovation and encouraging economic growth, and government efforts to support their development and expansion. Recognizing the importance of clusters, ISED is building a mapping portal to identify and analyze Canadian clusters. Also, the department is developing an Innovation Superclusters Fund, a large-scale initiative that aims to foster the growth and development of world-leading clusters in Canada.

The final article was written by colleagues at Spectrum, Information Technologies and Telecommunications Sector and discusses plans to adopt a "Tell Us Once" approach to service delivery at ISED. In order to keep pace with the changing needs of Canadians, the government must deliver integrated, innovative, and client-focused services. With this in mind, this article discusses ISED's "Service Management Strategy" to encourage the department to act as a single organization in order to minimize irritants like multiple logins and repetitive data entry for clients seeking government assistance.

We certainly hope that readers find this special edition of *Insights* informative.

Sincerely,

The ISED Insights editorial team

FEATURE ARTICLES:

IN EVERY ISSUE:

RECENT DEVELOPMENTS OF INTEREST TO ISED

BANK OF CANADA RELEASES ITS LATEST MONETARY POLICY REPORT

- The January 2017 edition of the Bank of Canada's *Monetary Policy Report* (MPR) expects global economic growth of 2.9% in 2016, which represents a slight upward revision relative to its October forecast, after a stronger-than-expected second-half to the year.
- Going forward, global real GDP is forecast to grow 3.2% in 2017 before strengthening to about 3.6% the following year. Emerging-market economies (EMEs) are expected to drive global growth in the foreseeable future, on the assumption that contractionary pressures have bottomed out in some of these countries. Solid US growth is also expected to provide an additional boost.
- In China, real GDP growth is expected to gradually soften from 6.6% in 2014 to 6.4% in 2018, as the economy continues to rebalance towards a more sustainable growth path with less reliance on business investment in mining and manufacturing.
- The Canadian economy is expected to post growth of 1.3% in 2016, an upward revision of 0.2 percentage points, as the resumption of oil sands activity following the Alberta wildfires provided a significant boost in the third quarter. Real GDP is expected to accelerate to 2.1% in both 2017 and 2018, as the Canadian economy continues to adjust to past declines in commodity prices and the service sector is expected to support gains in employment, household incomes, and consumption going forward.

INTERNATIONAL MONETARY FUND RELEASES ITS WORLD ECONOMIC OUTLOOK UPDATE

- The International Monetary Fund's *World Economic Outlook* (WEO) update calls for global economic growth of 3.4% in 2017 and 3.6% in 2018.
- The outlook for advanced economies has improved due to economic activity picking up in the second half of 2016, expectations for near-term fiscal stimulus in the US, and stronger oil prices projected to continue into this year.
- However, much of the support for global growth during 2017-18 is expected to come from emerging market and developing economies, despite the fact that growth projections have been revised downward for many of these countries.

- Canada is expected to record real GDP growth of 1.9% in 2017 and 2.0% in 2018, largely in line with the previous IMF forecast. This represents considerable improvement over 2015 and 2016, when growth was estimated at 0.9% and 1.3%, respectively.

CANADA RANKS AS THE 10TH BEST COUNTRY FOR DOING BUSINESS

- Canada placed 10th on Forbes Magazine's 11th annual "Best Countries for Doing Business" ranking, which assessed how attractive 139 economies were for capital investment based on their performance in 11 categories.
- Canada finished top-10 in the categories of personal freedom (1st), red tape (2nd), investor protection (7th), corruption (9th), and property rights (10th).
- Improvements could be made in the areas of monetary freedom (78th), trade freedom (37th), innovation (24th), market performance (22nd), and technology (21st).
- Sweden topped the rankings as the best country for doing business for the first time in 2016. The top-five was rounded out by New Zealand, Hong Kong, Ireland, and the UK.

5G: VERTICAL MARKET INTEGRATION IN VALUE CHAINS

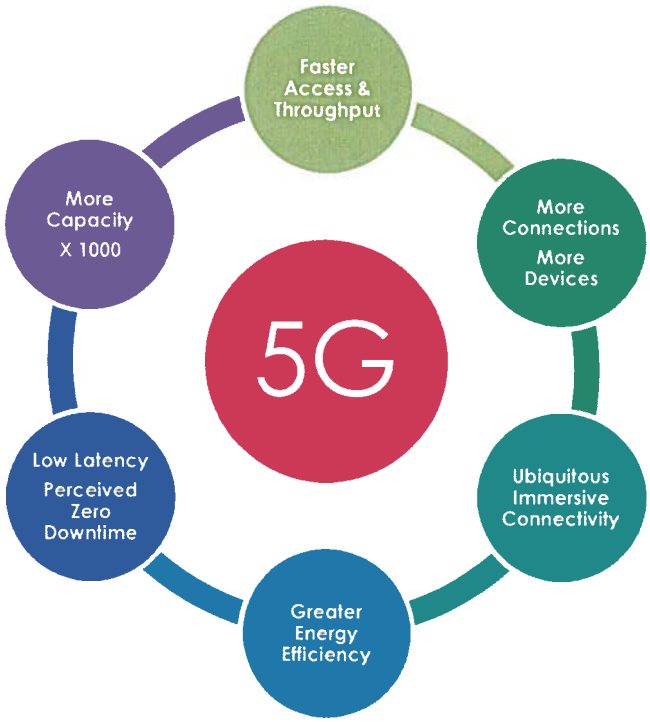
HIGHLIGHTS

- It is expected that all sectors of the economy will eventually be transformed by the evolution to 5G-next generation networks and the technologies they enable, such as the Internet of Things (IoT).
- The unique network and service capabilities of 5G will drive the adoption of IoT through applications for vertical markets and high-value solutions for users.
- Regulators are responding to 5G by providing technical analysis and leadership related to standards, policy and strategies, and undertaking research to address grand challenges.

BACKGROUND

The digital world is at an inflection point where the number of connected devices is expected to grow to 50 billion by 2020. The next generation of wireless communications systems, called 5G to denote that it is the 5th generation of development, will become the most critical building block of Canada's digital society for the next 10 years. It will facilitate the next generation of high capacity, extremely fast, reliable, secure, and ultralow latency wireless networks. 5G will also enable new systems and applications that rely on billions of sensors feeding continual streams of real-time data through machine-to-machine (M2M) communications. All sectors of the economy will eventually be transformed by this evolution to high speed wireless that will enable the Internet of Things (IoT). It is expected that these changes will challenge and transform the operations and business models of telecommunications operators, equipment manufacturers, most industries, and regulators.

Figure 1: Attributes of 5G



TRANSFORMING COMMUNICATIONS

Communications is being transformed as specialized network equipment and applications are being replaced by lower cost, generic versions, and proprietary network infrastructure is being replaced by software-defined networks. For example, Nokia now provides an LTE (Long-Term Evolution) network core controller based on Hewlett Packard (HP) servers. Traditional communications carriers are hopeful that 5G will reverse their declining share of industry revenues, even as it changes their business models.[1] In theory, 5G should support a variety of new services based on the leap in technology capabilities associated with it; however, it is not entirely clear whether incumbents or disruptive new players will eventually reap the rewards from this new technology. New entrants are expected to disrupt the ICT market with 5G-specific offerings, especially software solutions that reduce the importance of network equipment. Network equipment makers are likely to see their profit margins diminish on account of 5G technology, just as cloud computing hurt some incumbent IT players. This may finally bring about the convergence (i.e., a merging of IT and communications) of computers and telecom equipment manufacturers that has been long predicted, as standardisation and low margins may force them to come together.[2] 5G is expected to create an environment which disrupts and destabilizes large traditional firms in this sector, while accelerating the growth of agile start-ups that use the technology as a green field and are not burdened by legacy systems. Disruptive new technologies, such as 5G, usually provide huge opportunities across the economy for innovative and creative firms to grow and develop into global-leader firms in the future.

> "Today, the digital economy is the economy. There is not a single industry that digital technologies don't touch anymore. Digital technologies underpin every sector, from fishing and farming to mining and health."
>
> **—The Honourable Navdeep Bains, Minister of ISED**

TRANSFORMING INDUSTRIES AND USER EXPERIENCES

5G is being designed to support new opportunities across the economy, including the creation of communication-intensive apps that will transform industries. Previous generations of wireless networks provided major benefits to the economy and society, even though this was not a fundamental consideration during the development process. 5G is different in this respect, as assessing the potential socio-economic benefits associated with 5G was a key element of the strategic planning process for its introduction into Europe[3]. From a socio-economic standpoint, 5G is expected to facilitate the emergence of a more flexible, continuously connected, responsive digital world that encompasses the whole economy.

5G networks will not only connect computers and smart devices, but also IoT devices such as household appliances, cars, traffic lights, building systems and even animals. Embedding 5G capabilities into infrastructure and the world of things will require the closer integration of communications services and software developers into the value chains of a wide variety of industries. Not only will many industries learn to fully leverage the potential of 5G, the resulting vertical market applications and use cases (i.e. technologies and applications that could emerge when 5G is fully established) will fundamentally change business models in many of them.

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[1] The Economist, "Wireless: the next generation - A new wave of mobile technology is on its way, and will bring drastic change", February 20, 2016.

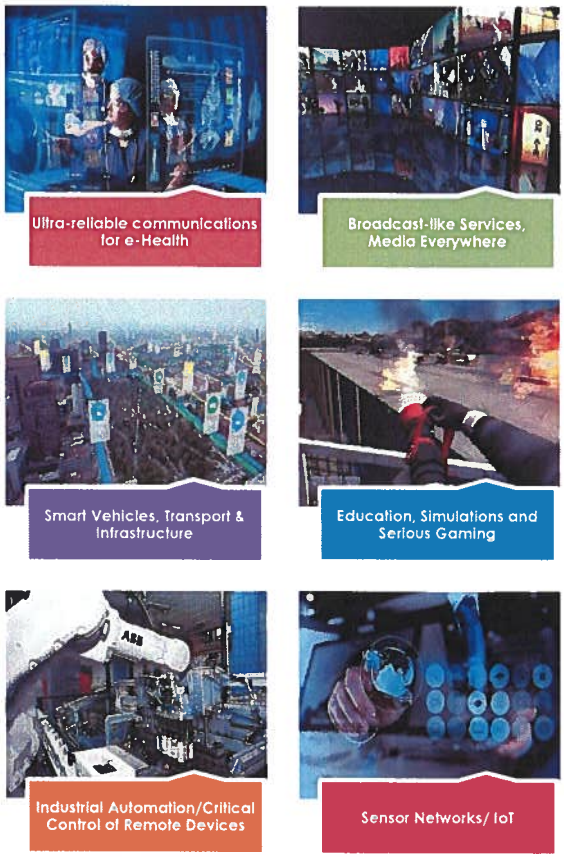
[2] Les Santiago and Mario Morales, *Mobile World Congress 2016 Key Takeaways Center on Crystalizing Timeline of 5G Deployments and Growing the IoT and Connected Car Ecosystem*, IDC Doc #US41058416, March 2016.

[3] European Commission, Directorate-General of Communications Networks, Content & Technology, *Identification and quantification of key socio-economic data to support strategic planning for the introduction of 5G in Europe*, European Union, 2016.

Transportation is expected to be among the industries that will experience significant changes, as connected and autonomous vehicles are developed and deployed. But what does that really mean for people? Automated cars will rely on a dense network of sensors that provide real-time data about road conditions, weather, other vehicles and hazards. A car skidding through a red light on a patch of ice will receive nearly instantaneous information about how to correct for the road conditions and the other cars at the intersection; simultaneously, all of the other cars on the road will be made aware of the car that is in distress quickly enough to react and attempt to avoid an accident.

The impact of advanced communications technologies will be seen in a variety of ways. 5G is expected to accelerate automation and transform work in industrial plants by reducing the need for physical labour and increasing the resources available for intellectual creativity. It will drive greater use of remotely monitored robots and machines, and enable factory automation that increases safety for workers by allowing dangerous tasks to be performed with robots. 5G will also enable advances in healthcare. For example, advanced medical monitoring systems, which keep patients connected to medical practitioners and services 24/7, will enable the elderly to remain in their homes longer and more securely. Furthermore, consumers will be able to access all media anywhere, on demand, and 5G networks will support immersive gaming and augmented reality that could be used for educational purposes as well as entertainment. These examples just scratch the surface of 5G and IoT's potential impacts on how Canadians work and live.

Figure 2: Use Cases across the Economy



HOW REGULATORS, INCLUDING ISED, ARE RESPONDING

As 5G transforms the economy, regulating it will need to move beyond telecommunications policy and standards and overlap into other regulated spheres, such as transportation and healthcare, and areas of government investment, such as infrastructure. However, developing regulations and technical standards for the 5G enabled Internet of Things will not fall entirely to governments. Just as the ICT industry plays a major role in the development of wireless standards, other industries must engage in the development of standards and regulations for cases emerging from their industries such as self-driving cars, remote patient monitoring and smart cities infrastructure, to fully realise the potential of this new disruptive technology.

Many countries (e.g. South Korea, Japan, the UK, China, Sweden, the US, etc.) have recognized the opportunities that 5G presents. This has led government regulators to back domestic companies by pushing for more favourable standards to help their firms capture market share early on and win in the marketplace. Regulators around the world are also investigating what 5G technology will mean for spectrum allocation and spectrum management methods.

5G is expected to require additional spectrum resources, new monitoring infrastructure and an updated regulatory framework. Innovative techniques are expected to improve spectrum utilization. Furthermore, spectrum sharing by different users is likely to increase once 5G infrastructure is introduced, and methods for more dynamic sharing of spectrum

are currently being investigated. Different bands will serve different purposes. A key aspect of 5G technology will be to integrate the various approaches and bands within a harmonised global framework. This will require innovative regulatory tools that not only enables equipment that uses new frequency bands, but will also coexist with exclusive mobile licences that have already been assigned spectrum for 5G systems. New regulatory compliances methods that can scale with the growth in spectrum utilization will also be required.

Beyond spectrum regulation, ISED has important roles to play in supporting 5G development in Canada. The Communications Research Centre (CRC) is contributing to the development of a Canadian 5G ecosystem through research, advice and collaboration. For example, CRC is: creating a 5G Living Lab to further research and showcase Canadian capabilities; working on breaking the frequency barrier (BFB) with 5G propagation, communications, and frequency reuse; and, planning the deployment of spectrum to 86 GHz, whereas most mobile use is presently under 6GHz.

What is "spectrum sharing"?

Spectrum sharing refers to the same spectrum (radio frequency) band being accessed by multiple users or for different types of uses.

Spectrum sharing is becoming increasingly important as billions of new internet users come on line and the exponential growth of wireless technologies translate into high demand for limited spectrum resources.

Another issue is the tremendous inefficiencies in the usage of this scarce resource. According to Professor Kevin Werbach, only about 10% of the total spectrum is actually being used at any given moment.

It is expected that new methods of spectrum sharing that are based on technology will emerge in the future, such as the trading of licensed spectrum in dynamic markets.

Sources: University of Pennsylvania, and Ofcom.

Regulating 5G and all of the technologies that it enables will require a whole new government approach, as broad adoption has wide-ranging implications for regulations. ISED will also need to work with all government regulators, including Transport Canada, Health Canada and Infrastructure Canada, to ensure that regulation supports innovation in the best way possible.

As shown in this article, 5G is not just an evolution of 4G, it is a technological advance that will create enormous opportunities and challenges as it enables a new hyper-connected digital world. Along with changing technology for users, 5G is expected to transform the communications services and equipment industries. 5G is one of those areas where Canada is a hotbed of innovation, and its development should contribute positively to the growth of the ICT industry in Canada. It will also provide opportunities for firms whose solutions exploit new networking infrastructure (e.g. autonomous car applications) to disrupt business models in other industries across the economy. Emerging technologies, such as 5G, will be a key element of the innovation story as well as the government's approach to digital policy under the Innovation Agenda. Government will play an important role in supporting 5G developments by evolving the regulatory and policy environment, supporting commercialization and bringing together stakeholders to leverage strengths across Canada to build a strong ecosystem.

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INVENTION IN CLIMATE CHANGE MITIGATION TECHNOLOGY: AN ANALYSIS OF CANADIAN PATENTING ACTIVITY

HIGHLIGHTS

- Climate change mitigation technology is an exciting and fast-growing sector that is linked to key priorities of the Government of Canada around clean technologies and sustainable growth.
- The Canadian Intellectual Property Office is currently undertaking a patent analytics study in the area of climate change mitigation technology.
- Preliminary results show that Canada has comparative advantages over its competitors in carbon capture, buildings, and smart grids, among other climate change mitigation technology fields.

BACKGROUND

The 2016 Federal Budget identified climate change as a key priority and detailed plans for strategic investment in clean technologies, including climate change mitigation technology (CCMT). Under the 2015 Paris Agreement on climate change, Canada committed to cutting its greenhouse gas emissions to 30% below 2005 levels by 2030. Meeting this target will require Canadians to adopt current energy-saving technologies and develop breakthrough innovations in CCMT.

A 2014 report on CCMT[1] released by the European Patent Office indicated that public policies may be effective in encouraging technological progress in clean technologies. The report looked at the relationship between policy and

[1] Climate Change Mitigation Technologies in Europe – Evidence from Patent and Economic Data (2015)

innovation in climate change by comparing the number of patented inventions in the area of CCMT to an OECD indicator of stringency in climate policy[2]. For instance, Figure 1 shows a positive correlation between climate change policy and patented inventions in Canada over the 1995 – 2010 period, while Figure 2 depicts the negative correlation between carbon dioxide intensity and CCMT innovation. A large body of literature has shown that, on average at the country level, increases in environmentally friendly technologies can be explained by environmental policy.[3] [4] Recent studies have provided evidence that energy R&D exhibits increasing returns.[5] Therefore, it seems that real opportunities exist for innovation to drive the necessary changes to meet Canada's climate change targets.

Figure 1: Number of Patented CCMT Inventions by Canadians and Stringency of Canadian Climate Policy

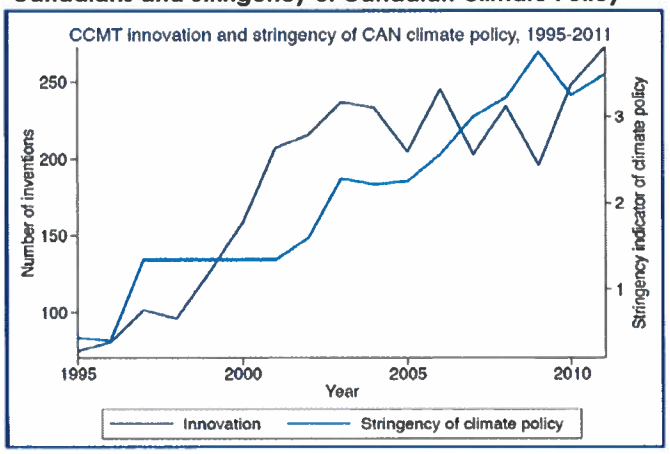
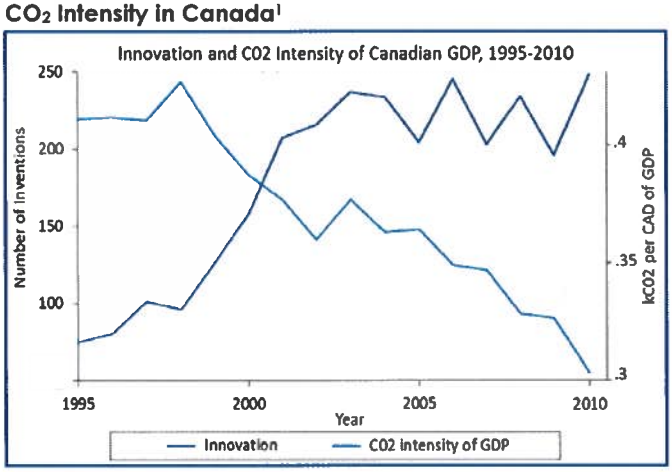


Figure 2: Number of CCMT Inventions by Canadians and CO_2 Intensity in Canada[1]



Source: Antoine Dechezleprêtre for CIPO

In this context, the Canadian Intellectual Property Office (CIPO) is currently undertaking a patent analytics study that will provide intelligence on the top Canadian companies and researchers in the area of CCMT. CIPO is working collaboratively with colleagues from Environment and Climate Change Canada, Natural Resources Canada, and the Clean Tech Group and Results Delivery Unit at ISED to develop the forthcoming study. This article is a first look at this effort, and more in-depth results will be presented in the broader study.

CIPO'S RESEARCH

The forthcoming CIPO study *Patented Inventions in Climate Change Mitigation Technology* investigates the patenting activity of Canadian researchers and Canadian firms.

First, the patent landscape map (Figure 3) provides a visual representation of the climate change mitigation technology patents applied for by Canadians around the world. The outlined shapes on the map represent the clustering of sub-technologies, where 'snow-capped peaks' represent the highest concentrations of patents.

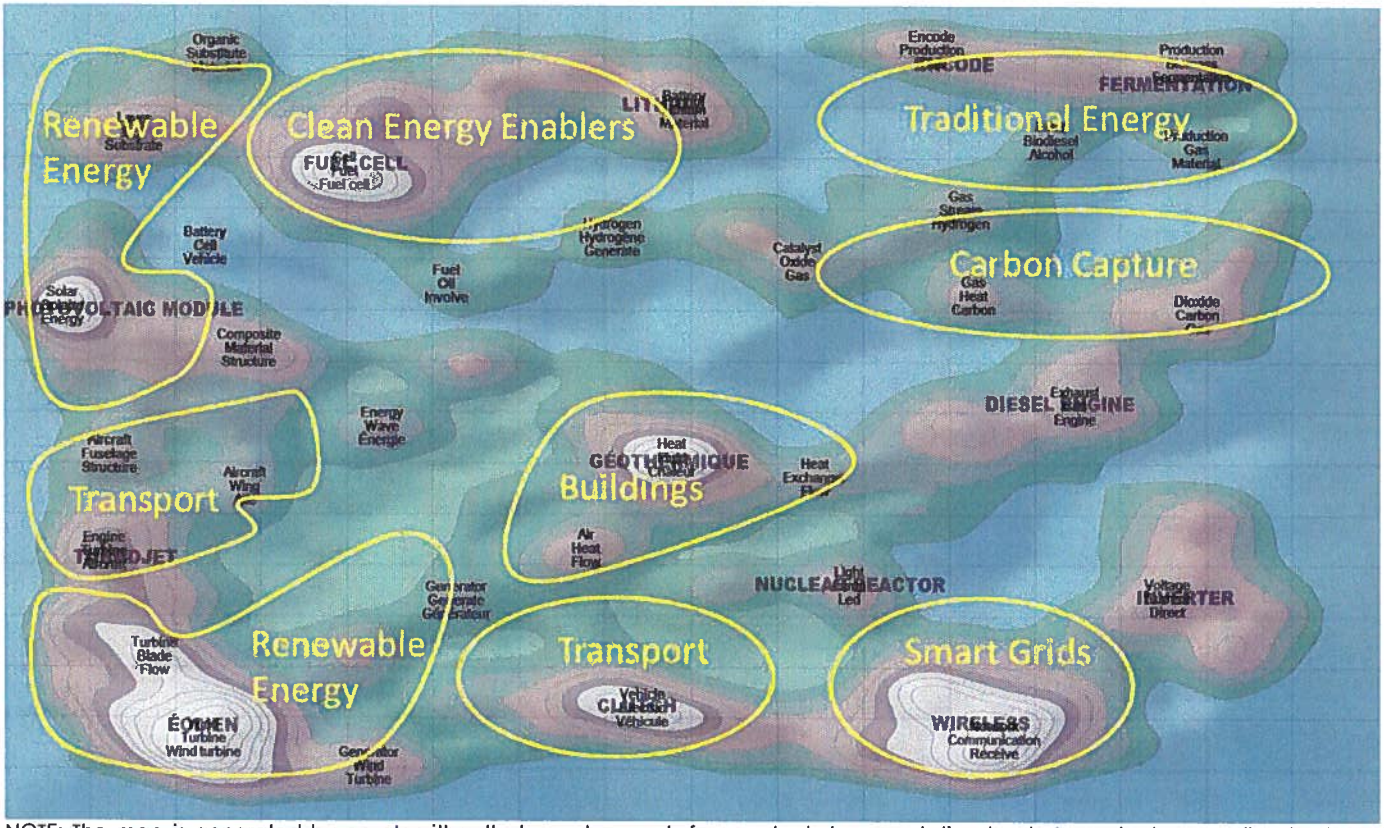
[2] Botta, E. and T. Koźluk (2014), "Measuring Environmental Policy Stringency in OECD Countries: A Composite Index Approach", OECD Economics Department Working Papers, No. 1177, OECD

[3] Climate Change Mitigation Technologies in Europe – Evidence from Patent and Economic Data (2015)

[4] Lanjouw and Mody, 1996; Jaffe and Plamer,1997; Brunnermeier and Cohen, 2003; Johnstone et al., 2010; Dechezleprêtre and Glachant, 2013; Newell at al., 1999; Popp, 2002; Verdolini and Galeotti, 2011; Aghion et al., 2012.

[5] Antoine Dechezleprêtre, David Popp (2015), "Fiscal and regulatory instruments for clean technology development in the European Union" ESRC Centre for Climate Change Economics and Policy Grantham Research Institute on Climate Change and the Environment.

Figure 3: Patent Landscape Map of Canadian Researchers in CCMT



NOTE: The map is generated by an algorithm that uses keywords from patent documentation to cluster patents according to shared language. Each dot on the map represents an individual patent invention. The shorter the distance between the dots indicates that the patents they represent share more commonalities relative to those that are further apart. The patents are organized based on common themes and are grouped as 'contours' on the map to identify areas of high and low patenting activity in Canada. The 'snow-capped peaks' represent the highest concentrations of patented inventions, and each peak is labelled with key terms that tie the common themes together. It should be noted that the map presents absolute patented invention counts and does not consider the fact that many other countries excel in the same areas.

The map shows that Canadians are very active in the areas of renewable energy and smart grids, and, to a lesser extent, transport, buildings and clean energy enablers. We are less active in carbon capture and traditional energy. However, as the next sections demonstrate, we may nonetheless have a relative advantage in areas where we are less active.

The seven sub-technologies presented on the patent landscape map are:

- ***Buildings***: Technologies designed to help reduce CO_2 emissions in buildings. Examples include lighting, heating, ventilation, elevators, escalators and thermal performance.
- ***Carbon Capture***: Technologies designed to capture waste CO_2 and other greenhouse gases.
- ***Renewable Energy***: Technologies such as wind and solar.
- ***Traditional Energy Sources***: Technologies such as nuclear, electrical power generation and non-fossil fuels.
- ***Clean Energy Enablers***: Energy conversion or management systems designed to reduce greenhouse gases.
- ***Transport***: Technologies designed to help reduce CO_2 emissions in transportation. Examples include: road transport, railways, air and marine.

- ***Smart Grids***: Improvement of technologies related to an electrical supply network that uses digital communication technology to detect and react to changes in usage, as well as the generation, transmission, or distribution of electrical power.

CANADIAN RESEARCHERS

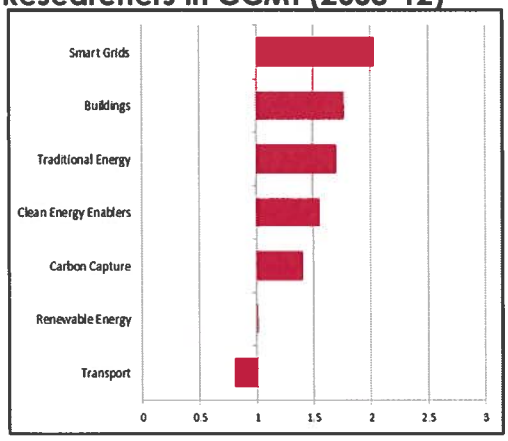
A recent empirical study prepared for ISED[6] uses US Patent and Trademark Office (USPTO) data to show that Canadian university researchers generally work on high-value patents. The authors found that the presence of a Canadian co-author or co-inventor is associated with a premium in patent value[7] that is 13% higher than the USPTO average. Canadian scientists and universities are seen as world leaders in CCMT[8]. Table 1 provides a list of the top-15 patenting Canadian researchers.

In order to gain a better understanding of Canada's strengths in CCMT research, we utilize the Revealed Technological Advantage (RTA) index[9], which was developed by the OECD and uses patenting intensity to allow for industries to be compared between countries of different sizes on a relative basis. The RTA index shows where Canadians have a comparative advantage over competitors. Figure 4 demonstrates that Canadian researchers are relatively specialized in carbon capture, buildings, smart grids and traditional energy, when compared to other top patenting countries in the area of CCMT.

Table 1: Top Patenting Canadian Researchers in CCMT

Inventor Name	Areas of Focus
Gerard, Rich David	Clean Energy Enablers
McLean, Gerard F.	Clean Energy Enablers
Schrooten, Jeremy	Clean Energy Enablers
Blouin, Nicolas	Renewable Energy
Mitchell, William	Renewable Energy
Husain, Sutarwala	Clean Energy Enablers
Tierney, Steven	Renewable Energy
Zimmermann, Joerg	Clean Energy Enablers
Donnelly, Frank Wegner	Transport
Praveen, Jain K.	Buildings
Borisovich, Rubin Leonid	Renewable Energy
Wu Chee-Ming, Jimmy	Clean Energy Enablers
Sobejko, Paul	Clean Energy Enablers
Huazi, Lin	Buildings
Voon, Gerard	Traditional Energy

Figure 4: RTA Index for Canadian Researchers in CCMT (2008-12)



As briefly described in the previous section, smart grid technology refers to ongoing adaptations to the electrical distribution grid, many of which rely on cutting-edge technologies that direct and store electricity. Smart grid technology reduces carbon emissions both directly, by reducing waste and thus reducing the need for energy production, and indirectly, by facilitating carbon-friendly policy choices. In particular, because many sources of renewable energy are intermittent in their power generation (e.g. wind and solar), advances in storage and smart grid technology are needed to ensure that they are reliable[10]. Canada is a large country with a low population density, which places high demands on some of our infrastructure. Accordingly, smart grid technology represents a vital source of innovation.

Improving the energy efficiency of buildings is another logical strength for Canadian researchers, given that Canada's climate is characterized by a

[6] Torrance, A. W., & West, J. D. (2016). Canadian Inventors of U.S. Patents. An Empirical Study for the Canadian Ministry of Innovation, Science, and Economic Development Canada.
[7] Value is measured with an innovative citation-based ranking system.
[8] Antoine Dechezleprêtre for CIPO.
[9] The RTA is the ratio of an economy's share in patents from a specific technology field to the economy's share in all patents from all technology fields. The index is equal to zero when the economy has no patents in a given field; it is equal to one when the economy's share in the sector equals its share in all fields (no specialisation); and above one when a positive specialisation is observed.
[10] Gretchen Bakke, The Grid.

wide variability in temperatures. Advances in insulation, ventilation, and related technologies can have enormous impacts on energy consumption.

Carbon capture technology helps prevent carbon from being emitted into the atmosphere by diverting it into a safe area or technology. This is significant for Canada because its economy relies on resource extraction, which often involves processes that are very energy-intensive.

CANADIAN BUSINESS

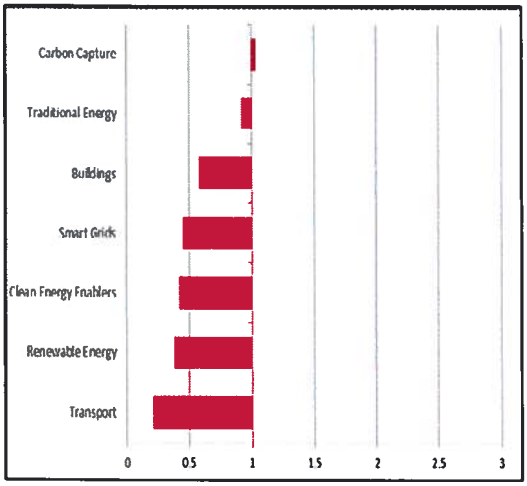
After establishing the areas in CCMT patenting where Canadian researchers have a relative advantage, it is now time to turn our attention to the activities of leading Canadian companies[11]. Table 2 lists the top-10 patenting Canadian companies in CCMT. The primary area of focus for five of the top-10 Canadian companies is 'transport'. 'Traditional energy' and 'clean energy enablers' are also areas with significant patenting activity by Canadian firms.

According to the OECD's RTA index, 'carbon capture' is the only category where Canadian companies possess a slight relative advantage (Figure 5). Canada lags its OECD counterparts in all of the other technologies in terms of expected patenting given its overall patenting performance. However, it should be noted that drilling down into the data reveals areas at the sub-technology level where Canada has a relative advantage. Further research is required to better understand these underlying trends.

Table 2: Top Patenting Canadian Companies in CCMT

Applicant	Areas of Focus
BlackBerry	Buildings
Bombardier	Transport
Magna International	Transport
Pratt & Whitney Canada	Transport
Westport Power	Transport
Iogen Bio-Products	Traditional Energy
National Research Council of Canada	Clean Energy Enablers
Angstrom Power	Clean Energy Enablers
Atomic Energy of Canada	Traditional Energy
Dana Canada Corporation	Transport

Figure 5: RTA Index for Canadian Businesses in CCMT (2008-12)



WHAT DOES IT MEAN FOR ISED?

LINK TO THE INNOVATION AGENDA

During consultations on the forthcoming Inclusive Innovation Agenda, Minister Bains announced that clean technologies will play an increasingly important role in Canada's transition to a low-carbon economy and that the government will be making new investments totalling more than $1 billion to support the development of clean technologies across all sectors of the economy. The landscape map in this article shows areas where Canadians are most active in patenting and the revealed technological advantage graphs show where Canadians have a comparative advantage in patenting. The forthcoming full study will also present collaboration maps in specific sub-technology areas, which will provide insights into innovation networks and clusters.

[11] Note that Canadian researchers might work for foreign-owned companies and Canadian firms might employ non-Canadian researchers (in their affiliates abroad).

IMPROVING DATA ON THE CLEAN TECHNOLOGY SECTOR

Natural Resources Canada, Statistics Canada and ISED are building a Clean Technology Satellite Account[12] (CTSA). This satellite account will take a broad definition of the sector, which consists of all companies or organizations either fully or partially engaged in the research and development, manufacture, application or sale of clean technologies. In other words, this definition would not only include "pure play" companies that are primarily engaged in R&D or the manufacture or sale of clean technologies, but also companies with clean technology business lines that would not necessarily be classified as clean technology firms. This patent analysis may provide some further insights into companies that are active in the clean technology sector, but may not emerge through other data collections.

FEDERAL-PROVINCIAL-TERRITORIAL WORKING GROUP ON CLEAN TECHNOLOGY, INNOVATION AND JOBS

A consensus has emerged from the Federal-Provincial-Territorial Working Group on Clean Technology, Innovation, and Jobs that "there is a significant opportunity to better stimulate economic growth and job creation, and improve environmental outcomes across all sectors in Canada by driving clean technology innovation." CIPO's research will provide an analytical link between goals and action by demonstrating where Canadian firms and researchers may have relative patenting advantages globally. There is an opportunity to align our development of domestic clean technologies and products with those sectors identified as priority opportunities by the provinces and territories.[13]

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[12] The Canadian System of Macroeconomic Accounts lays out the concepts, accounts and accounting rigour required to produce a set of integrated and internally consistent accounts. It also affords the compiler the flexibility of variation, and in a sense 'expand' the framework to address a specific need. At the limit, this 'expanding' is referred to as satellite accounting. These satellite accounts do not change the underlying concepts of the core system but provide an expanded perspective on a particular sector, group of products or activity.

[13] Discussion Paper of the Working Group on Clean Technology, Innovation and Jobs (2016)

THE FUNDAMENTAL SCIENCE REVIEW

HIGHLIGHTS

- Budget 2016 committed to a Fundamental Science Review in order to optimize federal funding in a manner that sustains and strengthens Canada's scientific excellence.
- The review, chaired by Dr. David Naylor, was tasked with examining government support for fundamental research in Canada, primarily through the granting agencies and the Canada Foundation for Innovation, and making recommendations to strengthen the system.
- The review represents a core component of the Innovation Agenda, as it lays out the conditions for effectively supporting scientists and advancing knowledge.

BACKGROUND

Budget 2016 announced a Fundamental Science Review to explore how federal science programs that support research conducted at higher education institutions can remain relevant and keep pace in a changing world. An expert panel has been appointed to conduct an in-depth analysis of issues related to the fundamental (or basic research) end of the research spectrum, with a particular focus on what is needed to sustain and strengthen Canada's science excellence.

"Our government must ensure its support for fundamental research is coherent, effective and agile enough to keep pace with the dynamic nature of contemporary science."
—The Honourable Kirsty Duncan, Minister of Science

Higher education institutions, including universities, colleges and polytechnics, are at the heart of the research and development process and play a vital role in advancing knowledge. In 2015-16, the federal government spent $10.5 billion on science and technology (S&T), 30 percent of which ($3.2 billion) was provided to the higher education sector. This funding to the higher education sector supports activities that can be broadly categorized into four foundational elements: the direct costs of research, the indirect costs of research (overhead costs associated with managing research), research infrastructure, and research talent. Federal funding for these elements flows primarily through the three granting agencies: Natural Sciences and Engineering Research Council, Social Sciences and Humanities Research Council, and the Canadian Institutes of Health Research. The Government of Canada also provides support to third-party organizations such as the Canada Foundation for Innovation (CFI), Genome Canada, and the Canadian Institute for Advanced Research.

In 2015-16, the combined S&T spending of the three granting agencies was $2.9 billion, which accounted for more than 90 percent of the total federal government S&T expenditures allocated to the higher education sector. It should be noted that this funding extends beyond fundamental science and supports the full spectrum of research from basic to applied. Furthermore, the government also indirectly supports the development of scientific capabilities through a number of initiatives, including: NSERC's Promoscience, which is focused on science promotion; and the Post-Secondary Institutions Strategic Investment Fund, which makes investments to accelerate strategic construction, repair and maintenance activities at universities and colleges across Canada.

Table 1: S&T Expenditures by the Three Granting Agencies, 2015 - 16

• Natural Sciences and Engineering Research Council:	$1.1 billion
• Canadian Institutes of Health Research:	$1.0 billion
• Social Sciences and Humanities Research Council:	$0.7 billion*
COMBINED TOTAL:	**$2.9 billion**

Source: Statistics Canada
* Includes funding for Research Support Fund.

WHAT IS THE REVIEW'S MANDATE?

The review focuses on areas of federal responsibility related to fundamental research and its scope includes the three granting agencies along with federally funded organizations such as the CFI. The review's mandate includes:

1. evaluating the effectiveness, efficiency and relevance of existing programs;
2. assessing whether these programs and instruments have kept pace with a changing domestic and global research landscape; and
3. determining how they can evolve to support research in the most strategic and effective ways.

Figure 1: The Mandate

The review tackles a number of challenges facing research, including multidisciplinary and international research collaborations, support for emerging researchers, funding for platform technologies (e.g., genomics, stem cells) and research areas of broad strategic and social relevance, support for infrastructure and big science, and the optimal balance of resources across the science ecosystem (i.e., the four foundational elements of federal support for post-secondary science).

It will also identify any gaps in support for fundamental research and detail how Canada may learn from the experiences of other countries in addressing these gaps. Ultimately, the objective is not only to maximize gains for the research community, but also for all Canadians who benefit from the economic, social, health and environmental advancements made possible by scientific discoveries.

WHO IS CONDUCTING THE REVIEW?

The Fundamental Science Review was officially launched on June 13, 2016 with the appointment of the Expert Advisory Panel by the Minister of Science, the Honourable Kirsty Duncan. This independent body was assembled to provide impartial advice and recommendations to the Minister. Chaired by Dr. David Naylor, former President of the University of Toronto, the Panel includes eight other experts drawn from a range of disciplines and experience.

Table 2: Members of the Expert Advisory Panel

- Dr. David Naylor, Chair, former President, University of Toronto
- Dr. Robert Birgeneau, former Chancellor, University of California, Berkeley
- Dr. Martha Crago, Vice-President, Research, Dalhousie University
- Mike Lazaridis, co-founder, Quantum Valley Investments
- Dr. Claudia Malacrida, Associate Vice-President, Research, University of Lethbridge
- Dr. Arthur McDonald, former director of the Sudbury Neutrino Laboratory, Nobel Laureate
- Dr. Martha Piper, interim President, University of British Columbia
- Dr. Rémi Quirion, Chief Scientist, Quebec
- Dr. Anne Wilson, Canadian Institute for Advanced Research Successful Societies Fellow and professor of psychology, Wilfrid Laurier University

The Panel is supported by a dedicated secretariat housed at Innovation, Science and Economic Development Canada, which provides analytical, advisory, and administrative services.

WHY IS THE FUNDAMENTAL SCIENCE REVIEW NECESSARY AND HOW DOES IT RELATE TO THE INCLUSIVE INNOVATION AGENDA?

Strong and sustained support for world-class excellence, from fundamental to applied science, is a critical foundation of Canada's innovation performance and economic growth. While transformative technologies have always started with curiosity-driven fundamental research, innovation depends on strengthening the full spectrum of basic and applied research capabilities while simultaneously promoting partnerships with businesses.

Canada's higher education research is highly regarded internationally and represents a strong asset for positioning Canada as a global centre for innovation. For instance, according to the OECD, Canada ranks 3rd in terms of the number of its universities that appear on the top-30 rankings of top-cited publications. However, it is valuable to review our fundamental science, given that we face questions such as whether existing federal support for fundamental science is optimally structured and delivered so as to meet the needs of science and scientists in Canada. Globalization, disruptive technologies and demographic changes are increasing pressure on Canadian researchers, businesses and government. To address the growing complexity of these challenges, research must increasingly be supported by state-of-the art infrastructure and conducted across disciplines, sectors and borders. In this context, the review is intended to identify existing gaps in the government's support for fundamental science and recommend how to rebalance and strengthen science and scholarship in Canada.

The review of fundamental science is a core component of the Government's Innovation Agenda, which anchors the government's vision for Canada's economy as a global leader in innovation. By strengthening Canada's global science excellence, the review will improve Canada's capacity for fundamental research and better enable researchers to pursue their best ideas and generate breakthroughs.

In short, the Fundamental Science Review is about ensuring Canadian scientific excellence and effectively supporting scientists, while the Innovation Agenda will consider how to translate that science excellence into applications and innovations that improve the economy and enhance the quality of life of Canadians.

HOW HAS THE PANEL ENGAGED CANADIANS?

The Advisory Panel has sought input on how to optimize support for fundamental science in Canada from both the research community and everyday Canadians. On June 13, 2016, the same day that the Panel was appointed, an online portal was launched so that all interested parties could provide input on the Panel's mandate. Over 400 submissions were received through this initial process. Subsequently, the Panel developed sets of questions that dove deeper into topics of relevance for different segments of investigator-led research in Canada (e.g., funders, administrators, researchers, students, etc.). By the time the online consultation closed on September 30, 2016, the Panel had received over 850 additional submissions.

The Panel consulted with the three granting agencies, the CFI, and other agencies or organizations that distribute federal funds to support investigator-led research. It also held roundtable discussions across the country to consult with various groups on specific topics such as early career researchers, diversity, big science, multidisciplinary research, and international research collaborations.

WHAT IS EXPECTED TO COME OUT OF THE REVIEW?

The panel is currently finalizing its report. The panel's report is expected to provide the federal government with advice on how to strengthen Canada's international standing in fundamental science and ensure that Canada's scientists have the tools, training and support needed to excel globally. The Science and Innovation Sector will take the lead in developing the federal government's response to the panel's findings.

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INNOVATION SUPERCLUSTERS: SUPPORTING CLUSTER DEVELOPMENT AND GROWTH IN CANADA

HIGHLIGHTS

- Clusters – private and public organizations inter-linked by their activities – play an important role in spurring innovation and economic growth.
- ISED is working to build a Canadian cluster mapping portal to identify and analyze Canadian clusters, and is designing a new Innovation Superclusters Fund.
- This initiative represents ISED's response to the Budget 2016 commitment of $800 million over four years to support innovation clusters in Canada.

BACKGROUND

Globally, companies are grappling with an unprecedented rate of technological change. To address key challenges, firms are partnering in new ways to create innovative solutions that would be beyond the scope of any single firm to deliver on their own. Industry leaders, whether they be start-ups, small and medium-sized enterprises (SMEs), or large corporations, are adopting models involving multi-sector collaboration, open innovation, and partnerships with researchers and post-secondary institutions. They are embracing projects with competitors to avoid disruption, and building new value chains with many other supply chain participants to accelerate their efforts and reduce risk. The development and growth of clusters that can attract global recognition depends upon assets and characteristics – some business-led and some offered by the public sector – that can provide advantages for the firms comprising it. This article examines the role of ISED in identifying current clusters and building a strategy to support the growth of key clusters in Canada.

In a globalized world, clusters can provide firms with advantages that contribute to long-run growth.

Clusters are recognized as geographically proximate entities linked by their interdependencies and reliance on specialized inputs in providing a related group of products and/or services. Collaborations take place within, and sometimes between, clusters in order to build on ideas and capabilities that support innovation and growth across varied, but related, sectors and subsectors of the economy. Around the world, government programs designed to commercialize research, solve

industry-relevant challenges or drive future economic growth are linked to the development of stronger innovation networks and clusters. Examples include Manufacturing USA (formerly the National Network for Manufacturing Innovation), Germany's Fraunhofer-Gesellschaft, and the United Kingdom's Catapult Programme, each of which encourage new and stronger linkages between research talent and industrial partners, creating productive relationships between firms and providing them with a competitive edge.

Clusters play an important role in spurring innovation, facilitating commercialization, enhancing firm productivity and operational efficiency, stimulating the formation of new companies and the growth of established ones, and achieving industrial competitiveness. The archetype of a successful cluster is Silicon Valley, where the business environment and world-leading academic institutions have combined to produce waves of product, process, and business model innovations, and support the global competitiveness of firms located within the cluster.

Manufacturing USA has established nine manufacturing innovation institutes over the past four years, with six more planned for 2017. Each institute is a public-private partnership with a distinct technology area of focus. The common goal of the program is to secure America's future through manufacturing innovation, education, and collaboration.

Fraunhofer-Gesellschaft (Fraunhofer Society) is a network of approximately 70 German institutes for applied research that translate basic research from university and non-university research organizations into demand-driven commercial products and industrial processes for German industry. Each Fraunhofer institute specializes in a particular technology or sector, covering a total of 250 research areas.

The Government of Canada has also turned its attention to clusters, recognizing them as engines of innovation that support the development and growth of globally competitive companies.

IDENTIFYING CLUSTERS IN CANADA

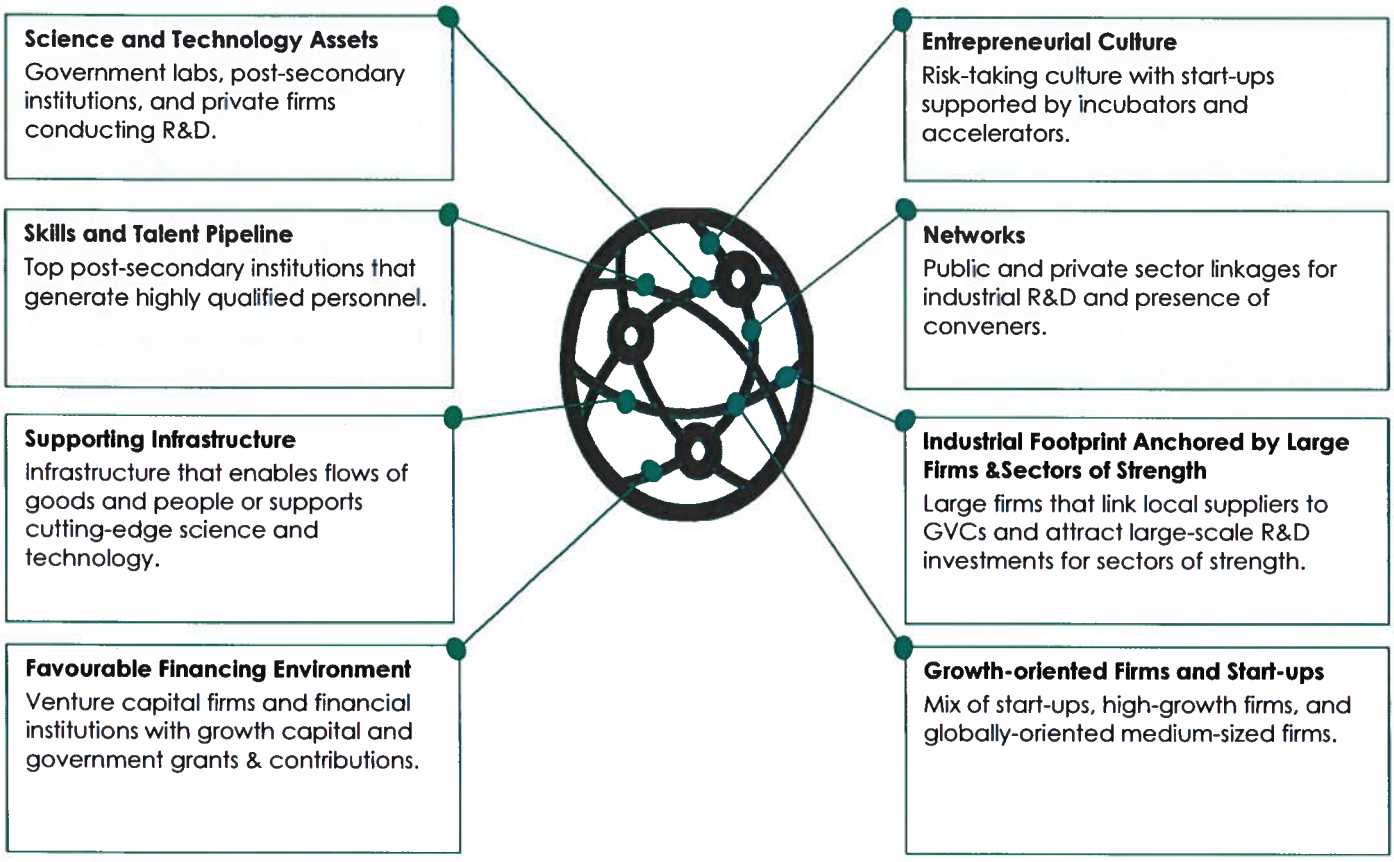
ISED's Manufacturing and Life Sciences Branch (MLSB) has developed an analytical framework for identifying and assessing clusters. The analytical framework will inform the architecture of the Canadian Cluster Mapping Portal – a Budget 2016 commitment – to visually showcase economic strengths and capabilities across the country.

Across the country, Canada has existing cluster strength in key sectors and technological areas.

MLSB's analytical framework acknowledges that a cluster's health is strengthened by its innovation assets and the linkages between these assets. Healthy clusters (Figure 1) often include small growth-oriented firms, robust multinational enterprises (MNEs), science and technology assets, enabling infrastructure, a pipeline of skills and talent, and an entrepreneurial culture supported by a favourable financing environment (e.g. venture capital, financial institutions offering growth capital, government grants and contributions, etc.). However, a healthy and prosperous cluster requires more than the presence of such assets. Innovation networks linking assets, industries, researchers, and government are critical to the development and growth of successful clusters. Strong linkages will accelerate economic growth and foster the critical mass needed for innovation to thrive in the face of global competition.

To support the development of the Canadian Cluster Mapping Portal, MLSB has been in dialogue with provincial and territorial counterparts to develop a Canadian data set, which includes cataloguing key assets across the country such as leading research institutions, trade corridors, and science and technology assets. Once a Canadian data set is complete, the Canadian Cluster Mapping Portal will underpin the department's analysis of clusters, and provide an evidence base that informs the design and delivery of programs in support of cluster growth.

Figure 1: Attributes of Healthy Clusters



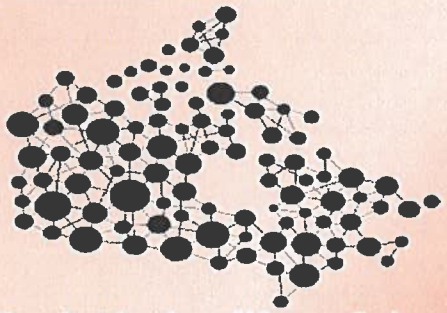
INNOVATION SUPERCLUSTERS AND THE INNOVATION AGENDA

The Government's Innovation Agenda recognizes that the development of world-leading clusters is central to building Canada into a global centre for innovation, achieving competitiveness, and growing global companies. To support cluster growth and development in areas where Canada is, or has the potential to become, a hotbed of innovation, Budget 2016 committed up to $800 million over four years to support innovation networks and clusters.

The Industry Sector's new Innovation Networks and Clusters Branch (INCB) is working to advance this commitment through the development of the Innovation Superclusters Fund. This large-scale initiative is designed to concentrate efforts and resources by supporting a small number of high impact investments.

Engagement will lay the foundation for program success. Consequently, INCB has been engaging stakeholders to identify Canada's regional and technological strengths and ensure effective program design and delivery. Many parts of ISED, including the Regional Offices, have actively contributed to identifying Canada's regional and technological strengths, as well as determining which valuable stakeholders need to be engaged as part of the design process. An announcement launching the Innovation Superclusters Fund will take place in 2017. Subsequently, it is expected that industry will be invited to express its interest in the program and identify the key technologies that the government should support and invest in.

This initiative aims at fostering the growth and development of world-leading clusters in Canada. By aligning resources – both public and private – that already contribute to a strong innovation ecosystem and targeting them on priority areas, federal investments can enhance a broad range of outcomes, including: fostering partnerships between SMEs and MNEs; driving firm creation; building and strengthening value chains; improving access to financing; increasing industrial research, development and demonstration; accelerating technology advantage and the commercialization of ideas; and, fostering company growth through the development of new products and the expansion of market access. Ultimately, clusters can help position Canada as a technology partner of choice and a prime destination for investment.



"These investments would focus on the key platform technologies that will drive growth across industries—areas where Canada has the potential to show global leadership. We have heard from Canadians that targeted, high-value investments will have greater impact than spreading ourselves too thin. That means we need to make strategic choices. And we'll need to be guided by leaders like you." **—The Honourable Navdeep Bains, Minister of ISED** at the Waterloo Innovation Summit, September 2016.

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TOWARD A "TELL-US-ONCE" APPROACH TO SERVICE DELIVERY

HIGHLIGHTS

- The Government of Canada must keep pace with technology advances to address the changing needs of Canadians. This means delivering integrated, innovative, and client-focused services.
- ISED has developed a Service Management Strategy with two goals: instituting a sustainable department-wide culture of service excellence; and delivering innovative, integrated, client-centric digital services.
- In doing so, ISED will adopt a "Tell-Us-Once" approach to service delivery, so that clients will not need to repeat information they have already provided to the Department when receiving services.

BACKGROUND

Do you remember life before bank machines, Interac, and credit cards? Can you recall running to the bank to grab cash before the weekend, or getting foreign currency or travellers cheques before a trip?

Banks, as institutions, used to be big, unyielding, and inflexible. Canadians had limited choice, and limited service options. Business was done on their time, on their terms, and in their offices. However, times have changed.

Using technology, banks have redefined their service delivery model, meeting clients anytime, anywhere, and on any device. They now analyze savings and spending habits of their clients to develop and provide value-added products and services targeted to their needs and lifestyles. Today, you can even take a picture of a cheque to make a deposit.

If you look around, you will see that such changes extend beyond just the banking industry. Throughout the economy industries are transforming: Facebook, one of the largest media companies, creates no content; Airbnb, one of the world's largest accommodation companies, owns no real estate; and Uber, one of the world's largest taxi companies, owns no vehicles.

Successful companies are using technology to redefine business models, improve their value proposition, and exceed customer expectations. These private sector innovators now set client service expectations, which now extend to government services. To stay relevant, government needs to be a fast follower of these leaders and provide Canadians with the simple, fast and integrated services that they demand, deserve, and expect. Governments must move beyond simple static web pages and feedback forms, and adopt a truly integrated and client-focused approach to service delivery.

> *"In an age of instant communications, Canadians expect quick results, while governments are often stuck using old, slow approaches that fail to meet expectations."*
>
> **Message from the Auditor General, Fall 2016**

This article presents a summary of Innovation, Science and Economic Development Canada (ISED) efforts to move toward a "Tell-Us-Once" approach to service delivery by instituting a sustainable department-wide culture of service excellence, and delivering innovative, integrated, client-centric digital services.

OUR SERVICES TODAY

Like banks, governments have been around for a long time. Our programs have grown and evolved, and are managed as independent business units. Behind the scenes, there are a large number of disparate processes, databases, and systems that do not work together or effectively communicate with each other. While each individual program may provide a high-quality service, collectively, the whole becomes less than the sum of its parts. Consider that within ISED, a single federal government department:

- Services are delivered through 100+ websites and 29 contact centres, with 15 different logins;
- Payment methods are inconsistent – Some accept Interac e-transfers, others use credit card payments but only over the phone, while others are still accepting cash or cheques;
- Common identification for business is lacking – Only one of our units uses the Canada Revenue Agency Business Number, a standard identifier for businesses; all others have their own identification system;
- Client data is not shared – When moving between ISED business units, federal departments, or other levels of government, our clients must repeatedly enter information at each encounter with "the government."

The result is a mish-mash of offline and online service experiences for our clients. In response, many clients call or visit to resolve their issues, which is time consuming and expensive for them and for us.

WHERE ARE WE GOING?

To address these inconsistencies, ISED has launched the "Service Management Strategy," which is built on a Tell-Us-Once approach to service delivery. We are focused on achieving two goals in the next five years.

First, we will institute a sustainable department-wide culture of service excellence. It is time to integrate, streamline, and design services for, and with, our clients. We must develop a culture that demands enterprise-wide thinking, data sharing, and services that "speak to one another." Our department must act as a single organization.

Second, we will deliver innovative, integrated, and client-centric digital services. This includes implementing five key elements across the Department:

- Identity management – one-time login with no need to re-authenticate when accessing multiple services;
- Business Number adoption – the standard identifier for every business;
- Client relationship management – holistic view of client interaction history across the Department;
- E-payment and e-billing – standardized and convenient solutions for clients;
- Real-time status updates – real-time tracking of client service requests.

> *"Government departments and agencies need to look differently at their positions as service providers. Government as a whole needs to identify the services that will be disrupted by technology, and it needs to be good at service delivery to remain relevant."*
>
> ***Message from the Auditor General, Fall 2016***

This is just the beginning. As we get our own house in order, the Tell-Us-Once approach becomes truly transformative when we expand our scope, and support clients as they move across departments and jurisdictions. For example, a company would be able to incorporate at ISED and seamlessly navigate to Export Development Canada when it is time to ship a product, or Global Affairs when moving into new markets, without needing to login again, or repeat information that has already been provided.

BENEFITS OF DIGITAL TRANSFORMATION AT ISED AND LINKS TO THE INCLUSIVE INNOVATION AGENDA

Collectively, the initiatives outlined in ISED's Service Management Strategy will lead to services that are responsive to evolving client expectations. Irritants such as multiple logins and repetitive data entry will be eliminated, and over the longer-term, we will focus on integrating service delivery throughout the federal-provincial, territorial and municipal landscapes.

Clients will benefit from reduced paperwork and frustration, saving them time and money and improving trust in our services. Government will benefit from improved client satisfaction, process efficiencies and the ability to aggregate client data, which will inform future service, program, and policy decisions.

The Tell-Us-Once approach to service delivery aligns well with the Innovation Agenda. To foster an entrepreneurial and creative society, government must play its part by making our services simpler for clients. By adopting a Tell-Us-Once approach to service delivery, the Government of Canada will be making it easier for businesses to deal with government, saving them time so that they can focus on innovation and growth.

JOIN THE CONVERSATION!

Interested in this new approach? Then join the conversation at the GCconnex Group on Digital Government. Share your thoughts on improved service design and delivery, and help us make the Tell-Us-Once service experience a reality.

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INSIGHTS DATA TABLE

Monthly Economic Indicators

	Reference period	Month-over-month growth (at monthly rates) Latest month	Prev. month	2 Months before	Q-o-q growth 2016Q3	Year-over-year growth 2015	2014
Mfg sales (current $)	Dec '16	2.3	2.3	-0.7	1.3	-1.7	5.3
Mfg sales (constant $)	Dec '16	2.3	1.8	-1.6	0.4	-1.2	2.8
Retail trade (current $)	Nov '16	0.2	1.2	0.9	0.3	1.7	4.6
Retail trade (chained $)	Nov '16	0.7	0.6	0.8	0.4	1.2	3.5
Real GDP	Nov '16	0.4	-0.2	0.4	0.5	0.9	2.6
-Services	Nov '16	0.2	0.1	0.1	0.5	2.1	2.4
-Manufacturing	Nov '16	1.4	-1.7	0.3	0.2	0.2	3.0
Exports (bop) (current $)	Dec '16	0.8	5.1	0.8	4.9	-0.7	10.3
Imports (bop) (current $)	Dec '16	1.0	-0.2	-5.4	2.5	4.5	7.6
All-items CPI	Dec '16	-0.2	-0.4	0.1	0.1	1.1	1.9
Core CPI	Dec '16	-0.3	-0.5	0.2	0.2	2.2	1.8
LFS employment (Δ in 000s)	Jan '17	48.3	46.1	-2.4	74.2	152.4	108.2
Unemployment rate (%)	Jan '17	6.8	6.9	6.8	7.0	6.9	6.9
US employment (Δ in 000s) (CPS)	Jan '17	-30.0	63.0	146.0	836.0	2,509.0	2,780.0
US unemployment rate (%)	Jan '17	4.8	4.7	4.6	4.9	5.3	6.2

Financial Indicators

	Reference period	Current value	Monthly average Latest full month	Prev. month	2 Months before	Annual average 2016	2015
Bank rate (%)	Feb 15 '17	0.75	0.75	0.75	0.75	0.75	0.88
Exchange rate	Feb 15 '17	130.8	131.9	133.3	134.4	132.6	127.9

Quarterly Economic Indicators

	Reference period	Quarter-over-quarter growth (at annual rates) Latest quarter	Prev. quarter	2 Quarters before	Year-over-year growth 2015	2014
Real GDP	2016Q3	3.5	-1.3	2.7	0.9	2.6
Final consumption expenditure	2016Q3	1.6	2.7	2.7	1.8	2.2
Gross fixed capital formation	2016Q3	-1.3	-0.4	-1.1	-4.6	0.9
-Machinery & equipment	2016Q3	-12.2	4.1	-2.2	-3.3	1.2
Exports	2016Q3	8.9	-14.8	9.0	3.4	5.8
Imports	2016Q3	3.3	1.4	2.3	0.3	2.2
Final domestic demand	2016Q3	0.9	2.0	1.8	0.3	1.9
Labour productivity	2016Q3	5.0	-0.9	1.7	-0.6	2.7
Unit labour cost	2016Q3	-2.7	3.1	-0.9	2.6	0.8
Industrial capacity utilization (%)	2016Q3	81.9	79.7	81.2	81.1	82.4
Real US GDP	2016Q4	1.9	3.5	1.4	2.6	2.4