McGill | MAX BELL SCHOOL of PUBLIC POLICY

# Improving Demand-Driven Innovation Policies in Canada

**Ana Gama Dias, Mauricio Horn, Eunice Mercado-Lara, Momanyi Mokaya, Francois Provencher**.

July 8, 2020

# Acknowledgements

We would like to thank the following people for their valuable support and guidance:

Our sponsor- Innovation Science and Economic Development

Our coach- Samer Faraj

The expert interviewees:

Aled Edwards — Structural Genomics Consortium, Chief Executive
Alejandro Martinez — Ramos, MTL NewTech, Programming Director & Team Coordinator
Allyson Hewitt — MaRS Solutions
Amélie Arès — Mangrove, Canadian Ecosystem Gathering Facilitator
David Gobeille — Kaufman, Mangrove, Founder & Chief Executive Officer
Germano Guimarães — Grupo Tellus
Héctor Faya — Rodríguez, Facebook, Policy Programs Manager for Latin America
James Hughes — Executive Lead, Government and Partner Relations McConnell Foundation
Maxwell Morgan — Agora Open Science Trust, Chief Executive Officer
Mischa Hamara — Director of gBETA Toronto
Onyeka Uche Ofili International School of Management — Professor
Yorck R. Hernandez — Co-Founder of CrowdPatent

## Table of Contents

# 1. Executive Summary

This project deals with ways to stimulate innovation within the context of the Max Bell School's Experimental Policy Lab capstone project in collaboration with the Department of Innovation, Science and Economic Development (ISED). As requested by the client, the project focuses on the federal government's demand-driven levers of innovation policy and how ISED can refine its policies to tackle Canada's major innovation challenges. The student team's recommendations focus on addressing one such challenge, namely Canada's commercialization gap: although Canada is a world leader in scientific research and boasts one of the world's most diverse populations, it fails to translate new ideas into revenue-generating ventures.

A crucial step in the process of turning ideas into commercial products and services is the concept of intellectual property. Working in collaboration with ISED, the student team chose to focus its research on this field and to review existing government tools that aim to spur innovation by leveraging Canada's IP assets. The 2018 National IP Strategy calls for new approaches to IP management and innovation policy; as such, it represents a policy window for the student team to influence policy. Specifically, the student team recommends changes to one of the strategy's cornerstone projects: ExploreIP.

ExploreIP is Canada's new IP marketplace which contributes to the diffusion of technology in Canada. The tool is still in its development phase and its project team is actively looking for new ideas to incorporate into its platform. Based on economic analysis and on the latest research on innovation policy, the student team recommends making several key modifications to ExploreIP that could transform the tool into a valuable collaboration platform. These recommendations include making fundamental changes to the marketplace framework, such as including privately-owned IP assets, and adding new sections to the website to help a broader set of users connect with one another and make better use of government services.

Although the brief mostly focuses on improvements to a specific tool, it also explores ways in which Canada's innovations policies can be reflective of broader societal demands. Policies that focus on creating technological clusters and improving access to international markets have contributed to significant economic gains, but also to the perception among some that these gains have not been shared equally and have contributed to the "rural-urban" divide. More recently, governments have scrambled to meet the demands imposed by the COVID-19 crisis, and protests for racial equality have raised questions about the inclusivity of Canada's policies. There is a need to make the government more responsive and open to the needs of society, especially to members of underrepresented groups.

By making marginal improvements to existing tools and reviewing our innovation policies to make them more inclusive, we take small steps towards making our society not only more equitable, but also more efficient. Research suggests that innovation policies that improve access to an innovation system and promote collaboration between existing actors can lead to better innovation outcomes. With this in mind, we hope that our recommendations for ExploreIP can serve as a case study in how the government can continue to improve its policies by making them more demand-driven, open, and inclusive.

# 2. The policy challenge

ISED asked the team for deep insight into government intervention on the demand side of innovation policy. Therefore, the team defined the overall objective to advance policy innovation challenges where market failures act as a barrier to private sector investment and proposed new avenues for innovation policy. ISED allowed the team to consider the power of the government as a buyer and as an actor that seeks to develop solutions for public policy issues through an innovation lens and challenges. ISED also delimited a set of restrictions on the recommendations: the recommendation should not argue for a new measure of productivity or create a comparative evaluation as a solution. Moreover, implementing a microeconomic policy tool to support companies, or suggesting financial support, subsidies, or fiscal incentives, was also considered out-of-scope for this project.

# 3. Methodology

ISED gave the team a broad mandate in terms of improving demand-driven innovation policies, which gave the team a lot of leeway, but the Policy Lab mission specified that the team needed to produce recommendations that were concrete and usable. In grappling with the complexities of innovation policy, the team began its focus on arguably the most concrete part of innovation policy, which is intellectual property (IP). Having received positive feedback from ISED with regards to an approach focused on IP, the team scoped the project around an approach that would make improvements to Canada's IP system. We held two general video conference meetings with ISED to better understand the most adequate approach for the solution. Once the approach was clear, we held 10 semi-structured interviews with individual ISED officials in Ottawa to better understand specific ISED programs and other relevant public efforts in place.

Before drafting a solution, the team conducted a more comprehensive analysis of Canada's innovation performance internationally, and domestically between provinces, to highlight Canada's innovation opportunities. The team contextualized the problem from a demand-driven innovation perspective. We identified how this model is different from the traditional model and the benefits it provides. To provide a customized solution, we performed an analysis of Canada's innovation performance from a conventional metrics perspective. We also included a provincial analysis to identify and reflect provincial innovation capacities and to arrive at a comprehensive solution for the federal government that takes into account provincial disparities.

To explore beyond the arguments found in our literature review, the team conducted semi-structured interviews with relevant actors in Canada's innovation ecosystem to map their incentives and organic collaboration dynamics. We started by reaching out to innovation ecosystem management organizations; they connected us with relevant actors working in the innovation field and with tertiary industry actors providing essential services, such as financial services and consulting. From there we implemented a snowball sampling approach[1] to explore outside the traditional collaboration ecosystem.

We concluded that the ExploreIP website is an interesting case study to illustrate how concrete changes on a government platform can open up governmental processes, creating true open innovation policy solutions in the Canadian context. We also identified that opening communication channels for public policy design is not enough: it is necessary to create public policy mechanisms that systematically open spaces for collaboration for underrepresented groups to avoid exacerbating information silos. Therefore, we added a recommendation to improve inclusivity in the innovation process.

[1] Naderifar, Mahin, Hamideh Goli, and Fereshteh Ghaljaie. "Snowball Sampling: A Purposeful Method of Sampling in Qualitative Research." Strides in Development of Medical Education 14, no. 3 (2017). https://doi.org/10.5812/sdme.67670.

# 4. Demand-side innovation policies

The process by which new ideas take shape and are diffused to improve our standard of living has become far more complex since the invention of the wheel. Among the variety of actors and institutions within our post-industrial capitalist economies, firms have become pre-eminent in the innovation process and garner the most attention from governments and policymakers.

An enterprise led by individuals conceiving original and effective solutions grounded in society's needs does not evolve in a vacuum, but amidst enabling socio-historical conditions. A vernacular idea of visionary geniuses and manufactures as *suppliers* can camouflage a complex innovation cycle, which can be described as one of: emergence, creation, diffusion, adoption, obsolescence, and creative destruction[2] that relies on decisive *conditions*.

Some of these conditions are: the resources available (e.g. financial, supplies); the trade mechanisms in place (e.g. markets); human capital (e.g. skills, knowledge, and experience); incentives (e.g. income, awards, tenure); determined institutions (e.g.: R&D department, university's technology transfer office); rules (e.g.: intellectual property protection), and cultures.[3] The latter constitutes the broad scenario of our lives in which innovative goods and services have *meaning*, purpose, and become noticeable as individual needs or interests, thus configuring social *demand* for innovation.

Government policies that acknowledge this complexity are able to look beyond supporting a firm's innovation capabilities to comprehensively enhance all conditions; they can align feasibility, technical and economic variables with the pursuit of the public interest, looking after the relevancy, broader impact, and outcomes of the innovations, as well as their social and environmental sustainability.

In this comprehensive approach, we place *demand-side innovation policies* (hereafter DSIP): the government's unique potential to intervene with planned instruments and measures that facilitate the creation of such multidetermined conditions, focusing on individuals' dispositions to obtain, consume, or utilize certain innovations.

However, government intervention through DSIP is partially based on its effectiveness, given that policies exclusively supporting the supply of innovation cannot succeed without a corresponding demand. It is equally based on understanding *demand* beyond the 'quantity of what consumers are willing and able to purchase', thus including identified needs to face crises and global development goals (comprising environmental protection, job creation, public health or other dimensions of individual wellbeing and social development) that likewise require innovation.

Increasingly, scholars and policy analysts are stressing the diversity of variables available to —effectively or potentially— pull demand for innovation[4].[5] Most of them correspond to those levers available that can be embedded into governments' existing instruments, despite the fact that they were not primarily conceived for this purpose. For instance, citizens' pecuniary contribution to governments are primarily used to fund state revenue; but a fine or tax can also be used to disincentivize the consumption of a technology in order to accelerate its obsolescence and replacement —thus furthering innovation —, or the opposite: a tax rebate can be used to accelerate the diffusion of a certain innovation. Other policies are not monetary, such as a

[2] Schumpeter, *Capitalism, Socialism, and Democracy*, 84.

[3] We highlight this cultural dimension of the demand for innovation, as Demand Side Policies are often framed exclusively from a quantitative economic framework, and we aim to bear in mind that the needs, interests, motivations that drive peoples' demands for innovative goods and services are not universal. While there is a tendency to adopt Occidental Culture consumption patterns as prevalent, our ascription to Canada's cultural diversity, multicultural and inclusivity policy frameworks lead us to acknowledge that innovation has an ethnographic component. Simply put, what is innovative for some social groups may not be equally for others.

[5] Edler, "Demand-Based Innovation Policy," 496; Edler, "Review of Policy Measures to Stimulate Private Demand for Innovation. Concepts and Effects"; Inno AG et al., "Supply and Demand Side Innovation Policies."

government campaign; while these were primarily conceived for public health or safety (e.g. reducing alcohol consumption, wearing seat belts), these policies can be adapted to promote innovation consumption (e.g. advising on safety of bioengineered food). These examples are meant to highlight that from our preliminary review, we conclude that DSIP are mostly policy measures implemented on top of pre-existing policies, a rationale that we consider can serve as a guide to further design new measures.

This section presents a mainstream definition of existing demand-driven policy tools as a model and highlights relevant features of these kinds of tools for the policy brief. It will also introduce key considerations for a successful implementation of demand-driven innovation policy.

## Demand-driven innovation model

A demand-driven model belongs to a framework in which innovation dynamics can be incentivized by pushing (supply-side) and by pulling (demand-side). This derives from the understanding that innovation requires market opportunities that are not given and static, but can be altered if effectively *pulled*:

> "These theories focus not on the beginning of the innovation chain but on its end: the marketplace. Demand is thus the force that directs resources and capabilities for innovation to meet societal needs (Schmookler, 1966; Rosenberg, 1969[6]). As a consequence, a demand-side policy approach focuses on boosting demand and on encouraging suppliers to meet expressed user needs [aiming to] reduce the barriers to innovation and stimulate the emergence or redesign of markets"[7]

DSIP are understood to be those policies that aim to create or improve determined conditions known to increase the demand for innovations. They can be pursued by government measures such as lifting or reducing consumption barriers, altering individuals' behaviours in their patterns of consumption. Levers such as price, cost-benefits, and individual needs, preferences or tastes are well-known and seem to dominate among the alternatives in policy design. Also, the consumer's choice to comply with regulations (such as purchasing a home heating system that meets municipal standards) or to fulfill emerging social values (such as opting for a product made from recycled materials or by a producer known for providing better labour conditions) are other examples of culturally biased levers needed to nourish a policy design.

Some theories shed light on the availability of information and communication as a lever, since users who do not know about the availability of an innovation cannot articulate the corresponding demand.[8] The information asymmetries are considered market failures that prevent individuals' fragmented needs from articulating and configuring a demand for innovation; it is argued that by articulating such needs, government DSIPs can produce the scale-effects to effectively *pull*.[9] More information on the factors affecting demand-driven tools can be found in Appendix 1.

Differentiations between innovation stages or cycles over time provide insights into the proper timing and strategy in the policy design process. Our review reveals general agreement on the efficacy of DSIP when diffusion of existing innovations is mostly needed, such as when a given technology is not entirely new but can be considered innovative when used in a different context or for new applications. In this case, a pull strategy is the most adequate to incentivize its spread. In contrast, during the early stages of an innovation, experts agree on the efficacy of a traditional supply/push policies (such as funding the development with R&D grants).

[6] Schmookler, *Invention and Economic Growth.*; Rosenberg, *The Direction of Technological Change*.
[7] Organisation for Economic Co-operation and Development, *Demand-Side Innovation Policies*, 18.
[8] Jakob Edler, *Demand-Based Innovation Policy* (Manchester: Manchester Business School, University of Manchester, 2007); Jakob Edler, "Demand-Based Innovation Policy," in *The Theory and Practice of Innovation Policy : An International Research Handbook*, PRIME Series on Research and Innovation Policy in Europe (Edward Elgar Publishing, 2012), 496–496.
[9] Cervantes, "Demand-Led Innovation: What Role for Policy?," 6.

The following typology introduces the main instruments of demand-driven policies. A more detailed description of each type of measure is provided in Appendix 2.

The following list provides some examples of demand-side innovation policies:

- Public procurement
- Public purchase for private use, or catalytic procurement
- Innovation-orientated rebates
- Innovation-orientated regulatory policies
- Standards and certifications
- Consumer awareness
- Combinations of instruments and systemic approaches

## Key considerations for implementing demand-driven policies:

- **Disincentivizing innovation.** Some instruments may vary in how effectively they promote innovation demand. While procurement or education can eventually produce no impact if wrongly implemented, they will hardly act to disincentivize innovation. However, other measures, such as regulations and standards, when misused or outdated, can potentially constrain innovation demand, vouch for the status quo, and/or promote obsolete technologies.[10]

- **Cost-efficiency.** Even if a DSIP attains its objective, it might not be cost-effective. For instance, while government regulations can contribute to meeting better standards that induce innovation, this will create a cost burden on firms to adopt modern technology, a cost which will be borne by end-users[11]; additionally, governments assume higher costs when purchasing more innovative products and services.

- **Identifying levers.** Analysts have difficulty isolating each tool and how specific levers shape innovation. Innovation itself often takes a complex, sinuous path and cannot rely on the launch of an economic stimulus or a regulatory framework. These policy instruments aim to configure the broad social conditions for demand, that is, to pull innovations that have their own inherent dynamics, such as the current state of the research in specific scientific disciplines, and that have many contingencies and uncertainties, such as a global pandemic.

- **Supply-side responses.** Efforts to stimulate innovation from the demand-side need to consider the many supply-side responses that will be required, along with existing barriers to implementation.

[10] The controversy among scholars on whether standards and regulations hamper or stimulate innovation (Johnstone, Haščič, and Kalamova, "Environmental Policy Design Characteristics and Technological Innovation"; Ortt and Egyedi, "The Effect of Standards and Regulation on Radically New Innovations"; Swann et al., "The Economics of Standardization: An Update"; Swann and Lambert, "Why Do Standards Enable and Constrain Innovation?") is profusely grounded in data and literature of maximum relevance to be examined for the design of policy instruments; a relevant feature of this growing controversy is about how 'healthy' constraints have a positive effect over innovation (Acar, Tarakci, and Knippenberg, "Why Constraints Are Good for Innovation."). For a more detailed view on the Canadian Standards-Innovations liaison amidst the Covid-19 scenario, see: Standards Council of Canada, "The Innovation Initiative.".

[11] Organisation for Economic Co-operation and Development, *Demand-Side Innovation Policies*, 49.

- **Supply-side negative effects.** Theory points to a possible accommodation of firms to a government's DSIPs in ways that limit the effort of continued innovation; in the case of a "created demand" (e.g. through procurement), producers may not feel pressure to invest in further improvements to a technology, thereby restricting the innovation trajectory to a sub-optimal level[12]

- **Complexity of the public sector.** Lessons drawn from recent experiences, especially with procurement measures, show evidence of barriers to implementation. A preliminary evaluation by the U.K. government[13] points to the difficulties of identifying who *holds* each demand-side lever within a vast number of bodies and a complex structure within a risk-averse culture. Moreover, it also points out that the skills and organizational incentives of public servants need to be aligned: e.g. changes to the procurement manual do not necessarily result in changes to the practice of procurement.

## Summary – Demand-side innovation policy and the current context

The incorporation of DSIPs in the domestic policy agenda and, ultimately, the implementation of consistent stimulus instruments, are the missing pieces of the puzzle, pieces that that can, when combined with intellectual property protection, complete the picture for Canada's innovative industries, allowing them to succeed in a risky and highly competitive post-Covid-19 business environment.

Traditional supply-side incentives (such as grants or subsidies) that target the innovation of domestically produced goods and services, combined with regional and global legal conditions to protect Canadian inventions and creativity, are insufficient to succeed alone, especially amidst an ongoing economic recession and shrinking markets.

Changes in the context can create new demands for innovation, this can be analyzed in two recent events. The Covid-19 pandemic, and the urgent need for health supplies, delivered clear lessons to policymakers on the role of policy in identifying and anticipating product gaps and on the powerful role that governments can play in mobilizing innovative industries through public procurement. These lessons can cross-pollinate innovation policies in other technology fields and industrial sectors, as well as potential future circumstances similar to those resulting from this pandemic. Another example that policymakers are called to react and can expect more demands in the future is the Black Lives Matter movement. Started in the US and rippled through the world, currently the movement demands more police accountability, but it also sheds a light on structural racism and all institutions are called to action. Concrete actions are demanded to private organizations and governments to innovate in pursuing safety, accountability, and equality public provision. This is also an opportunity for the government to mobilize innovators to tackle these pressing issues, but also to create measures of inclusiveness in innovation.

The OECD[14] has collected a great number of DSIP from its members. Besides the known case of governments using their purchasing powers to stimulate public demand for innovation, countries with high pressures on their fiscal budgets have explored and tested other creative instruments to boost their innovative industries without engaging in major spending. Drawing lessons from OECD country cases and experiences, we foresee great potential for this new breed of policies that pursue matching and accompanying innovation trajectories from discovery and inception on the supply-side by pulling towards public and private consumption. The positive evaluation of the demand-side instruments furthermore makes the case for orientating innovation to meet strategic demands in areas such as environment, energy, health, and social inclusiveness. This would

[12] Organisation for Economic Co-operation and Development, 13.
[13] Evans, "Key Issues in Demand-Side Innovation Policies."
[14] Organisation for Economic Co-operation and Development, *Demand-Side Innovation Policies*.

include effectively targeting start-up companies and SMEs demonstrating innovation in the context of Canada's Covid-19 recovery strategy.

On the other hand, the Conference Board of Canada measures IP as a function of innovation performance through patents. Specifically, it compares peer jurisdictions on the number of patents they produce per 100,000 people. However, many critics believe that supply-side policy interventions that aim to increase the supply of patents do not lead to better innovation outcomes and economic prosperity.[15] Instead, the proponents of demand-driven innovation policy believe that innovation policy must prioritize the diffusion of ideas into the market. Research from Statistics Canada shows that technology diffusion is a major problem in Canada, and that "non-frontier firms," i.e. those which do not have cutting-edge technology, account for a large proportion of the productivity lag. Increasing the diffusion of leading-edge technologies could help bring Canadian companies to their full productivity potential.[16] The dispersion of innovation between large and small companies can be attributed to factors such as organization capital and intellectual property, due to economies of scale in these areas.[17]

There is ongoing debate on the merits of demand-side versus supply-side policies. Many experts believe that demand-side innovation policy has been marginalized in recent policy discussions, and that an increase in the use of tools such as public procurement, regulation, and consumer awareness campaigns, are key to improving innovation policy. Ultimately, however, both supply-side and demand-side innovation policies are crucial to the growth and development of innovation ecosystems. Thus, our policy brief will recommend an approach that considers demand-side innovation policy while focusing primarily on improving existing government tools that facilitate interactions between innovation suppliers and consumers.

Our recommendations will focus on the government's role as an intermediary between suppliers and consumers of innovation, and the ways in which it can refine its tools to facilitate transactions between these actors. Specifically, it focuses on how IP assets can be leveraged to promote these transactions, and on how they can be used to bring a more diverse set of actors into the innovation process. In order to make sure that these policy changes fit within the Canadian context, we need to analyse the country's innovation metrics and identity gaps in the innovation performance.

# 5. Canada's performance in terms of traditional innovation metrics

Canada's innovation performance over the past decade can be compared to that of other countries using two well-known indices of innovation. The term innovation can be largely thought of as how new methods of production, new products, and new organizational structures and managerial techniques are presented and used in an economy. Although several individual measures of innovation are mentioned in the literature, no solitary measure is evidently preferable[18]. Therefore, most scholars prefer using indices that aggregate several different individual measures. In this case, we used the innovation indices reported in the Global Innovation Index (2019) and the Global Competitiveness Report to evaluate Canada's performance relative to its international peers, followed by metrics on provincial innovation. Both indices provide similar insight: Canada's relative innovation performance has worsened in recent years.

Any empirical description of data on innovation activity in Canada must first address the issue of how innovation is quantified. Most descriptions emphasize business activity. In this regard, a general definition of

[15] Edler, Jakob. "A Costly Gap: The Neglect of the Demand Side in Canadian Innovation Policy." *IRPP*, 27 May 2019
[16] Statistics Canada. "Study: Productivity Dispersion, Technological Diffusion and Productivity Growth in Canada." *The Daily* - , 17 Jan. 2020.
[17] *Ibidem.*
[18] Steven Globerman & Joel Emes, *Innovation in Canada: An Assessment of Recent Experience*, (Vancouver, B.C: Fraiser Institute, 2019), 23.

innovation in the business sector encompasses a new marketing method, the implementation of a new or significantly improved product or process, or a new organizational method in business practices, external relations, or workplace organizations similar to the aforementioned definition[19]. There are various measures of innovation that have been suggested in empirical studies, such as the combination of various measures to derive a multivariable index while the Organization for Economic Co-operation and Development (OECD) *Oslo Manual* reports a large set of national measures related to innovation, e.g. Research and Development (R&D) spending, patents, science and technology, personnel, etc. The literature on measuring innovation is vast; however, discussion of each measure is beyond the scope of this paper to discuss in detail. Therefore, the measures used to analyse the global data on innovation in Canada will be the two stated above, namely the Global Innovation Index, and the Global Competitiveness report.

## What is the Global Innovation Index (GII)?

This index aims to capture the multi-dimensional components of innovation and offer the tools that can assist in tailoring policies to improve productivity, promote long-term output growth and job growth. The GII assists in establishing an environment in which innovation factors are continually evaluated. It delivers a vital tool and a rich database of comprehensive metrics for economies, which in 2019 encompassed 129 economies.

The index, which is publishing its 12th edition this year, is co-published by Cornell University, INSEAD, and the World Intellectual Property Organization (WIPO, a specialized agency of the United Nations). The heart of the GII Report consists of a ranking of the innovation capabilities and results of the world's economies. Historically, the GII has proven itself to be a leading reference on innovation. Understanding in more detail the human aspects behind innovation is essential in designing policies that help promote richer, innovation-prone environments locally along with economic development. The GII identifies the crucial role of innovation as a driver of economic growth and prosperity, and the need for a broad, horizontal vision of innovation applicable to developed and emerging economies, so it includes indicators that go beyond the traditional measures of innovation, such as the level of research and development.

Statistics Canada has been tracking innovation in the business sector since 1996 through its Survey of Innovation and then through the Survey of Innovation and Business Strategy (SIBS), first conducted in 2009 and then in 2012. Enterprises that implemented product innovations reported that, on average, 9.4% of their sales came from goods or services that were new to the enterprise. These enterprises also reported that, on average, 9.1% of their sales came from products that were new to at least one of their markets in 2017. The sale of goods or services that were unchanged or slightly modified accounted for the remaining 81.5%. Finance and insurance companies, excluding monetary authorities, reported that 5.5% of their sales were of products that were new to their markets, while construction companies reported that only 4.4% of their sales were due to new products, and business management companies recorded the highest average of sales due to innovative products, at 12.9%.[20]

Using the GII to measure the effect of this domestic innovation on a global scale shows that Canada's growth in innovation has been on the decline. Figure 1 below shows that since 2011, the level of innovation in Canada has been declining in comparison to the global leader (Switzerland) and compared to the United states (3rd). The second chart attached in the Appendix 3 deepens this analysis by highlighting Canada's strengths and weaknesses in comparison to the other top 25 countries. Based on our definition of demand-driven innovation, many categories can be highlighted as hindering the pursuit of further demand-driven innovation and there is a strong need to enhance the coalition and commercialization of innovation in Canada's system.[21]

[19] Fred Gault, "Defining and Measuring Innovation in All Sectors of the Economy," *Research Policy* 47, no. 3 (April 1, 2018): 617–22.
[20] "Survey of Innovation and Business Strategy (SIBS)," Statistics Canada Website, Last modified December 31, 2019.
[21] "Global Innovation Index 2019," World Intellectual Property Organization.

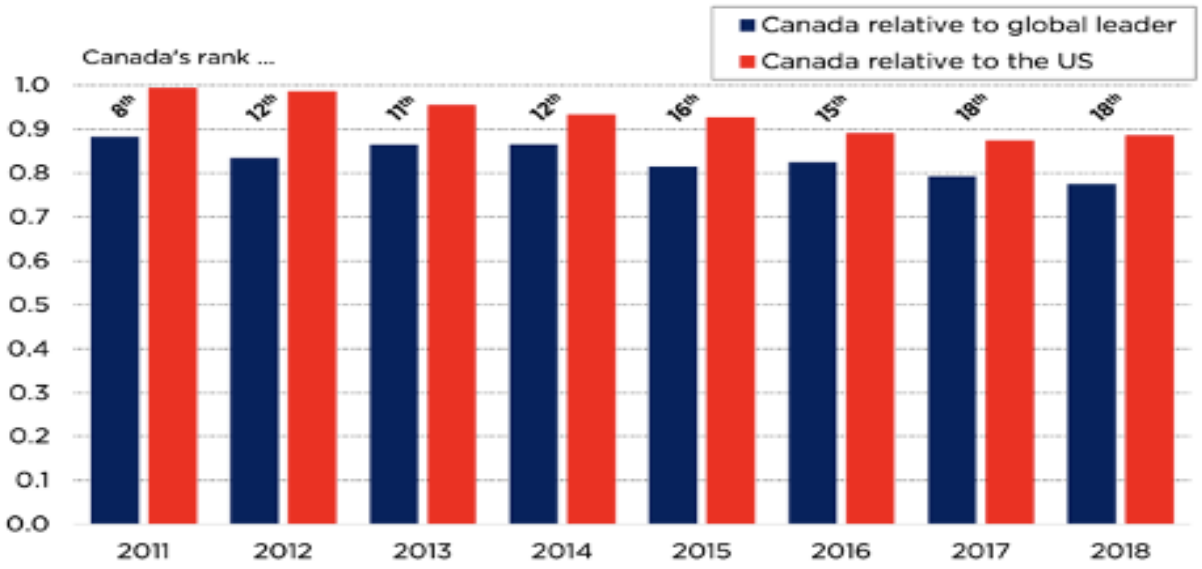



Figure 1
Source: Global Innovation Index

The Global Competitiveness Report (GCR) echoes the same trend. There has been a decrease in performance with regard to Canada's ranking on the Global Competitive Index (GCI) score relative to other countries in the OECD. The ranking largely underscored Canada's deteriorating performance relative to other member countries, and specifically, the deterioration of Canada's innovation performance. In 2019, Canada was down to 14th place on the GCI, compared to its 12th place in 2018. In terms of innovation ecosystems, Canada is ranked 12th in business dynamism and 16th in innovation capacity[22]. Therefore, there is clearly a need to spearhead a more comprehensive, demand-driven innovation ecosystem to help achieve the country's goal of becoming an innovation powerhouse. The main reason for promoting demand-driven innovation is due to the economic benefits associated with it, namely the increase in productivity that subsequently leads to an increase in economic growth. However, this can only be achieved by having a robust innovation ecosystem that is collaborative and inclusive, thus also giving opportunities to underrepresented groups.

## Innovation in Canada

Analysis of innovation performance in Canada is based on the various innovation grading report cards used by the Conference Board of Canada[23] (the construction of the report cards is detailed in Appendix 4). While data on firm-level innovation activity are collected and equated internationally using the GII, GCR or the Oslo Manual, ample data has not been collected by Statistics Canada to permit provincial-level analysis. Also, to the best of our knowledge, comparable and complete international and provincial data that directly measures firm-level innovation (process, product, or service innovation) and its results are not collected. Moreover, data for the territories' performance with respect to the innovation report card indicators are unavailable or are available but clustered together rather than differentiating between Northwest Territories, Nunavut, and Yukon. In some cases, the data is available but too few indicators are available to reliably generate a reasonable picture of their overall innovation performance.

[22] "Global Competitiveness Report 2019," World Economic Forum.
[23] "Innovation Provincial Rankings: How Canada Performs," The Conference Board of Canada.

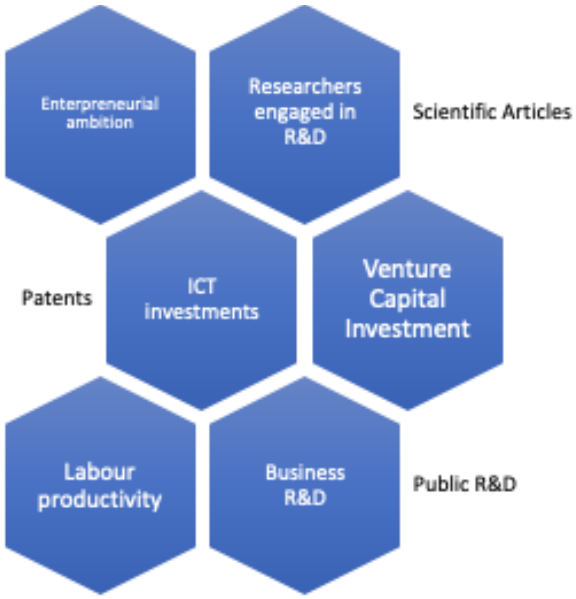



Figure 2
Source: Conference Board of Canada

## Provincial analysis of innovation

A provincial analysis helps to highlight the differences in innovation performance between provinces in Canada's decentralized federal system. For a federal agency such as ISED, we believe in an approach that benefits underperforming provinces while still strengthening the provinces that drive innovation in Canada.

1. Ontario This is the top-ranked province, with public R&D accounting for 0.96 of GDP. Ontario is a member of an exclusive club of top-ranked jurisdictions in the world. It receives a high score for entrepreneurial motivation, a gauge that all provinces within Canada score especially well in relative to the group of international peers. However, the province scores sub-optimally on enterprise entry and scientific articles. Furthermore, the province lacks the diversification of venture capital and ICT investment. This surprisingly low score arises from the province's lack of business R&D and low scores for two of the innovation results: patents and innovation results, which clearly suggests that the province continues to face hurdles in commercializing and reaping the larger benefits of innovation.

2. Quebec Although the province had been slipping in terms of innovation, its situation has recently improved, particularly in two areas: public R&D and entrepreneurial ambition. Quebec's provincial and municipal governments have prioritized R&D as a way to foster innovation within the province, as we will later discuss, through participation in various government programs and challenges. Although the province's venture capital investment has increased from 0.14 to 0.2 percent of GDP, the government still faces glaring innovation challenges. The province is not a strong performer in terms of research, scientific articles, or business R&D. Although it is industrially on a similar footing as Ontario, the province scores lower in patents, enterprise entry, ICT investment, and labour productivity. Therefore, the two provinces share a common denominator in terms of weakness in commercialization, coalition building, and capitalization to foster innovation.

3. British Columbia According to the Conference Board, this province has also fallen back in the innovation standings, namely to 17th of 26 comparable jurisdictions. Amid its international peers, it outperforms only the United Kingdom and Ireland. Although it has improved in enterprise entry, this does not affect the province's overall grade: B.C dropped in the following indicators: venture capital, scientific articles, ICT investment, and researchers engaged in R&D. In addition to its persistent

weakness in public R&D and patents, the West Coast province is plagued by poor labour productivity and business R&D. B.C. finds itself falling behind and ranks below an already mediocre Canadian average. The province needs to turn its performance around quickly before low innovation symmetry becomes the standard. Matching innovation supply to demand through a nationwide ecosystem, as well as fostering an open innovation system, could be one way to quickly revive its innovation capabilities.

4. Alberta Similar to its western counterpart, Albertan innovation has also declined. Formerly ranked 15th among 16 comparable jurisdictions, the province has dropped to 19th position. Alberta continues to perform relatively well on entrepreneurial ambition and enterprise entry, but has dropped slightly in terms of scientific article publication. The province has remained constant in all other indicators when compared to international peers. Nonetheless, the province still underperforms in terms of ICT investment, public R&D, venture capital investment, and patents. Generally, the province's slightly waning innovation performance, combined with relative enhancements in innovation among its international peers, results in its lower grade and ranking overall.

5. Nova Scotia This province ranks the highest among its Atlantic counterparts. However, it has seen a decrease in ICT investment and receives a low ranking in business R&D, patents, and labour productivity. Nonetheless, the province does well in terms of public R&D, which accounts for 1.2 percent of GDP and the province leads on this indicator. Moreover, Nova Scotia has witnessed improvements in its scientific article indices while the province's higher education sector provides a solid bedrock for science and innovation potential: the province is the best performer among 26 similar jurisdictions with respect to higher education R&D. However, the lack of an integrated coalition system makes it difficult for the inventions produced to be matched with the needs of the market. For example, if comprehensive R&D results in the manufacturing of a new lubricant in Nova Scotia, there is no platform enabling an oil processing plant in Alberta to access the product and probably request possible changes that would benefit their processes.

6. Newfoundland and Labrador The province faces innovation weaknesses that are similar to those of Nova Scotia, including lack of business R&D, researchers, and patents, which are the province's Achilles heel. Furthermore, the province has experienced mediocre performance in areas such as ICT investment and venture capital, as well as in scientific article publication and labour productivity. Nevertheless, the province does perform well in terms of enterprise: its rate of 15% is the second-best among its Canadian peers. Entrepreneurial ambition has also been on the rise in the province despite declining labour productivity.

7. Saskatchewan Similar to Newfoundland, the province performs well in terms of entrepreneurship, with indicators ranking 7th among international peers on entrepreneurial ambition and 5th on enterprise entry. However, the province's scores for scientific articles and labour productivity are pedestrian. Saskatchewan is weak in terms of spending and attracting capital for innovation. The province scores poorly in venture capital accumulation, business R&D, ICT investment, public R&D, as well as on researchers and patents. Saskatchewan's innovation woes testify that entrepreneurial entry and spirit are not enough to lift a region's entrepreneurial status, and that more needs to be done.

8. Manitoba Following a similar narrative, the province performs well in entrepreneurial ambition and enterprise entry, but fares poorly in scientific articles and ICT investment. Manitoban firms drew in $90 million in venture capital in 2016, the highest recorded in the province in more than a decade. Nonetheless, the province continues to underperform in innovation indices such as researchers, business R&D, and patents, thus providing further proof that entrepreneurial spirit is not enough to spur demand-driven innovation. Particularly in the areas dealing with patents, there is a need for a more cooperative and integrated system.

9. Prince Edward Island The smallest province scores well in enterprise entry. However, its public R&D and ICT investment scores are falling. The province scores poorly on indicators related to innovation activity and capacity, scoring low on scientific articles, venture capital, and ICT investment. Furthermore, the province also lags in patents and labour productivity. Given its small size, P.E.I. is unlikely to become a global frontier of innovation. However, the challenge within Canada is that specialization and collaboration need to occur so that provinces with comparative or competitive advantages can concentrate in those areas, consequently giving provinces such as P.E.I an opportunity to find a niche in local and global supply chains linking innovative demand to supply.

10. New Brunswick The province ranks last among all provinces and international peers. In terms of innovation capacity, the province's rating is very average, it has very few researchers engaged in R&D, and it produces few scientific articles. Furthermore, in innovation activity, the province lacks ICT investment, venture capital injection, and business R&D. In terms of innovation results, the province scores poorly on labour productivity, enterprise entry, and patents. On the other hand, venture capital deals have slowly been on the rise over the past few years, which is a positive sign that investors are slowly starting to recognize the business potential within the province.

## Summary: Canada's performance in terms of traditional innovation metrics

The brief analysis of innovation weaknesses presented by each of the provinces presents two common denominators: patents and labour productivity. We focus on patent development as a subsegment of innovation because this is a tool that can directly help explain technological growth in Marginal Factor Productivity (MFP) and subsequently economic growth. MFP improvement is the component of growth that is most related to technological progress. MFP growth results from both innovations that improve upon best-practice production techniques and the catch-up via the adoption of state-of-the-art technologies and organizational practices, thus in turn helping labour productivity. There is consensus that technological improvements can be accounted for by the number of patents, as this represents the actual creation and dissemination of knowledge in productive activities. Thus, innovative activity through the growth in patent development is one of the main sources of technological progress and, ultimately, economic growth[24].

A more detailed chart outlining all the report card indicators for each province can be found in Appendix 5. Nonetheless, every province in Canada seems to be plagued by poor performance in these two indicators, thus making the growth in innovation within the country slow and, in some cases, stagnant or diminishing in nature. There is a need to boost coordination of patent development within the country, including a coordinated approach to avoid wasting resources. Currently, this function is carried out by ExploreIP, which is a federal government platform that will be discussed in detail further on in the report. Nonetheless, there is a strong need for a centralized system of patent development by both public and private partners. The duplication of resources, and the lack of communication and coordination between provinces, is another glaring innovation pitfall. Competition does spark innovation, but competition between jurisdictions can also harm it, as shown in the above analysis: large provinces dominate in almost all dimensions of innovation, thus leaving smaller provinces such as P.E.I and New Brunswick at the tail end. With the growth of an integrated system (which will be discussed below), specialization can begin to take root in the Canadian innovation ecosystem.

Canada as a country and even on an individual level, needs to do what Canadians are best at and specialize in certain skills that bring about the best returns, in the long run, to take the path of least resistance. If that means moving manufacturing out of one province and instead only exporting knowledge, then it should be considered . Failure to continue to create specialized services, goods, and knowledge that people want in the international community is how a country starts failing, as shown by the constant decline in labour productivity in the country. Particularly, in terms of patent development, and further, to develop open innovation models, Canada should consider an open innovation approach to accelerate its innovation metrics.

[24] OECD, Economic Outlook. Vol. II, 2002.

Moreover, inclusion of underrepresented groups, and collaboration with such groups, are areas for innovation that have not yet been tapped. There still exists a gap between ecosystems and inventors from underrepresented groups within Canada, and a primary reason for this gap is the lack of awareness of innovation platforms where small-scale ideas can result in large community benefits. More work needs to be done to ensure that access to an innovation ecosystem does not benefit only a few but is a public good that promotes inclusiveness and equality.

# 6. Conceptual framework for the analysis

So far, our review of the literature has shown that any innovation process loses efficiency when it remains isolated in a particular ecosystem. In the Canadian context, we have also seen that provincial innovation performance is asymmetrical. In addition, from a public policy perspective, any publicly funded scientific initiative should aim to create as much public value as possible.

The DSIPs approach transforms the policymaking process into a mechanism more sensitive to society's needs. Only through this approach can innovation outcomes realistically target complex, real-life problems. From a policy perspective, the implementation of DSIPs relies on implementing two-way channels of communication, so the demand and the supply can meet efficiently. The cutting-edge academic discussions point towards open innovation as the most efficient organizational construct to accelerate communications and interactions between essential stakeholders, thus ensuring public value in the innovation outcomes created.

## 6.1 From innovative organizations to innovation ecosystems

During the 1980s, technology companies faced a rapidly evolving technology landscape and found it increasingly beneficial to collaborate and share knowledge[25]. Collaboration schemes could be formal or informal, but they were limited to physical interactions between experts and organizations. Geographic and cognitive proximity expanded or limited the scope of these collaborations. Currently, partnership for innovation is aimed at solving particular deficiencies among the actors who participate in it, and responds more to cognitive proximity than to physical closeness. For example, start-ups are often self-sufficient during the initial stages of the innovation process, but they collaborate with incumbent companies for production and marketing. In turn, incumbent companies benefit from new ideas that emerge in start-ups to develop novelty, so they often work together with them during the R&D process[26].

The growing need for customization in products further imposed the idea of collaborative innovation and took it beyond the community of experts. Over the past ten years, innovation has found much value in collaborating with product users to improve novelty and value chains. In many industries, such as video gaming, users became the source of new products[27]. Collaboration with users provides the potential for quicker and cheaper development of products and services, and produces a higher volume of innovation[28], provides access to customer's tacit knowledge[29] and stronger customer lock-in [30]. Because of pressures for quicker innovation, firms often view collaboration as essential for survival.

[25] Robert C. Allen. "Collective Invention," *Journal of Economic Behaviour and Organization* 4, no. 12 (1983):1–24.
[26] Massimo G. Colombo, et. al., "In search of complementary assets: the determinants of alliance formation of high-tech start-ups," *Research Policy* 35, no. 8 (2006):1166–99.
[27] Charles R. Greer & Charles D. Stevens, "HR in collaborative innovation with customers: role, alignment and challenges," *The International Journal of Human Resource Management* 26, no. 20 (2015): 2569-2593.
[28] Charles R. Greer & David Lei, "Collaborative Innovation with Customers: A Review of the Literature and Suggestion for Further Research," *International Journal of Management Reviews* 14, (2012):63–84.
[29] Larry Selden & Ian MacMillan, "Manage Customer-Centric Innovation Systematically," *Harvard Business Review* 84 (2006): 108–116.
[30] Sandra Vandermerwe, "How Increasing Value to Customers Improves Business Results," *Sloan Management Review* 42, no. 1 (2000): 27 – 37.

The open innovation (OI) framework proposed by Chesbrough encourages organizations to overcome the innovation model based on internal processes and invites them to expand beyond the organization's limits, in "the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively."[31] According to Chesbrough, organizations can initiate R&D processes internally. This is considered desirable, since it makes it easier to ensure that the objectives of innovation remain aligned with those of the organization. However, every internal process of innovation reaches a point where the generation of knowledge reaches its limits and loses efficiency. This is when the company should choose to open processes to collaboration with other actors.

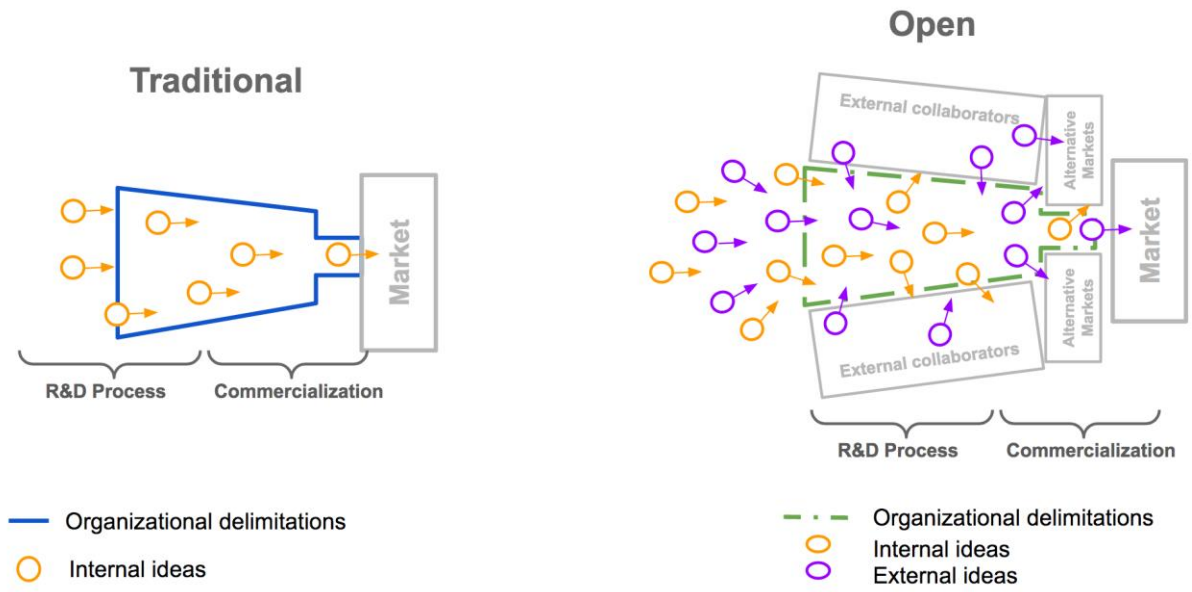



Figure 3: Open Innovation Dynamics
Source: Own elaboration with information of Chesbrough, 2003.

Consequently, OI can be understood as "a distributed innovation process based on purposely managed knowledge flows across organizational boundaries."[32] OI involves many other actors that fall far outside traditional supply chains (such as universities or individuals). These participants can be influenced, but often are not directed or managed. Some claim it is user innovation. It is not. The user is undoubtedly significant to open innovation, but so are universities, start-ups, corporate R&D, and venture capital.

## Canada's innovation ecosystem

Traditionally, the dynamics of Canada's innovation ecosystem are understood as a linear relationship between government agencies, institutions of higher education, the private sector and global markets (Appendix 6). The role of government agencies is that of funders and regulators, educational institutions as creators of knowledge applications, the private sector as the main actor in the production and commercialization of goods, and global markets as consumers of innovation.

[31] Henry W. Chesbrough, "The Business Model," in *Open Innovation: The New Imperative for Creating and Profiting from Technology* (Boston, Massachusetts: Harvard Business School Press, 2003), 63-92.
[32] Henry Chesbrough, & Marcel Bogers, "Explicating Open Innovation: Clarifying an Emerging Paradigm for Understanding Innovation" in *New Frontiers in Open Innovation*. (Oxford: Oxford University Press, 2014), 3-28.

In recent years, we have seen that innovation is not limited to technological improvements[33]. Users, the public sector, and citizens, for example, are valuable assets to spur innovation, particularly when solving complex problems that have applications in the social sphere. The central argument of this report is that the dynamics in innovation processes are not linear and benefit from including actors outside the spaces that are traditionally described[34]. The academic debate on innovation policy impact is shifting towards the development of impact indicators, such as how much an innovation contributes to solving complex problems, such as climate change. It considers fewer and fewer indicators that only measure the results in the number of patents, or jobs created, among others[35].

The dynamic capacities of the public innovation system to solve 21st century problems must go beyond the traditional debate. This new vision points towards a new generation of innovation policies based on the logic of "distributed agency", including international organizations, civil society, ordinary citizen users, among others[36]. They should not limit design mechanisms to solving market problems; instead of measuring their success in terms of results, they should focus on measuring their impact (solving real problems)[37]. The complex challenges of today require a more extensive diversity of expertise, skills, and knowledge than those traditionally described in the ecosystem illustrated in Appendix 6.

## Open innovation technologies and the creation of public value through interactions

We have shown that increasing interaction between actors in innovation ecosystems is relevant. In this section, we will first define the objectives of these interactions and, based on them, we can identify the main characteristics of the platform.

As we have seen, OI approaches extend the frontiers of scientific knowledge development, inventive capacity, and technological production. Innovation has, to some extent, always been open. This section addresses the creation of public value for innovations by increasing interactions. The success of innovations in the context of the Information Society goes beyond technological development, and it depends more on their ability to solve complex, real-world problems.

The value that Information Technology (IT) creates in government is related to building public value. Just as managers in the private sector seek to create value in their companies, public managers must strive for public value creation. IT resources in public organizations can enable public managers to advance public-value frontiers by cultivating the following five organizational capabilities[38]:

- Public service delivery
- Public engagement
- Co-production
- Resource-building

[33] Jan Fagerberg, "Mission (im)possible? The role of innovation (and innovation policy) in supporting structural change and sustainability transitions," *TIK Working Papers on Innovation Studies* No. 20180216 (Oslo: University of Oslo Centre for Technology, Innovation and Culture, 2018).
[34] Lindner, R., Daimer, S., Beckert, B., Heyen, N., Koehler, J., Teufel, B., Warnke, P., Wydra, S. (2016). 'Addressing directionality: orientation failure and the systems of innovation heuristic. Towards reflexive governance,' Fraunhofer ISI Discussion Papers Innovation Systems and Policy Analysis No. 52. Fraunhofer ISI: Karlsruhe.
[35] Mazzucato, M. (2017), 'Mission-oriented innovation policy: challenges and opportunities,' UCL Institute for Innovation and Public Purpose Working Paper, IPP WP 2017-01.
[36] Kuhlmann, S., Rip, A. (2018), 'Next generation innovation policy and grand challenges,' Science and Public Policy, 45 (4), 448 – 454.
[37] Kattel, Rainer, and Mariana Mazzucato. "Mission-oriented innovation policy and dynamic capabilities in the public sector." (2018): 787-801.
[38] Pang, M. S., Lee, G., & DeLone, W. H. (2014). IT resources, organizational capabilities, and value creation in public-sector organizations: a public-value management perspective. Journal of Information Technology, 29(3), 187-205

- Public-sector innovation

An open innovation platform must have the ability to create value in all five dimensions. By combining them, a creative dynamic of solutions arises that includes an additional element of value: they incorporate broader visions, thus becoming more applicable in real life. The challenge is to create an ecosystem where these interactions add as much public value as possible in the most efficient way.

Generally, digital ecosystems (DE) tend to create their inertias since they assume different dynamics than physical ecosystems (PE) and offer other benefits too[39]. The ability to successfully replicate PE interactions and in-place incentives in a DE is one of the most critical challenges when designing a platform[40]. The root of this problem lies in the very nature of both. Unlike PEs, which are characterized by more fluid and organic dynamics, the construction of the DE requires a technical dimension based on the use of standards, protocols, and mechanisms to transfer and process information[41]. This characteristic makes digital ecosystems more rigid and static. Therefore, it limits their ability to adapt to the interaction needs of their members and, therefore, their early evolution to more complex interactions[42]. Any design error, even those that result from omission, imposes high costs on the added value that the digital ecosystem can generate since such design errors may limit users to a certain number of interactions, which could be far fewer than they really need[43].

Open digital platforms provide the best options for resolving the dilemma between rigidity and adaptability to create DEs that aim to increase collaboration. Providing for the highest level of appropriation of technologies and processes, beyond just providing access to the platform, allows for more organic DEs[44]. Even though this implies losing control of the platform, this design favours collaboration and, therefore, innovation.

## Summary: Toward platforms that support demand-side innovation

Open platforms for innovation can naturally help to get closer to an optimal allocative efficiency, thus resolving some market failures, especially those associated with increasing competition in the market of ideas, information asymmetries, and the reduction of barriers to entry. Depending on the user's appropriation, these technologies are capable of adapting themselves quickly to changing demands on the ecosystem, thus, solving those market failures associated with rapid changes in decision-maker preferences[45].

Based on the cases reviewed, we can conclude that a federal innovation platform can address innovation market failures by facilitating three concrete interactions[46]:

1. Collaboration: By effectively connecting experts and stakeholders, it accelerates collaboration and reduces information asymmetries.

2. Competition: Public challenges to find the best solution creates more competitive offers and reduces the cost of searching.

[39] Heylighen, F. Complexity and Self-organization. Encyclopedia of Library and Information Sciences, eds. MJ Bates & MN Maack Taylor & Francis, (2008)
[40] Briscoe, G. Complex Adaptive Digital Ecosystems. Proceedings of the International Conference on Management of Emergent Digital EcoSystems, ACM (2010), 39–46.
[41] Jansen, S. and Cusumano, M. Defining Software Ecosystems: A Survey of Software Platforms and Business Network Governance. Proceedings of IWSECO, (2012), 41-58.
[42] Briscoe, G. and De Wilde, P. Digital ecosystems: evolving service-oriented architectures. Proceedings of the 1st international conference on Bio inspired models of network, information and computing systems, ACM (2006).
[43] Li, W., Badr, Y., & Biennier, F. (2012, October). Digital ecosystems: challenges and prospects. In proceedings of the international conference on management of Emergent Digital EcoSystems (pp. 117-122).
[44] Boudreau, K. (2010). Open platform strategies and innovation: Granting access vs. devolving control. Management science, 56(10), 1849-1872.
[45] Terwiesch, Christian, and Yi Xu. "Legitimization" in *Innovation contests, open innovation, and multiagent problem solving*. Management science 54.9 (2008): 25-27.
[46] Terwiesch, C., & Xu, Y. (2008). Innovation contests, open innovation, and multiagent problem solving. *Management science*, *54*(9), 1529-1543.

3. Transactions: Allowing actors to conclude a transaction in the same place that previous interactions occurred increases its value from a user's perspective.

The design of the technological solution will focus on these three dimensions, as appropriate to the Canadian context. The solution's capacity to create public value depends on its ability to include as many relevant actors as possible in an efficient way.

## 6.2 Inclusiveness

### Disparities in the innovation sphere

Diversity plays an essential role in opening up innovation, so inclusiveness is a lens that should be considered in this approach. The current innovation sphere lacks diversity[47] which in turn, hinders innovation across the country. Diversity can be divided into two categories: *inherent* and *acquired*. According to the Harvard Business Review "Inherent diversity involves traits you are born with, such as gender, ethnicity, and sexual orientation. Acquired diversity involves traits you gain from experience: Working in another country can help you appreciate cultural differences, for example, while selling to female consumers can give you gender smarts."[48] There are gender, racial, and ethnic disparities and underrepresentation in the scientific, innovation and entrepreneur sphere in general.

The Centre for Gender, Diversity and Inclusion Statistics states that women's participation in scientific occupations is significantly lower than that of men, partly due to lower participation in fields of study related to science, technology, engineering and mathematics (STEM).[49] This is also reflected in lower rates of appointment to leadership roles.[50]

Since the issue of patents will be addressed in the recommendations, we took a closer look at the patent market, which reveals yet another problem regarding gender gaps in the innovation sphere: in 2015-2016, research by the Canadian Intellectual Property Office (CIPO), found that only 12% of Canadian inventors filing under the International Patent Co-operation Treaty were women.[51] The report also points out that the share of women engaged in patent-related activity has been persistently lower than the share of jobs held by women in STEM fields. This means that it is not only a problem of low participation due to fewer women in those fields, but rather that even the women who are engaged in innovation do not apply for patents.[52] Patents and intellectual property are examples of measured disparity gaps, but the lack of engagement in innovative processes is a result of exclusion. Patents are not the only way to measure innovation. In fact, part of our recommendations challenges the concept of patents as a measure of innovation. However, we have used it here to better illustrate diversity gaps in the innovative sphere in Canada.

A study conducted in the US also sheds some possible light into the problem of underrepresentation. Hosfstra et al found that PhD students from underrepresented groups had higher rates of innovation, however their innovative contributions were discredited, and they were less likely to earn academic positions.[53] The results from the CIPO report and this study point towards the same conclusion; the current model for innovation centered in silos is not only hindering innovation from underrepresented groups, but also blocking access from those already innovating. Underrepresented groups are not part of the traditional and diffused innovation

[47] Sylvia Ann Hewlett, & Melinda Marshall and Laura Sherbin. "How Diversity Can Drive Innovation." Harvard Business Review, August 1, 2014.
[48] Deutsch, Waverly. "Innovation: What's Diversity Got to Do with It?" Chicago Booth Review, 2019.
[49] Government of Canada, Statistics Canada. "Insights on Canadian Society: Women in Scientific Occupations in Canada.", June 24, 2016.
[50] Longpré-Verret, Léa-Maude. "The Infographic Sheds Light on the Representation of Women in Leadership Positions within Corporations Conducting Business in Canada for the Year 2016." Statistics Canada: Canada's national statistical agency. Government of Canada, Statistics Canada, May 7, 2019.
[51] CBC News. Canada lags on patent applications by women. CBC/Radio Canada Website, November 22, 2017.
[52] *Idem*
[53] Hofstra, Bas, Vivek V. Kulkarni, Sebastian Munoz-Najar Galvez, Bryan He, Dan Jurafsky, and Daniel A McFarland. "The Diversity-Innovation Paradox in Science." Proceedings of the National Academy of Sciences of the United States of America 117, no. 17 (2020).

sphere due to lack of accessibility and diffusion of knowledge. There is a need to engage underrepresented groups in innovation, but also to ensure that innovators from underrepresented groups gain access to a broader innovation ecosystem.

## The impact of diversity

As with innovation, the scientific process involves much more than academic rigour; it also involves formulating a question, targeting a problem, choosing procedures and measurements.[54] As has been pointed out, "A diversity of scientists is important for reducing bias and for providing different ways of looking at the world."[55] Diverse perspectives and values are important for ensuring that a broader set of solutions are offered, but also, that a wider set of problems and targeted populations are also considered.[56]

Scientists and economists have conducted research on the positive impact of diversity on innovation.[57] Oreskes points to the concept of standpoint epistemology, where individual perspective depends greatly on social position, therefore diversity will increase the number of different perspectives on any subject matter.[58] Socially diverse groups, "those with a diversity of race, ethnicity, gender and sexual orientation" are more innovative than homogenous groups[59]. Including more diverse voices in the innovation process can enable stronger processes of innovation and collaboration. Research shows a correlation between diversity and better decision making[60], while other studies have shown that diverse groups can increase innovation, creativity and problem-solving.[61] Data from a study in 2013 shows that homogeneity across inherent and acquired diversity actually stifles innovation.[62] Diversity has been strongly correlated with increased "financial returns and greater likelihood to introduce radical innovation"[63], while other research shows that diversity unlocks innovation and drives market growth.[64]

More specific cases show the impact of diversity on innovation differently. A study in Germany found higher levels of research and development and innovation in regions that had higher levels of cultural diversity.[65] Research by McKinsey shows that racially and ethnically diverse companies are 35% more likely to have higher financial returns than their peers.[66] Another research study conducted in the banking sector suggests that racial diversity leads to better financial performance.[67] The McKinsey research found that gender-diverse companies are 15% more likely to have higher financial returns,[68] while another research points to the specific increase in firm value when there is female representation in top management.[69] Finally, there has been increased research on the impact of migration and innovation, as host countries increase diversity demographically and culturally. "In recent years migration research has demonstrated positive economic impacts of cultural diversity on

[54] Medin, Douglas. "Point of View Affects How Science Is Done." Scientific American. Scientific American, October 1, 2014.
[55] *Idem.*
[56] *Idem.* "It is commonly said that scientists should have a professional distance from what they study. But the metaphor of distance is misleading. Science, like a painting, necessarily has a perspective. To the extent that we can remove our biases and learn from multiple perspectives, we will understand our world better."
[57] Douglas. *Op. Cit.*
[58] Oreskes- Sandra Harding and Helen Longino Why Trust Science? 2019 By: Naomi Oreskes Ch.1: Perspectives from the History and Philosophy of Science
[59] Douglas. *Op. Cit.*
[60]Hunt, Vivian, Denis Layton, and Sara Prince. Rep. Diversity Matters. McKinsey & Company, February 2, 2015.
[61] Kwon, Seok-Woo, and Paul S. Adler. "Social Capital: Maturation of a Field of Research." Academy of Management Review 39, no. 4 (2014): 412–22.
[62] Deutsch, 2019 *Op. Cit.*
[63] Ozgen, Ceren, Peter Nijkamp, and Jacques Poot. "The Impact of Cultural Diversity on Innovation: Evidence from Dutch Firm-Level Data." EconPapers, July 15, 2014.
[64] Hewlett, *Op. Cit.*
[65] Kwon, *Op. Cit.*
[66] Hunt, *Op. Cit.*
[67] Richard, Orlando C., Tim Barnett, Sean Dwyer, and Ken Chadwick. "Cultural Diversity in Management, Firm Performance, and the Moderating Role of Entrepreneurial Orientation Dimensions." Academy of Management Journal 47, no. 2 (2004): 255–66.
[68] Hunt, *Op. Cit.*
[69] Kromatic. "Diversity Is an Innovation Metric." Medium. Medium, September 25, 2019.

productivity and innovation at the regional level" and the same paper points out that "more diverse foreign workforces are more innovative, particularly in terms of product innovations."[70]

Innovation, like science, becomes stronger through inclusion, as Oreskes states an "individual's beliefs, values, life experiences necessarily affect their work (scientific or not) so the best way to develop objective knowledge is to increase diversity of knowledge-seeking communities."[71] Therefore, for effective innovation and research, diversity is essential.

## Inclusiveness in innovation

Inclusiveness in the open innovation model refers to targeting more diverse and underrepresented groups to engage in innovative solutions, from scientists, R&D engineers and inventors. Inclusiveness benefits from the model of collaboration and cooperation that open innovation proposes. However, due to the current centralized model of innovation, inclusiveness cannot be expected to happen unless there are efforts made in that direction. There are lessons to be learned from companies that put diversity up front as a strategic goal for government policies, the main one being accountability.[72] Companies that designate a task force to increase diversity are more likely to ensure inclusiveness, not only in the recruitment processes, but also in management and promotions.[73] Efforts that focus on inclusiveness, such as the strategy of "Building a nation of innovators", are essential to include diversity in the context of Canadian innovation and should be expanded.[74]

However, accountability and measuring progress is also a challenge in the current model. A report on diversity from McKinsey states "The people in science and engineering are driving the world's most vital engine of prosperity and new ideas. Who are they?"[75]There is very little publicly available data on Canadian patents and innovations by persons of color, Indigenous people, or even less traditional actors in innovation. The collection of disaggregated data to study diversity is essential, not only to understand the dimension of the gap, but also to create targeted solutions for inclusiveness. Another example from the private sector can help further expand this idea the Open Diversity Data[76] initiative and others like it have started to emerge from the public's demand that companies disclose their diversity statistics.

## Summary: Inclusiveness opens innovation

Diversity plays an essential role under an open innovation model; however, there needs to be measures to ensure inclusiveness of underrepresented groups in the innovation sphere. These measures include collecting innovation data that is disaggregated by gender, racial, ethnic, and provincial grounds, and also by creating accountability standards.

---

[70] Ozgen, *Op. Cit.*
[71] Oreskes, *Op. Cit.*
[72] Plaut, Victoria. "3 Myths Plus a Few Best Practices for Achieving Diversity." Scientific American. Scientific American, October 1, 2014.
[73] *Ibidem.*
[74] Branch, Communications and Marketing. "Building a Nation of Innovators." Innovation for a better Canada. Innovation, Science and Economic Development Canada, February 14, 2019.
[75]To that end, we believe that data should be a high priority. Scientists pride themselves on their objectivity, but personal experience and point of view have a lot to do with what questions get asked in the first place and how researchers go about answering them (Hunt, *Op. Cit*).
[76] Union, Double. Open Diversity Data Website.

# 7. Recommendations

## 7.1 ExploreIP: A case study in innovation policy

The previous sections have outlined the commercialization problem in our innovation system, and we have research suggesting that demand-driven, open, and inclusive approaches to innovation policy lead to better outcomes. The data tells us that amongst other problems, patenting and IP are weaknesses in Canada's innovation metrics and that many minority groups are underrepresented in these areas. We also know that Canadian research is well-funded and produces excellent results, and that we have one of the most diverse populations in the world.

We recommend that ISED review its innovation policies to ensure that they are demand-driven, open, and inclusive. Our research suggests that policies that incorporate these elements would be better positioned to convert Canada's strengths into better innovation outcomes. However, these innovation outcomes can be challenging to measure. Thus, it is difficult to know where to start when conducting a review of ISED's policies. The field of IP provides a good starting point for a review of innovation policy, since IP assets are the way in which our legal system concretizes innovation into assets with which society can interact to create public value.

Making changes to Canada's IP system represents a difficult task: many industries depend on the stability that IP provides for the success of their business ventures. However, we believe that the 2018 Intellectual Property Strategy is an expression of ISED's renewed focus on IP management policy and its importance to Canada's innovation policies. Launched by ISED in 2018, Canada's IP strategy is a renewed effort to improve Canada's intellectual property metrics. The strategy is three-fold: to increase IP awareness; to implement new tools to leverage IP as a driver of growth; and to improve the existing legislation that regulates IP. Of specific interest, one of the tools implemented by ISED is an IP marketplace. This marketplace has evolved into ExploreIP, which currently provides visibility on publicly owned patents.[77]

The new strategy provides funding for additional services and tools to better support Canadian innovators, and we believe it represents a policy window for marginal improvements to Canada's IP management system. We have identified ExploreIP as a promising tool that incorporates many of the advantages of demand-driven innovation policy. ExploreIP has its origins in the new strategy, which called for the development of "Strategic IP Tools for Growth"[78]. ExploreIP's marketplace framework was designed to help provide opportunities for the sale and licensing of Canada's publicly owned patents, and thus increase the rate at which taxpayer-funded research is diffused in the economy. Online marketplaces hosted by the government have applications for various sectors. For example, HealthCare.gov, a product of the *Affordable Care Act* in the United States, is an online marketplace for users to shop for health insurance plans. Although the platform's rollout could have been better executed, it still represents a technological and procedural innovation since it provides a service not previously available to the public.[79]

Although ExploreIP is currently active, it is still in the development phase and its development team is actively looking for ways to improve it (appendix 7). Our recommendations propose to make the tool more demand-driven, open, and inclusive, and thus improve its ability to achieve innovation outcomes. The nature of these recommendations aligns with the many goals of the 2018 Intellectual Property Strategy, which aims to adapt existing policies to be more inclusive of underrepresented groups, such as women and Indigenous peoples.[80]

---

[77] ISED. "ExploreIP: Canada's IP Marketplace - Innovation, Science and Economic Development Canada." *Government of Canada, Innovation, Science and Economic Development Canada*, 30 May 2019.
[78] ISED Communications and Marketing Branch. "Intellectual Property Strategy." *Home*, 28 May 2020.
[79] "Foreword." *Innovative State: How New Technologies Can Transform Government*, by Aneesh Chopra and Ethan Skolnick, Grove Press, 2016.
[80] ISED Communications and Marketing Branch. "Intellectual Property Strategy." *Home*, 28 May 2020.

To incorporate our theoretical concepts into the existing ExploreIP interface, we are proposing to add new "tabs" to ExploreIP, which will enable the tool to provide more value to its users. We believe that the "Explore" in ExploreIP can take on a broader meaning, and that IP assets such as patents can be re-imagined, not only as a way to protect ideas but also as a catalyst for collaboration. Our initial recommendations propose making changes to the existing marketplace structure, and then we propose additional "tabs" to help users leverage ExploreIP's listings for collaborative purposes. To illustrate, figures 4 represents the current view of ExploreIP, while figure 5 shows the proposed view.

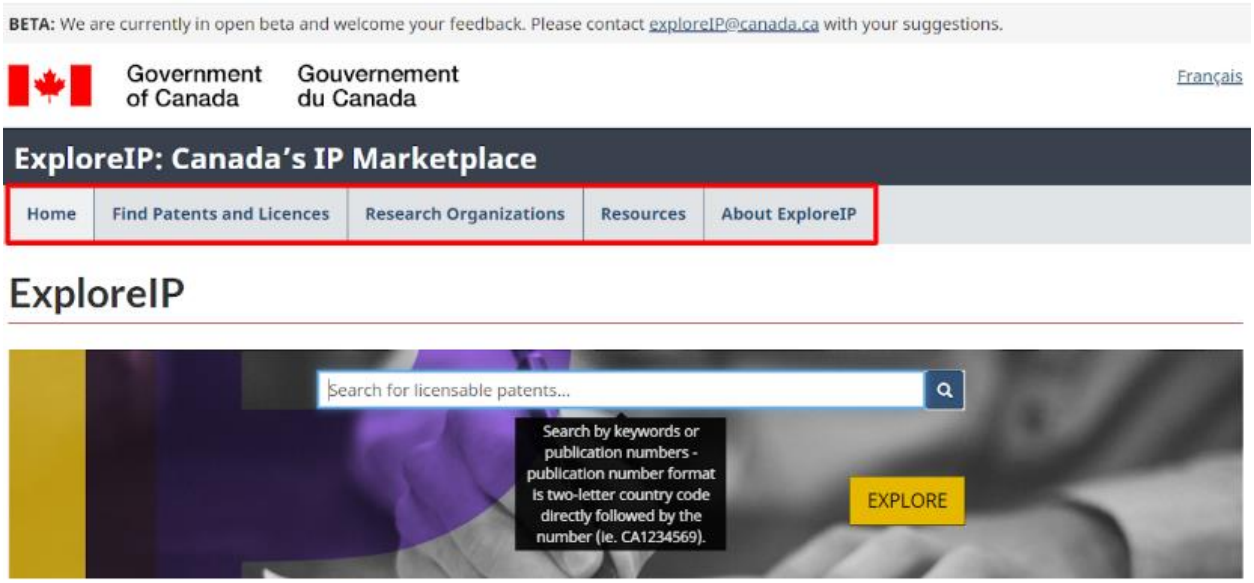



Figure 4, Existing view

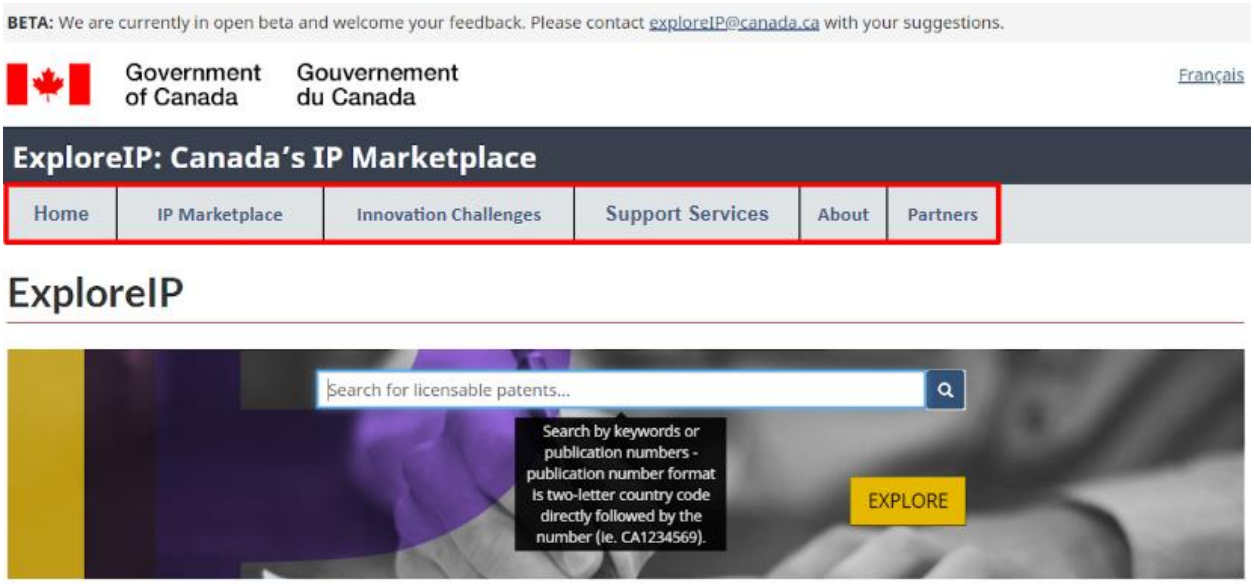
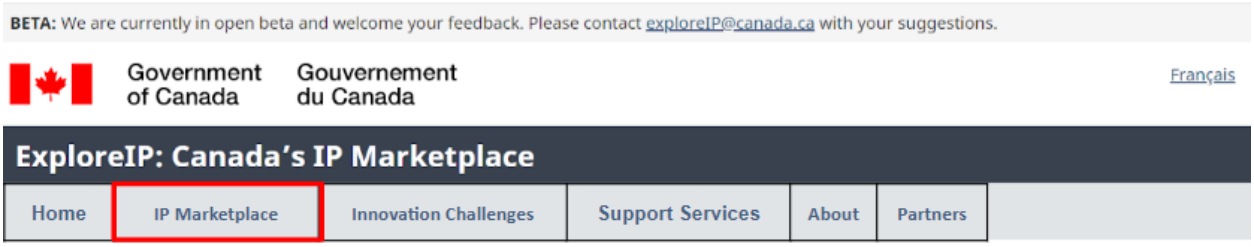



Figure 5, Proposed view

## 7.2 Changes to the IP marketplace framework

### The addition of privately-owned patents to the IP marketplace listings




The OECD's definition of innovation describes a process in which new ideas are not only developed but also diffused throughout society to improve productivity.[81] Hence, the "commercialization gap" outlined in the previous sections represents the pivotal challenge of translating Canada's research acumen into innovative outcomes. Innovation outcomes are defined as follows: the "ultimate impacts of innovation are the satisfaction of current or future human needs at either the individual or collective level."[82] Research conducted by the Council of Canadian Academies illustrates Canada's innovation "paradox": the country is very capable of inventing, but lags behind its peers in its ability to translate inventions into innovation outcomes.[83]

Proponents of demand-driven innovation policies believe that Canada's innovation system could be improved by making improvements to the support services provided by the government. These services would lead to better innovation outcomes through the creation of collaboration opportunities between various levels of government, academia, and the private sector.[84] The inclusion of private patents into the current listings offered by ExploreIP could create such opportunities by enabling the site's users to browse and purchase the IP developed by Canadian innovators privately. This could improve the efficiency of Canada's innovation ecosystem by connecting more innovators to tools such as ExploreIP, which helps diffuse innovations. This approach could improve Canada's patent metrics through a "pull" model by making transactions or licensing opportunities more interesting to potential buyers. By providing more opportunities for the sale and licensing of IP assets, ISED could increase the economic value of patents and incite innovators to turn their ideas into IP.

This approach contrasts with "push" models of conventional innovation policy, which aim to reduce the cost of patents. However, reducing the cost without improving the rate of diffusion of the technology underlying the patents would not necessarily increase innovation outcomes, since these depend on the market, which absorbs the ideas that the patents represent. Indeed, a push model that would aim to increase the number of patents by making the process of patenting cheaper or free could lead to negative outcomes, such as patent trolling or patent thickets, where development actors apply for patents as a rent-seeking activity.[85] A marketplace approach would increase incentives for the application of patents through an increase in their commercial potential. In other words, IP assets would become more valuable as an input for other products and services, and only inventions with market feasibility would be rewarded through a marketplace approach. In this sense, the ExploreIP platform represents a "demand-driven" innovation policy that does not disrupt incentives in the ideas market.

[81] OECD/Eurostat (2019), *Oslo Manual 2018: Guidelines for Collecting, Reporting and Using Data on Innovation, 4th Edition*, The Measurement of Scientific, Technological and Innovation Activities, OECD Publishing, Paris/Eurostat, Luxembourg
[82] *Ibidem*
[83] Gallini, Nancy, and Aidan Hollis. "To Sell or Scale Up: Canada's Patent Strategy in a Knowledge Economy." *IRPP*, 27 Aug. 2019
[84] Watters, D. B. 2013. Q&A. What Are the Components of Canada's Innovation Ecosystem and How Well Is it Performing?. *Technology Innovation Management Review*, 3(9): 38-41.
[85] Merges, Robert. (2010). The Trouble with Trolls: Innovation, Rent-Seeking and Patent Law Reform. 24.

Two important aspects of the future of innovation in Canada are the concepts of *economically inclusive* innovation and *autonomy enhancing* innovation. Economically inclusive innovation is defined as innovation that provides opportunities for the poor and the middle class, while autonomy enhancing innovation is described as innovation that provides opportunities for groups to make their own choices with regards to their living arrangements and working conditions in the context of rapid change.[86] It is essential to consider these concepts when designing innovation policy at a time when the benefits of significant trends, such as automation and globalization, are not broadly shared amongst social classes in Canada. The urban/rural divide has led to political polarization, which is dangerous for democracy. Thus, it is essential that we seek ways to ensure that Canada's rural areas share in the benefits of the transition to a knowledge economy. One way to achieve this is to provide pathways for rural stakeholders to join Canada's innovation ecosystems. A patent marketplace that promotes private patents could help provide visibility and commercial opportunities to Canada's rural inventors. Enabling privately held patents to be sold on the IP marketplace would allow inventors outside of academic circles to license and sell their IP.

ExploreIP is currently limited to the sale and licensing of publicly owned intellectual property. Although this is a critical aspect of diffusing publicly funded and developed IP, the new marketplace could include IP developed by start-ups and individual inventors. This could contribute to increasing interest in, and traffic to, the platform while also providing more visibility for IP generated outside of traditional centers of innovation. This feature could serve as a useful tool for individual inventors or start-ups located in rural communities.

To implement this change, ISED could look to private IP marketplace models as a starting point. There exist other IP marketplaces in Canada, including PCTxs, which offers a free digital marketplace for the transaction of private patents.[87] There are also examples of governments successfully hosting B2B models of IP marketplaces. For example, the Danish Patent and Trademark Office is currently running *ip-marketplace.org*, which allows investors from around the world to purchase and license privately owned Danish patents, which are translated into English. The Danish Trademark and Patent Office has recently signed a cooperative agreement with SourceIP, the Australian inspiration for ExploreIP. The Danish Trademark and Patent Office is open to signing cooperation agreements with as many partners as possible, and to promote each other's IP. Hence, a cooperation agreement could be signed for the design and promotion of an IP marketplace that would host listings of privately-owned Canadian patents.

## Adding capability for users to express their innovation needs

Another recommendation for improving the demand for innovation amongst ExploreIP users and within Canadian industry is to incorporate a "request" function for users. Users should be able to post needs for inventions they are willing to license or produce. In our previous discussions on open innovation for governments, we outlined how information from sources outside the government can inform decision-making and improve outcomes. By providing an outlet for IP requests within an IP marketplace, ISED benefits from new ideas for policies or for design challenges. This feature would provide insight into what the market is demanding in terms of new technologies, processes and ideas. Through an open marketplace that allows for private transactions, companies are essentially creating their own "challenges", ones that would have direct market feasibility. Questions remain over how to incentivize follow-up on transactions and how to prevent exploitation within the system. Thus, more research is needed in this direction. However, this feature is an example of how a marketplace framework could be leveraged to achieve more open innovation between firms themselves. Firms have already begun using a framework with this kind of dynamic, namely through platforms such as Santé Libre in Québec, a platform that was designed to organize the procurement of medical supplies during the COVID-19 pandemic.[88]

[86] Canada 2020 Innovation Project. Towards an Inclusive and Innovative Canada. Canada 2020 Innovation Project, 2017.
[87] PCTxs, "FAQ." Frequently Asked Questions: Buyer/Licensee Questions. PCTxs Website. Accessed July 8, 2020.
[88] Polytechnique Community Members, "COVID-19: Polytechnique Community Members Support the Santé Libre Initiative." *Carrefour De L'actualité*, 14 Apr. 2020.

This request feature would be based on the WIPO Green platform, hosted by the World Intellectual Property Organization, through which users would be able to express their needs for technologies or ideas on the marketplace, which would represent an expression of the "demand" for innovation in Canadian industry.[89] The new "private" owners of IP could respond to these requests, which could lead to collaboration opportunities. By combining these requests with new analytical capabilities, enough inputs for a significant sample size could lead to interesting data that ISED analysts could use to further study of innovation demand in Canada.

## Bridging the language gap in ExploreIP's listings

In the short term, the ExploreIP marketplace could be improved by making its content more accessible to Francophone users. Currently, many of the patents hosted on ExploreIP lack French translations. An expanded IP marketplace, hosted by the Canadian government, should require that the descriptions of all IP assets be listed in both French and English. Although this could represent an initial challenge for inventors, and overhead costs to translate material, it could help the platform expand its user base and density. Collaboration happens through the medium of language, and language is an essential component of the cognitive proximity (CP) required for the building of trust and of networks.[90] Actively pursuing full bilingualism within the platform could also become a source of competitive advantage in the future. By hosting Francophone content and providing a translation service, Canada's new open innovation platform could attract investment and interest from established Francophone business communities in Western Europe and from the rapidly growing innovation communities in Francophone Africa and give the latter better access to global value chains. One way to achieve this would be to leverage AI-enabled translation services to translate highly technical patent material into other languages. The ExploreIP team is working with WIPO Translate, an AI-enabled tool, to translate highly technical information, broadening the base of users. The team should continue to leverage these tools to ensure that all content on the platform is available in both official languages.

## Including other types of intellectual property

In addition to other types of industrial property, such as trademarks, ExploreIP could also consider adding copyright, which is an IP category that includes literature, art, architectural designs, etc. This could lead to more opportunities for Canadian artists to commercialize their art, and could eventually boost the national visibility and creative industries of minority communities, such as Indigenous groups. Currently, ExploreIP is limited to patents and licences for patents.

The World Intellectual Property Organization separates intellectual property into two categories: industrial property and copyright. The former covers patents for inventions, industrial designs, geographical indications and trademarks, while copyright refers to the intellectual property of literary works, films, artistic work, and architectural designs.[91] Currently, ExploreIP is limited to a certain kind of industrial property, namely patents and their licences. However, there may be an opportunity to expand the program to include other types of industrial property, such as trademarks and industrial design. In an effort to support artistic industries in Canada, and communities whose economies depend on the creative industries, expanding ExploreIP to include certain elements of copyright may be an interesting avenue in the future.

## Additional analytic capabilities and data segmentation

Once the ExploreIP platform is expanded to allow private transactions and enables requests for patents, the platform could then augment its analytical capabilities to help inform the government on the state of demand for innovation in Canada. The addition of a user account for users of ExploreIP could provide vital information on the location and capabilities of participating firms. Cross-indexing this information with other sources of

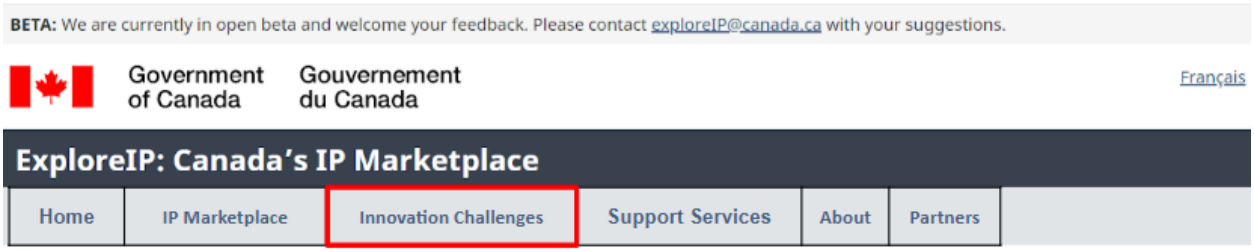
[89] "About WIPO GREEN." *World Intellectual Property Organization*. WIPO Website.
[90] Huber, Franz. "On the Role and Interrelationship of Spatial, Social and Cognitive Proximity: Personal Knowledge Relationships of R&D Workers in the Cambridge Information Technology Cluster." Regional Studies 46, no. 9 (2011)
[91] "What Is Intellectual Property?" WIPO. Accessed July 8, 2020.

information, such as ISED's Survey on Science, Innovation and Business Strategy (SIBS), could provide information into what kinds of firms are not participating in ExploreIP, and then to tailor marketing strategies to attract more users. Expanding the services offered by ExploreIP and making it a hub in the spoke of government services for innovators could make it a more attractive destination for online users and expand its base.

ExploreIP's database could also be modified to enable additional segmentation of data and to make that data more accessible to new users of the platform. The Canadian government has recently implemented several programs to improve accessibility to public sector data in other programs, such as the Treasury Board's *InfoBase* database.[92] Other organizations, such as Research Data Canada, are also working to make public data more open and accessible to Canadian innovators.[93] Currently, ExploreIP offers limited data exploration opportunities. Users are able to search for patents by technology category, by licensing options, and by organization. To its credit, the ExploreIP team has been able to respond to market demand through the creation of a new technology category for products and services used to combat the spread of COVID-19. However, we believe that adding additional search capabilities could help make the database more useful to a broader range of clients, such as NGOs, B-corps, and charities. These organizations have social objectives, and as such, they could benefit from being able to filter patents by owner attributes. They would thus be able to reach out to innovators from target communities to begin discussions on collaboration opportunities.

A greater leveraging of collaboration tools, such as ExploreIP, could be one way of fostering collaboration between underrepresented groups. Academics describe two critical elements to user engagement in platforms: openness and authority. Openness refers to the criteria for accessibility, i.e. who can use the platform, while authority relates to what users can actually do on the platform. He argues that opening up platforms to more users is the best way to achieve more innovation in platforms.[94] Sharing government data and best practices can be useful not only for innovators, but also for other innovation stakeholders, such as NGOs dedicated to innovation ecosystems in Canada. Organizations that manage innovation ecosystems could benefit from gaining visibility on the patents and inventions coming from their regions. ExploreIP could also help innovation stakeholders identify trends in Canada's knowledge production at an earlier stage.

## 7.3 The addition of an "Innovation Challenges" tab




Innovation challenges could act as a useful demand driver for innovators in Canada. Competitions, and their associated funding and procurement opportunities, are a way to "pull" innovation demand in an open way. These challenges engage citizens in the innovation process to find and solve public sector problems. Open innovation does not come naturally to the public sector. Instead of relying on a list of pre-approved vendors, open innovation policies try to engage with outside amateurs to "crowdsource" a solution to problems.[95] The Canadian federal government hosts a wide variety of "Innovation Challenges", which aim to spur innovation

[92] Treasury Board Secretariat of Canada. "Open Data for Innovation." *Open Government, Government of Canada Website.*
[93] Research Data Canada, "About Us." *Research Data Canada About Us Comments*, Research Data Canada, 2020.
[94] Eisenmann, T. R., Parker, G., & Van Alstyne, M. (2009). Opening platforms: How, when and why?. Platforms, markets and innovation, (ed. Gawer, 2009), 131–162
[95] Mergel, Ines. "Open Innovation in the Public Sector: Drivers and Barriers for the Adoption of Challenge.gov." Public Management Review, vol. 20, no. 5, 2017, pp. 726–745.

in a demand-driven way. However, these challenges are spread out over various organizations and departments, making it difficult for innovators to find the right opportunities for their research.

By regrouping all these challenges into a single database or digital page, users are better able to leverage the potential IP asset outcomes of these challenges through the use of the IP marketplace. They could potentially use their patent or asset as a basis for responding to other challenges, which they can now see. ExploreIP may not be the best place for this, but all these challenges are related, in the sense that they can produce IP outcomes. In its 2019 report, *Building a Nation of Innovators,* ISED states that it has made significant efforts to consolidate many of its government programs. Consolidating all federal innovation challenges on a single page could significantly improve ISED's website metrics and reduce the cost of innovation challenges that drive demand.[96]

ExploreIP was developed in collaboration with the Australian government and based on Source IP, the Australian Patent Office's IP marketplace. Aside from facilitating the diffusion of publicly held IP, Source IP also promotes innovation challenges through a global third-party platform service, Innovation Catalyst.[97] The US government has created an Online Open Innovation platform, called Challenges.gov, which acts as an interdepartmental database for users to browse a wide selection of innovation challenges in a convenient and efficient way.[98] The website makes use of quantitative data collected from the challenges, along with qualitative interview data, to analyze trends in open innovation.[99] ISED could take a similar approach to trend analysis, but it would first need to regroup a broader range of challenges from across departments in order to conduct analyses similar to those being conducted with Challenges.gov. The Challenges tab we are proposing to add to ExploreIP could be a starting point for a comprehensive database of federal government innovation challenges. There currently exists a wide variety of problems that could benefit from being more digitally proximate to one another. A few examples of relevant challenges that could be incorporated are listed below.

## Innovation challenges

Canada's Innovation Challenges website invites Canadians to help solve the challenges proposed by various departments.[100] However, as opposed to the U.S. Challenge.gov, it does not specify how citizens were engaged in the *creation* of the challenges, though it does provide an opportunity for citizens to suggest challenges themselves. Open innovation means being receptive to outside opinion on the direction of policy and creating a two-way flow of information. Although the departmental challenges have the potential to pull innovation demand, Innovation Challenges could make use of citizen engagement to better understand what the market is demanding. We recommend that future ISED challenges be proactive and share the internal processes of how these challenges are designed to better engage with citizens and industry. In a similar way, international challenges could also be incorporated into this tab. Those challenges that specifically target Indigenous or minority groups could be accessed through a search function.

[96] Kortum, Philip, and Claudia Ziegler Acemyan. "The Relationship Between User Mouse-Based Performance and Subjective Usability Assessments." Proceedings of the Human Factors and Ergonomics Society Annual Meeting 60, no. 1 (2016).
[97] Innovation Challenges, "Source IP." Source IP: Innovation Challenges Website, August 1, 2015.
[98] Challenges.Gov. "About." About | Challenge.gov Website, 2020.
[99] Mergel, Ines. "Open Innovation in the Public Sector: Drivers and Barriers for the Adoption of Challenge.Gov." Public Management Review 20, no. 5 (05, 2018): 726-745.
[100] ISED Communications and Marketing Branch. "Challenges." *Innovative Solutions Canada Website*, 2 June 2020

## Impact Canada

Another challenge-based initiative is Impact Canada, which is managed by "a Centre of Expertise housed within the Impact and Innovation Unit of the Privy Council Office, which also manages this platform in partnership with Government of Canada departments."[101] Touted as a "government-wide" program to push Canadians to solve pressing challenges, participation in the program is limited to the following line departments:

- Department of Fisheries and Oceans
- Employment and Social Development Canada
- Indigenous Services Canada
- Infrastructure Canada
- Health Canada
- Natural Resources Canada

Notably, this list excludes ISED. In our opinion, a program designed to spur innovative solutions to problems should include challenges from the federal department responsible for the development of innovation in Canada. Impact Canada hosts two challenge "streams," namely the Smart Cities Challenge and a stream related to the development of clean technology.[102] Impact Canada's website does not specify how it engages with outside stakeholders in the development of its challenges either, and could be more transparent by sharing how their challenges are designed. Literature on open innovation focuses almost exclusively on the private sector; however, to maximize the benefit of open government initiatives, such as challenges, it is vital to consider how the government can increase transparency, participation, and collaboration.[103]

Both Innovation Challenges and Impact Canada post challenges on topics that have a large amount of overlap. For example, they both host challenges from the same departments and both host innovation challenges related to cleantech projects, projects related to health and COVID-19 response, marine and fisheries problems, etc. The existence of separate innovation challenge platforms is a symptom of siloed government funding and structure. We believe that a genuinely government-wide open innovation platform that encompasses both these initiatives in a single space would yield economies of scale by increasing traffic and improving marketing outcomes.

## Regional development agency challenges

Interestingly, Impact Canada includes specific challenges from ISED's Regional Development Agency, such as the Hull Design Efficiency Challenge from the Atlantic Canada Opportunities Agency (ACOA).[104] This challenge is not currently active on ISED's Innovation Canada challenges website, despite being run by an agency under ISED's responsibility.

Also, many of Canada's Regional Development Agencies host their own innovation challenges on their respective websites. Once again, the themes and topics of these challenges overlap the same fields as those in the national programs. For example, Canada's Economic Development for Quebec Regions (DEC) hosts the

[101] Impact Canada, "About Impact Canada." *Impact Canada Website*, 2020.
[102] Impact Canada, "How It Works." *Impact Canada Website*, 2020.
[103] Mergel, I. 2015. "Opening government: Designing Open Innovation Processes to Collaborate with External Problem Solvers." Social Science Computer Review 33 (5): 599-612.
[104] Impact Canada, "Challenge: Impact Canada." Challenge | Impact Canada. Accessed July 8, 2020.

*Défi Propulsion* challenge, which invites users to respond to the challenges.[105] Most of these programs help throughout the innovation and development stages of the ideas and provide funding for prototyping.[106] These prototypes could be patented and converted into valuable IP assets, which could be commercialized by the inventors themselves or by interested buyers on the IP marketplace.

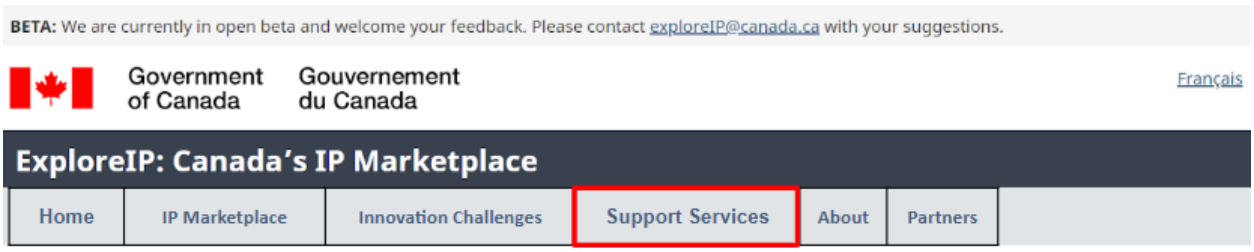
### Opportunity for ExploreIP

In addition to the benefits of grouping these challenges onto one comprehensive platform, bringing together challenges on ExploreIP could benefit Canadian innovators by providing them with more opportunities to commercialize their prototypes and IP assets. The patent marketplace would be well-positioned within the same site to link the user to collaboration and IP sales opportunities, while also providing links to resources to help throughout the process.

When challenges lead to potential procurement opportunities, ExploreIP's Challenges Tab could eventually incorporate other departments, such as the Treasury Board's buyandsell.gc.ca, the Canadian government's procurement database. Letters of intent and direct procurement opportunities could be available to those who develop the required patents and commercialize their ideas. According to Jakob Edler, an innovation expert from the University of Manchester, government procurement can act as an essential catalyst to early-stage innovation.[107] Such government purchases can also spur "lead markets," where a region or country which successfully implements an innovation provides an example for other areas lagging behind. This process helps accelerate the diffusion of technology and thus creates surplus economic benefit.[108] Lead markets were crucial in the worldwide dissemination of innovations such as the internet, the facsimile machine, and the mobile phone, and have the potential to help spread technologies that help address environmental issues.[109]

Bringing in challenges from various government departments, and incorporating their procurement services early in the process, could lead to a more engaging and interesting experience for innovators looking to diffuse their research into the economy. In addition, the process of bringing in these various departments and programs together could serve as a useful exercise in cross-departmental collaboration, and help the Canadian federal government break silos between workgroups in these departments.

## 7.4 The addition of a "Support Services" tab




The purpose of this tab would be to better link existing ISED services to the ExploreIP website to enable its users to make greater use of the IP marketplace and the new challenges tab. ExploreIP could actively promote certain tools provided by the Canadian Intellectual Property Office (CIPO), which offers a wide variety of training and development programs. The CIPO also hosts a database of all Canadian patents registered since 1869.[110] This database could be integrated into a marketplace framework that would incorporate privately

[105] Gouvernement du Canada, Développement économique Canada pour les régions du Québec Website, 2020.
[106] Branch, Communications and Marketing. "Program Eligibility and Process." Innovative Solutions Canada Website, 2018
[107] Edler, Jakob. "A Costly Gap: The Neglect of the Demand Side in Canadian Innovation Policy." *IRPP*, 27 May 2019,
[108] Janicke, Martin and Klaus Jacob. "Lead Markets for Environmental Innovations: A New Role for the Nation State." Global Environmental Politics 4, no. 1 (02, 2004): 29-46.
[109] *Ibidem.*
[110] Office, Canadian Intellectual Property. "Search CIPO Content." Canadian Intellectual Property Office. ISED, June 30, 2020.

owned patents, where patent owners could be identified and invited to post their patents as a listing on ExploreIP.

In addition, ExploreIP could itself be promoted as a tool for users of other government services. For example, innovators applying for funding through ISED's Strategic Innovation Fund are required to detail their IP strategy; leveraging an ExploreIP tool, which now includes private patents, could become an integral part of their strategies. In the short term, the addition of links between these two government services could facilitate the integration of the two programs and lead to synergetic effects.

We recommend that the support services tab be developed in conjunction with industry experts and leaders in open data initiatives. For example, the ExploreIP team could reach out to Research Data Canada, an organization devoted to making public data more open and accessible to Canadian innovators.[111] By connecting ExploreIP's user base with the wide variety of services offered by CIPO and Innovation Canada, ExploreIP can begin to work as an IP consulting platform similar to premium IP marketplaces such as IPNexus.[112]

Other interesting functions of this tab could include an events section that would advertise upcoming governmental and private events related to innovation. This section could be expanded in a larger Open Innovation Platform, which could promote events hosted by ISED, other departments, or outside stakeholders that help innovators engage in face-to-face interactions with government representatives and innovation experts. In addition to conferences hosted by ISED and the Regional Development offices, events such as the Canadian Ecosystem Gathering could be a tool to increase visibility and could provide opportunities for Canadian innovators to learn about their local ecosystem.[113]

## Creating space for new forms of patents

The Support Services Tab, or a new tab altogether, could also incorporate new models of IP currently being developed by private industry and government initiatives. Examples of these models are presented below:

- The Patent Collective Program, an ISED-led initiative that aims to create groups of small-to-medium enterprises (SMEs) that can access a pool of patents. The objectives of this pilot program include: increasing the participation of SME's in the IP system and the innovation process; increasing the participation of underrepresented groups, such as Indigenous groups, women, and other minorities, in the IP system; and increasing collaboration between members to increase the value of existing IP assets.[114]

- "No Patenting" Models of IP

- Peer-to-Patent is a way for lawyers to volunteer knowledge of "prior art", accelerating the patent approval process in some cases. This has seen some success in the UK, US, Germany (etc.), although this model lacks economic incentives for lawyers to participate.

- Dividing patent periods, a way of dividing benefits to resolve conflicts and also to divide the benefits of patents. Businesses and individuals can share a patent by being awarded periods of time to use the patent. (One year to the first business, then three years to the second business, etc.)

- Crowd patenting is an innovative solution to this problem, which allows individuals, businesses and governments to invest in ideas through patents. These "idea shares" grant royalty dividends for the

[111] Research Data Canada, "About Us." Research Data Canada Website, 2020.
[112] IP Nexus, "The Global Marketplace For Intellectual Property." IP Nexus Website, 2020.
[113] Canadian Ecosystem Gathering, "About." Canadian Ecosystem Gathering, Mangrove Canada Website, 2020.
[114] Patent Collective Pilot Program "Patent Collective Program Guide", Patent Collective Pilot Program Website, 2019.

commercialization of patents, but they work somewhat analogously to preferred stock options, in the sense that they do not grant "voting rights" or direct influence on the process. The patent owner retains the sole ownership of the patent with the ability to sue for infringement. However, the "idea share holders" may be inclined to support a lawsuit case against a violator if their cash flow from the idea share royalties are threatened.

- Indigenous models of IP protection. There is a need to review the way in which patent law protects the intellectual property of indigenous peoples. The 2016 Stonecircle Report outlines some uses of Canada's IP services by Indigenous peoples and recommends investigating new models based on community IP systems.[115] This would help address many of the issues outlined in the Stonecircle report, including lack of knowledge of IP systems and the high cost of patenting.

## 7.5 Communications Campaign Considerations

The considerations below are based on the assumption that the recommendations to change ExploreIP would be integrated.

### Goal:

To implement a communications campaign for the expansion of ExploreIP that engages various actors in the scientific and innovative community. The communications campaign must not only provide affirmative information regarding the program but also open collaborative communications channels between ISED and other innovation networks.

### Communication objectives:

- Enhance public awareness on the relevance of intellectual property
- Engage various actors in the innovation ecosystem
- Increase public perception of ExploreIP's new features
- Engage underrepresented groups in using the platform

### Targeted audiences/actors in innovation:

- Federal government
- Granting councils/federally funded not-for-profits
- Higher education institutions
- Provincial and territorial governments
- Network of Canada Excellence program

[115] "First Nations, Inuit and Métis Experiences with Canada's Intellectual Property System: Stone circle Report Executive Summary." Intellectual Property Strategy, 26 Apr. 2019,

- Private sector/access to risk capital institutions
- Global markets
- Networks/organized communities of underrepresented groups in the innovation sphere
- Regular citizens

## Considerations

The new features of ExploreIP use patents as a tool for collaboration. However, it cannot be a "build-it-and-they-will-come" approach; openness does not guarantee collaboration or even diversity. Especially for underrepresented groups, there is a reason for their lack of participation: they must be sought out directly and mechanisms should be in place to ensure and encourage their participation. Creating an open innovation model through patents means that information must be disseminated among and between users; we must ensure that external flows of information are incorporated into ExploreIP.

We recommend an analysis of the best ways to deliver the message to different actors. First, as Explore IP becomes fully bilingual, it opens new avenues for dissemination of content into francophone communities. It is also important to start the communications campaign with the members already registered in the platform. Conducting follow-up meetings with these inventors can open new ideas of dissemination of content among new users.

Engagement with the platform is the measure of success, but it is also the main challenge; we must ensure an increasing number of platform users. The communications strategy should outline to each actor how the platform will meet their specific needs. Each actor will benefit differently and will face different challenges when engaging with the platform. The communications strategy will need to incorporate a communications approach that takes this into account. Some examples include;

- Universities may gain from using the platform to commercialize the innovations created within the academic community.
- Another approach would be required to spur citizen innovation, in which those who are not professionally involved in the innovation sphere could be encouraged to create a profile to contribute ideas, requests, or needs that demand a particular innovative solution.
- Innovators would also benefit from interaction with citizens: by opening the discussions outside the traditional sphere, citizens could provide feedback to create new patents and innovations.
- Underrepresented groups tend not to engage naturally in the innovation process; therefore, the communications strategy for inclusiveness should target direct contact. It is recommended that ISED involve mobilized networks of underrepresented groups in innovation in Canada as a strategy for inclusiveness (Appendix 8). Receiving feedback and identifying local partners to reach out to organized communities would ensure dissemination of the program while fostering inclusiveness.

It is important to outline that the communications strategy should open channels of communication between ISED and the actors in innovation, more than simply promote the platform. These channels can be as simple as an email address or phone number on the platform, or as complex as developing an artificial intelligence chat that appears when entering the website to clarify questions and direct the user to a person in case of a more complex question. It should also communicate that users can filter the collection of data to find innovations by specific types of innovator characteristics (such as gender, race, ethnicity, territory, province).

The data collection can also serve as input for the communications strategy to target different audiences (Who are the users? How can they be reached? How can they connect other users?)

## 8. Conclusion

The proposal is that the new tabs for ExploreIP would work in synergy to drive demand by facilitating interactions between innovation users and producers. IP assets are expensive, and so we can make them more valuable to their owners by giving them the tools to find collaborators to use their hard-earned IP assets. Making IP assets more valuable to their owners could increase the number of patents filed, which would help boost some traditional innovation metrics. However, we also want to challenge these metrics and ensure that we are improving the rate of knowledge diffusion and the rate at which innovations make it to market. Inventions only become innovations when they are utilized.

Our recommendations, while not directly related to a specific demand-driven lever such as public procurement or regulation, incorporate many important elements of demand-side innovation policy. Leveraging a marketplace to facilitate the diffusion of patents inherently places the emphasis on the diffusion of new ideas and innovation outcomes. Other recommendations, such as adding the capability for users to request needs in ExploreIP, provide a way for the market to express its demand for new technologies.

Our recommendations also consider the need to "open" government platforms and to provide opportunities to increase two-way flows of communication between government and its clients. We recommend that ISED's innovation tools take positive steps to ensure that these new flows of information come from a more diverse set of stakeholders. These stakeholders could be the new users of ExploreIP, such as rural inventors who can now promote their inventions on a national marketplace. NGOs, B-corps, and other socially-driven organizations could become new users of this tool by adding new analytical tools and data segmentation capabilities to the platform. In this way, we can expand ExploreIP's potential as a tool for collaboration. We believe that by making innovation policy more demand-driven, open, and inclusive, we can provide more opportunities for growth and equality in Canada.

# 9. Bibliographic references


Allen RC. Collective invention. Journal of economic behaviour and organization. 1983;4(12):1–24

Aneesh Chopra & Ethan Skolnick "Foreword." Innovative State: How New Technologies Can Transform Government, Grove Press, 2016.

Acar, Oguz A., Murat Tarakci, and Daan van Knippenberg. "Why Constraints Are Good for Innovation." Harvard Business Review, November 22, 2019. https://hbr.org/2019/11/why-constraints-are-good-for-innovation.

Boudreau, Kevin. "Open Platform Strategies and Innovation: Granting Access vs. Devolving Control." *Management Science* 56, no. 10 (2010): 1849–72. https://doi.org/10.1287/mnsc.1100.1215.

Branch, Communications and Marketing. "Building a Nation of Innovators." Innovation for a better Canada. Innovation, Science and Economic Development Canada, February 14, 2019. https://www.ic.gc.ca/eic/site/062.nsf/eng/h_00105.html.

Briscoe, Gerard. "Complex Adaptive Digital EcoSystems." *Proceedings of the International Conference on Management of Emergent Digital EcoSystems - MEDES '10*, 2010. https://doi.org/10.1145/1936254.1936262.

Canada 2020 Innovation Project. Towards an Inclusive and Innovative Canada. Canada 2020 Innovation Project, 2017. http://innovationproject.ca/wp-content/uploads/2017/02/towards_an_inclusive_innovative_canada.pdf.

CBCnews, "Number of Patents Filed by Canadian Women Stalled, Study Finds | CBC News." CBCnews. CBC/Radio Canada, November 22, 2017. https://www.cbc.ca/news/politics/patents-canada-women-stem-1.4412880.

Cervantes, Mario. "Demand-Led Innovation: What Role for Policy?" Workshop presented at the OECD Workshop on Demand-Led Innovation Policies, Paris, France, September 14, 2009. http://www.oecd.org/sti/inno/oecdworkshopondemand-ledinnovationpolicies14-15september2009.htm.

Challenges.Gov. "About." About | Challenge.gov, U.S. Federal Government, 2020, www.challenge.gov/about/.

Chesbrough, H. W. (2003). Open innovation: The new imperative for creating and profiting from technology. Harvard Business Press.

Church, P. (2016). Global Advantage Consulting. (2016). "Canada's 2016 Science & Technology Innovation Ecosystem Map". Available in: https://docs.google.com/document/d/1rHEc7rcvJF5TGsP8xVjomkOt0XQ3B71E/edit

Colombo M, Grilli L, Pili E. In search of complementary assets: the determinants of alliance formation of high-tech start-ups. Res Policy. 2006;35(8):1166–99

Deutusch, Waverly. "Innovation: What's Diversity Got to Do with It?" Chicago Booth Review. Accessed June 30, 2020. https://review.chicagobooth.edu/entrepreneurship/2019/article/innovation-what-s-diversity-got-do-it.

Edler, Jakob. "A Costly Gap: The Neglect of the Demand Side in Canadian Innovation Policy." IRPP, 27 May 2019, irpp.org/research-studies/costly-gap-neglect-demand-side-canadian-innovation-policy/.

———. "Demand-Based Innovation Policy." In The Theory and Practice of Innovation Policy : An International Research Handbook, 496–496. PRIME Series on Research and Innovation Policy in Europe. Edward Elgar Publishing, 2012.

———. "Review of Policy Measures to Stimulate Private Demand for Innovation. Concepts and Effects." Nesta Working Papers. Manchester, UK: Nesta & Manchester Institute of Innovation Research, University of Manchester, November 2013. www.nesta.org.uk/wp13-13.

Eisenmann, T. R., Parker, G., & Van Alstyne, M. (2009). Opening platforms: How, when and why?. Platforms, markets and innovation, (ed. Gawer, 2009), 131–162

Evans, David. "Key Issues in Demand-Side Innovation Policies." Workshop presented at the OECD Workshop on Demand-Led Innovation Policies, Paris, France, September 14, 2009. http://www.oecd.org/sti/inno/oecdworkshopondemand-ledinnovationpolicies14-15september2009.htm.

Fagerberg, J. (2018), 'Mission (im)possible? The role of innovation (and innovation policy) in supporting structural change and sustainability transitions,' TIK Working Papers on Innovation Studies No. 20180216. Centre for Technology, Innovation and Culture: University of Oslo.

Fred Gault, "Defining and Measuring Innovation in All Sectors of the Economy," Research Policy 47, no. 3 (April 1, 2018): 617–22, https://doi.org/10.1016/j.respol.2018.01.007

Gallini, Nancy, and Aidan Hollis. "To Sell or Scale Up: Canada's Patent Strategy in a Knowledge Economy." IRPP, 27 Aug. 2019, irpp.org/research-studies/to-sell-or-scale-up-canadas-patent-strategy-in-a-knowledge-economy/.

Greer CR & Charles D. Stevens (2015) HR in collaborative innovation with customers: role, alignment and challenges, The International Journal of Human Resource Management, 26:20, 2569-2593, DOI: 10.1080/09585192.2014.1003086

Greer CR, Lei D. (2012). Collaborative innovation with customers: a review of the literature and suggestion for further research. Int J Management Rev. 2012;14:63–84

Heylighen, Francis. "Complexity and Self-Organization." *Encyclopedia of Library and Information Sciences, Third Edition*, 2009, 1215–24. https://doi.org/10.1081/e-elis3-120043869.

Hofstra, Bas, Vivek V. Kulkarni, Sebastian Munoz-Najar Galvez, Bryan He, Dan Jurafsky, and Daniel A McFarland. "The Diversity-Innovation Paradox in Science." *Proceedings of the National Academy of Sciences of the United States of America* 117, no. 17 (2020). https://doi.org/https://doi.org/10.1073/pnas.1915378117.

Huber, Franz. "On the Role and Interrelationship of Spatial, Social and Cognitive Proximity: Personal Knowledge Relationships of R&D Workers in the Cambridge Information Technology Cluster." *Regional Studies* 46, no. 9 (2011): 1169–82. https://doi.org/10.1080/00343404.2011.569539.

Hunt, Vivian, Denis Layton, and Sara Prince. Rep. *Diversity Matters*. McKinsey & Company, February 2, 2015. https://www.mckinsey.com/~/media/mckinsey/business%20functions/organization/our%20insights/why%20diversity%20matters/diversity%20matters.pdf.

Impact Canada, "Challenge: Impact Canada." Challenge | Impact Canada. Accessed July 8, 2020. https://impact.canada.ca/en/challenges/hull-design-efficiency.

Industrial Technologies Office, "Patent Collective Program Guide." Patent Collective Pilot Program, February 13, 2019. http://ito.ic.gc.ca/eic/site/135.nsf/eng/00001.html.

Inno AG, University of Manchester (MIOIR), INNOVA Europe, and SQW Limited. "Supply and Demand Side Innovation Policies." Directorate-General for Research and Innovation 2015, 7th Framework Programme (FP7). Luxembourg: European Commission, February 20, 2015. https://rio.jrc.ec.europa.eu/library/supply-and-demand-side-innovation-policies.

Innovation Challenges,"Source IP." Source IP: Innovation Challenges. Australian Government, August 1, 2015. https://sourceip.ipaustralia.gov.au/challenges.

Intellectual Property Strategy, "First Nations, Inuit and Métis Experiences with Canada's Intellectual Property System: Stonecircle Report Executive Summary." Intellectual Property Strategy, 26 Apr. 2019, www.ic.gc.ca/eic/site/108.nsf/eng/00006.html.

ISED Communications and Marketing Branch. "Intellectual Property Strategy." Home, 28 May 2020, www.ic.gc.ca/eic/site/108.nsf/eng/home.

ISED "ExploreIP: Canada's IP Marketplace - Innovation, Science and Economic Development Canada." Government of Canada, Innovation, Science and Economic Development Canada, 30 May 2019, ised-isde.canada.ca/ipm-mcpi/resources-ressources?lang=en.

Johnstone, Nick, Ivan Haščič, and Margarita Kalamova. "Environmental Policy Design Characteristics and Technological Innovation: Evidence from Patent Data," March 16, 2010. https://doi.org/10.1787/5kmjstwtqwhd-en.

Kattel, Rainer, and Mariana Mazzucato. "Mission-Oriented Innovation Policy and Dynamic Capabilities in the Public Sector." *Industrial and Corporate Change* 27, no. 5 (2018): 787–801. https://doi.org/10.1093/icc/dty032.

Kortum, Philip, and Claudia Ziegler Acemyan. "The Relationship Between User Mouse-Based Performance And Subjective Usability Assessments." *Proceedings of the Human Factors and Ergonomics Society Annual Meeting* 60, no. 1 (2016): 1174–78. https://doi.org/10.1177/1541931213601275.

Kortum, Philip, and Claudia Ziegler Acemyan. "The Relationship Between User Mouse-Based Performance And Subjective Usability Assessments." Proceedings of the Human Factors and Ergonomics Society Annual Meeting 60, no. 1 (2016): 1174–78. https://doi.org/10.1177/1541931213601275.

Kromatic. "Diversity Is an Innovation Metric." Medium. Medium, September 25, 2019. https://medium.com/@Kromatic/diversity-is-an-innovation-metric-1d7e2b79eb64.

Kuhlmann, Stefan, and Arie Rip. "Next-Generation Innovation Policy and Grand Challenges." *Science and Public Policy* 45, no. 4 (2018): 448–54. https://doi.org/10.1093/scipol/scy011.

Kwon, Seok-Woo, and Paul S. Adler. "Social Capital: Maturation of a Field of Research." *Academy of Management Review* 39, no. 4 (2014): 412–22. https://doi.org/10.5465/amr.2014.0210.

Li, Wenbin, Youakim Badr, and Frédérique Biennier. "Digital Ecosystems." *Proceedings of the International Conference on Management of Emergent Digital EcoSystems - MEDES '12*, 2012. https://doi.org/10.1145/2457276.2457297.

Lindner, Ralf, Stephanie Daimer, Bernd Beckert, Nils B. Heyen, Köhler Jonathan Hugh, Benjamin Teufel, Philine Warnke, and Sven Wydra. *Addressing Directionality Orientation Failure and the Systems of Innovation Heuristic: towards Reflexive Governance*. Karlsruhe: Fraunhofer ISI, 2016.

Mazzucato, Mariana. Working paper. *Mission-Oriented Innovation Policy: Challenges and Opportunities*. UCL Institute for Innovation and Public Purpose, July 2017. https://www.ucl.ac.uk/bartlett/public-purpose/publications/2018/jan/mission-oriented-innovation-policy-challenges-and-opportunities.

Medin, Douglas. "Point of View Affects How Science Is Done." Scientific American. Scientific American, October 1, 2014. https://www.scientificamerican.com/article/point-of-view-affects-how-science-is-done/.

Mergel, Ines. "Open Innovation in the Public Sector: Drivers and Barriers for the Adoption of Challenge.Gov." Public Management Review 20, no. 5 (05, 2018): 726-745. doi:http://dx.doi.org.proxy3.library.mcgill.ca/10.1080/14719037.2017.1320044.

Mergel, Ines. "Open Innovation in the Public Sector: Drivers and Barriers for the Adoption of Challenge.gov." Public Management Review, vol. 20, no. 5, 2017, pp. 726–745., doi:10.1080/14719037.2017.1320044.

Merges, Robert. (2010). The Trouble with Trolls: Innovation, Rent-Seeking and Patent Law Reform. 24.

Naderifar, Mahin, Hamideh Goli, and Fereshteh Ghaljaie. "Snowball Sampling: A Purposeful Method of Sampling in Qualitative Research." Strides in Development of Medical Education 14, no. 3 (2017). https://doi.org/10.5812/sdme.67670.

OECD, ed. Rep. OECD Economic Outlook. Vol. II, 2002. https://doi.org/https://doi.org/10.1787/16097408

OECD/Eurostat (2019), Oslo Manual 2018: Guidelines for Collecting, Reporting and Using Data on Innovation, 4th Edition, The Measurement of Scientific, Technological and Innovation Activities, OECD Publishing, Paris/Eurostat, Luxembourg, https://doi.org/10.1787/9789264304604-en.

OECD/Eurostat, "Oslo Manual 2018: Guidelines for Collecting, Reporting and Using Data on Innovation", 4th Edition, The Measurement of Scientific, Technological and Innovation Activities, OECD Publishing, Paris/Eurostat, Luxembourg, 2019, https://doi.org/10.1787/9789264304604-en.

Office, Canadian Intellectual Property. "Search CIPO Content." Canadian Intellectual Property Office. Innovation, Science and Economic Development Canada, June 30, 2020. https://www.ic.gc.ca/eic/site/cipointernet-internetopic.nsf/eng/wr00012.html.

Office, Canadian Intellectual Property. "Search CIPO Content." Canadian Intellectual Property Office. Innovation, Science and Economic Development Canada, June 30, 2020. https://www.ic.gc.ca/eic/site/cipointernet-internetopic.nsf/eng/wr00012.html.

Oreskes, Sandra, and Helen Longino. "Chapter 1. Why Trust Science? in Perspectives from the History and Philosophy of Science," 2019, 15–68. https://doi.org/10.1515/9780691189932-003.

Ortt, Roland, and Tineke Egyedi. "The Effect of Standards and Regulation on Radically New Innovations," 1–12, 2013. https://doi.org/10.1109/SIIT.2013.6774580.

Rosenberg, Nathan. The Direction of Technological Change: Inducement Mechanisms and Focusing Devices. Chicago: University of Chicago Press, 1969.

Organisation for Economic Co-operation and Development. Demand-Side Innovation Policies. Paris: OECD, 2011. https://read.oecd-ilibrary.org/science-and-technology/demand-side-innovation-policies_9789264098886-en.

Ozgen, Ceren, Peter Nijkamp, and Jacques Poot. "The Impact of Cultural Diversity on Innovation: Evidence from Dutch Firm-Level Data." EconPapers, July 15, 2014. https://econpapers.repec.org/paper/izaizadps/dp6000.htm.

Pang, Min-Seok, Gwanhoo Lee, and William H Delone. "IT Resources, Organizational Capabilities, and Value Creation in Public-Sector Organizations: A Public-Value Management Perspective." *Journal of Information Technology* 29, no. 3 (2014): 187–205. https://doi.org/10.1057/jit.2014.2.

Patent Collective Pilot Program "Patent Collective Program Guide", February 13, 2019. http://ito.ic.gc.ca/eic/site/135.nsf/eng/00001.html.

PCTxs, "FAQ." Frequently Asked Questions: Buyer/Licensee Questions. PCTxs Website. Accessed July 8, 2020. https://www.pctxs.com/faq/.

Phillips, Katherine W. "How Diversity Makes Us Smarter." Scientific American. Scientific American, October 1, 2014. https://www.scientificamerican.com/article/how-diversity-makes-us-smarter/.

Plaut, Victoria. "3 Myths Plus a Few Best Practices for Achieving Diversity." Scientific American. Scientific American, October 1, 2014. https://www.scientificamerican.com/article/3-myths-plus-a-few-best-practices-for-achieving-diversity/.

Research Data Canada, "About Us." Research Data Canada About Us Comments, Research Data Canada, 2020, www.rdc-drc.ca/about-us/.

Richard, Orlando C., Tim Barnett, Sean Dwyer, and Ken Chadwick. "Cultural Diversity in Management, Firm Performance, and the Moderating Role of Entrepreneurial Orientation Dimensions." *Academy of Management Journal* 47, no. 2 (2004): 255–66. https://doi.org/10.5465/20159576.

Selden, L., & MacMillan, I. C. (2006). Manage customer-centric innovation systematically. Harvard Business Review, 84, 108–116.

Schmookler, Jacob. Invention and Economic Growth. Cambridge: Harvard University Press, 1966.

Schumpeter, Joseph. Capitalism, Socialism, and Democracy. New York; London: Taylor & Francis; Routledge, 2003.

Schumpeter, Joseph. *Capitalism, Socialism, and Democracy*. New York; London: Taylor & Francis; Routledge, 2003.

Statistics Canada, "Survey of Innovation and Business Strategy (SIBS)," Statistics Canada Website, Last modified December 31, 2019, https://www.statcan.gc.ca/eng/survey/business/5171.

Statistics Canada, "Women in Corporate Canada: Who's at the Top?" Statistics Canada: Canada's national statistical agency / Statistique Canada : Organisme statistique national du Canada. Government of Canada, Statistics Canada, May 7, 2019. https://www150.statcan.gc.ca/n1/pub/11-627-m/11-627-m2019028-eng.htm.

Statistics Canada, "Women in Scientific Occupations in Canada." Statistics Canada. Accessed June 30, 2020. https://www150.statcan.gc.ca/n1/pub/75-006-x/2016001/article/14643-eng.htm.

Statistics Canada. "Study: Productivity Dispersion, Technological Diffusion and Productivity Growth in Canada." The Daily - , 17 Jan. 2020, www150.statcan.gc.ca/n1/daily-quotidien/200117/dq200117c-eng.htm.

Standards Council of Canada. "The Innovation Initiative," 2019. https://www.scc.ca/en/flagships/innovation.

Swann, G. M. Peter, Jean-christophe Graz, Richard Hawkins, John Hudson, Eric Iversen, Kai Jakobs, and Ken Krechmer. "The Economics of Standardization: An Update." Innovative Economics Limited, 2010. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.618.5922&rep=rep1&type=pdf.

Swann, Peter, and Ray Lambert. "Why Do Standards Enable and Constrain Innovation?" European Academy for Standardisation, 2010. https://www.iso.org/sites/materials/standards-and-innovation/education_innovation-list/educational_innovation-detaild820.html.

Steven Globerman & Joel Emes, Innovation in Canada: An Assessment of Recent Experience, (Vancouver, B.C: Fraiser Institute, 2019), 23.

Sylvia Ann Hewlett, Melinda Marshall and Laura Sherbin. "How Diversity Can Drive Innovation." Harvard Business Review, August 1, 2014. https://hbr.org/2013/12/how-diversity-can-drive-innovation.

Terwiesch, Christian, and Yi Xu. "Innovation Contests, Open Innovation, and Multiagent Problem Solving." *Management Science* 54, no. 9 (2008): 1529–43. https://doi.org/10.1287/mnsc.1080.0884.

The Conference Board of Canada, "Innovation Provincial Rankings: How Canada Performs,", accessed June 29, 2020, https://www.conferenceboard.ca/hcp/provincial/innovation.aspx

Treasury Board Secretariat of Canada. "Open Data for Innovation." Open Government, Government of Canada, 7 June 2019, open.canada.ca/en/idea/open-data-innovation.

Union, Double. Open Diversity Data. Accessed July 8, 2020. http://opendiversitydata.org/.

Vandermerwe, S. (2000). How increasing value to customers improves business results. Sloan Management Review, 42(1), 27 – 37.

Watters, D. B. 2013. Q&A. What Are the Components of Canada's Innovation Ecosystem and How Well Is it Performing? Technology Innovation Management Review, 3(9): 38-41. http://doi.org/10.22215/timreview/727

WEF, "Global Competitiveness Report 2019," World Economic Forum, accessed June 11, 2020, https://www.weforum.org/reports/global-competitiveness-report-2019/.

WIPO, "Global Innovation Index 2019," World Intellectual Property Organization, accessed May 11, 2020, https://www.globalinnovationindex.org/gii-2019-report#

WIPO, "What Is Intellectual Property?" World Intellectual Property Organization. Accessed July 8, 2020. http://www.wipo.int/publications/en/details.jsp?id=99.

# 10. Appendices

**Appendix 1**

Detailed explanation of the demand-driven model

The levers (price, preference, values, compliance, information, etc.) vary and, as seen, these intervening factors can align or misalign with each other. Hence, an accurate analysis requires applying behavioural economics to innovation consumption, comprising the effects of all psychological, cognitive, emotional, cultural ,and social factors, articulated over the decisions of individuals and the institutions. The latter are crucial to consider for DSIPs, since we will include the purchases made by both firms and governments, and not only end-users.

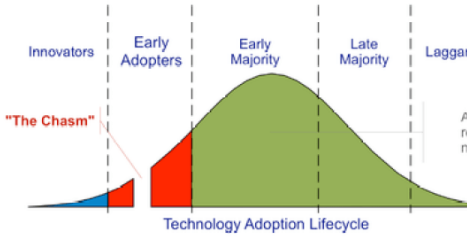
In terms of DSIP design, the relevance of recognizing the complexity of these intertwined levers requires us to concede some uncertainty, and a lack of causal linearity between these demand levers and the expected results of innovation dynamics, since we are considering human behaviour taking place under singular social and historical conditions.

Also, the same definition of the expected results of the DSIP on innovation dynamics will vary largely, since one measure can deliver results that alter many possible aspects, over all the phases involved in innovation processes, as well as the singular type of innovation, the industrial or service sector, and specific phase within a wide timeframe.

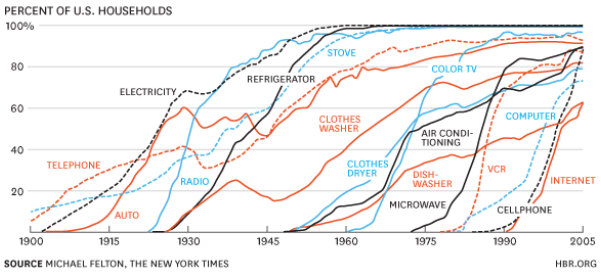
The following example illustrates this complexity: if the DSIP policy objective is to intervene in the innovation uptake curve of large-scale, energy-storage technology (as a component of a low-carbon energy policy strategy), it will require policymakers to understand the state of that singular development's response to issues such as:

- current state, and prospective evolution, of the supply market of lithium;
- the current frontier of scientific knowledge and its limits, e.g. membrane electrolysis for the removal of Mg2+ and Ca2+ from lithium-rich brine;
- a hypothesis on the shape of the technology's adoption curve;
- possible results over a mid-to-long period after a pull intervention.

As the spread and adoption curves of innovation show, the intervals between an innovative development and its adoption vary both in a micro-scale of a unique evolution (see left chart) and a macro-scale (see right chart), in which broad economic and historical factors intervene. This should serve to recognize that DSIP will attempt to pull demand of innovations that can be situated in a singular instance: from "stuck" in very early development stage or fully mature innovations requiring dissemination; and that the barriers for each case will be unique, the best levers will differ, as well as the targeted consumers of the potential demand, and the variety of results that can be expected in an evolving complex lifecycle.




Consumption spread of innovations




From Crossing the Chasm (Moore, 2014)

https://archive.nytimes.com/www.nytimes.com/imagepages/2008/02/10/opinion/10op.graphic.ready.html

When it comes to end-users of technologies, the behavioural motivations that underly the demand in each stage contribute to understanding and predicting whether a certain DSIP lever can eventually succeed. Following Moore (2014), the early adopters will be "technology enthusiasts" and "visionaries", the early majority will be "pragmatists", and the late majority of adopters "conservatives" (left chart). From this perspective, comprehending these cultural and psychological traits, as they relate to consumption of a given innovation, is indispensable to effectively pull and cross that "chasm" with the most customized DSIP possible.

**Appendix 2**

Detailed descriptive typology of traditional demand-driven policies

1. Public procurement

Recently, the most common example of a government initiative aiming to pull demand for innovation is the use of the government's purchasing power.

Its first goal is, naturally, to satisfy a government need to purchase and consumer a product or service in order to achieve its mission. As an externality, a procurement system will mobilize a market of suppliers and their respective chains.

Based on the government's scale and the scope of its needs, this purchasing power can be used as a policy tool to stimulate innovation in general. Furthermore, the definition of such needs and specifications in a tender will shape innovation in a given way over economic sectors or technologic areas considered more valuable or strategic.

This innovation is primarily a direct result of the acquisition, but secondarily, and perhaps as more far-reaching, it can have an indirect outcome due to its signalling effect, which can be widespread over other markets. This means that government can acts as a lead user, with the potential to influence other users, and moreover, to expand geographically into markets of other regions and countries, even though the policy may have been initially pursued to benefit the domestic economy.

Widely known examples of technologies of greatest impact that followed this innovation path are the GPS used in smartphones, or the ARPANET project that laid the groundwork for developing the Internet, both started by the U.S. Department of Defense in the 1960's and 1970's.

However, nowadays, policy discussion aims to adopt this model to induce innovations at all government levels and on much smaller scales by better defining the functional requirements for products and services. In this sense, a main challenge persists within the criteria that permeates the elaboration of regular public tender specifications (often rigidly defined in government procurement guidelines and manuals), since attaining the lowest cost is often more relevant than the inclusion of innovative features in securing a procurement contract of a product or service. (An analysis of procurement criteria within EU countries shows: 9% is for the weight of "Innovative product", compared to 30% for "Cost"; See Van Eijl, 2009, p. 5). As we will later explain, this type of policy can be considered as not cost-efficient if the value of the innovation externality is not properly weighted.

The expected innovation outcomes achieved through government procurement can vary, and it is argued that governments should reach minimum levels of innovation demand through their public tenders to, at least, enable, unlock, or not hinder innovation, if not always producing the greatest pull effect. This is why terms such as Innovation-friendly public procurement or Innovation-orientated public procurement are beginning to take pride of place in the public procurement lexicon.

As we will see, compared with the following types of DSIP in which governments attempt to mainly affect private consumers through their pro-innovation procurement policies, this is the only DSIP in which the government will represent both the demand and simultaneously the consumer.

2. Public purchase for private use, or catalytic procurement

However, there is a type of policy that is somewhat in between public procurement and the remaining private-demand-side innovation measures we will here describe, in which the government purchases innovations that will belong to individual private end-users.

This less-common approach is more likely seen in developing countries when, for instance, governments purchase and freely distribute low-consumption lamps or appliances for households. The policy pursues a wider social benefit, such as energy-efficiency, by shaping the demand with the expectation that the larger diffusion of determined technology will persist as a consumption pattern over time.

3. Innovation-orientated rebates

Kindred to the previous type (catalytic procurement), a rebate policy directed to end-users that will be purchasing specific innovations is another type of DSIP.

This can be seen as an indirect way by which government also partially purchases the product, since it assumes a portion of the costs to make a discount possible.

In many cases, government rebates are implemented through tax credits. In Canada, for instance, homeowners purchasing energy-efficient construction materials (that comply with pre-determined performance certified standards) are eligible for such a credit, in the expectation that these credits with produce a consistent stimulus for producers to innovate to reach the standards and thus achieve greater environmental benefits.

4. Innovation orientated regulatory policies

Regulatory policies and their supervision, enforcement, and control mechanisms are diverse and vast, cutting across all governmental areas, sectors, and levels.

Similarly to government procurement as an innovation policy whose main objective may be to purchase goods and services which may also have secondary innovation-related goals, regulatory policies may also have a variety of primary goals. Generally speaking, innovation oriented regulatory policies are meant to meet and maintain environmental, health, and safety conditions in all public and private activities, protect consumers, or make possible technical interoperability, among other applications.

Although a government's regulatory power in any field aims to pursue a determined public benefit, such as safety, it will also unavoidably be shaping a given set of markets for goods and services.

These policies, which refer to the quality of products and services, and/or to the effects and consequences of their given usage, are meant to influence the behaviour of individuals and firms. While some regulations target the supply (affecting what can be designed, produced and commercialized), others target demand, orientating purchase and usage. From the perspective for potential demand-side policies, the latter are those that can be built upon to spur innovation consumption.

An extensive example is the regulation of materials incorporated into building and constructions, traditionally certified to meet health and safety standards, and lately incorporating renewable and/or energy efficient technologies.

Note that these regulatory policies are fraught with the same structural organizational issues, the same complexity due to multiple governing agencies, authorities and regulatory bodies, and a variety of enforcement mechanisms (such as inspection, supervision), and consequently, this regulatory capacity is highly segmented in areas, fields, and disciplines. From this we can deduce that demand-driven innovation cannot be generically and broadly implemented through innovation orientated regulatory. However, the effectiveness of these policies in inducing innovation consumption in narrowed areas and fields is very high.

The strong influence of some regulatory agencies in outlining innovation demand incentives (or eventually disincentives) far beyond their own jurisdiction is well-known and extensive: the United States' USDA, FDA and EPA in are excellent examples.

Although we have labeled such policies as regulatory, their functioning is not always based on regulations strictly speaking, but also on guidelines, recommendations, and other soft mechanisms. In many areas, their roles are highly interrelated with the definitions of standards, and policy is subsequently addressed.

5. Standards and certifications

Most policy analysts frame standard-setting together with regulations within DSIP. We have decided to present them separately for two main reasons: first, regulation setting is exclusively a government prerogative, while standard-setting is mostly run by autonomous bodies based on international, technical and industry-wide consensus; second, regulations have an enforcement power while standards are mostly voluntary.

Standardization can structure innovation demand by laying out the set of conventions and metrics used in trade, industry, technology, and multiple professional practices and services at large.

Standards can be defined as the terms, definitions, codes, dimensions, and specifications that are utilized to inform levels of quality and safety, cutting across most environmental and health issues, and that are based on some degree of consensus within a community of industrywide stakeholders, where firms and international organizations play a key role.

It is argued that "standardization helps create critical mass in the formative stages of a market. Standards can focus demand for innovations that might otherwise be spread over many technical solutions. Standards are especially important in network industries, such as ICTs, in that they can facilitate the formation of a critical mass of users. In this connection, standards ease the emergence of technological platforms – independently supplied yet interoperable components with shared technical standards. Many successful platforms, such as the Internet and the cellular telephone, are based on open standards." (Organisation for Economic Co-operation and Development, 2011, p. 48)

Although standards have a notable and proven effect on innovation demand, unlike regulations they are not a lever that is clearly within the government's reach for policymaking. The public sector plays a key role in facilitating and coordinating with firms and other governments, as a broad consensus is indispensable for networks, platforms, and interoperability in a globalized economy. However, countries that lead in setting standards and definitions can take advantage of this fact by having their technological and productive base adapted in advance, in a race that can take several years to establish and eventually adopt the standards.

Even if they are not proactive in defining them, governments can adopt or enforce likely global standards in their national regulations and include them in public procurement tenders. Thus, for policymaking, this is highly interrelated with the demand-driven modalities previously described.

6. Consumer awareness

As with most of these policies, these strategies are used to assist consumers in making informed decisions, and in the end, influence their behaviour by enhancing cultural factors. While they are traditionally directed to contribute to matters involving public health and safety, they can be adapted to other purposes, such as encouraging the consumption of an innovative product or service.

The policies comprised under this category are based on disseminating the knowledge and skills within the demand on the one hand, and can be combined with creating the transparency and availability of information from suppliers on the other. They are designed to diminish asymmetries so that consumers can exercise a critical engagement in their transactions. The existence of standardized "comparison labels" in all food products is a common example.

Many specific policy tools have been broadly used with effectiveness over the past few decades: campaigns, education, labelling, especially to drive demand away from nonbenign consumption, such as smoking. Nevertheless, experts widely recommend raising consumer awareness as a policy instrument to enhance the public's readiness to take up innovations.

Labelling has roused controversial discussions about its effectiveness in promoting informed decisions, especially when some "endorsement labels" are associated with a presumably positive qualities, such as GMO-free, while they are seemingly a sales instrument rather than a reliable source of information. Nevertheless, there are policy experiences in which endorsement labels aim to promote consumption of products driving innovation in energy-efficiency, such as the "Energy Star" program (the symbol developed by the U.S. Environmental Protection Agency, the Department of Energy, and partnering appliance firms).

Consumer education and literacy initiatives are expected to have long-term results compared to media campaigns that aim to produce an immediate impact, and both can be applied to stimulate innovation demand.

7. Combination of Instruments and Systemic Approach

The typology as presented aims to introduce the mainstream tools and recommendations in an organized way, though simplifying the way that policies are delivered to focus on the specificity of each instrument.

However, most of the real policy experiences reviewed integrate such instruments in some fashion, and moreover, analysts highlight that they should be combined to gain effectiveness.

For instance, in the energy sector: Feed-in tariffs (FITs) are used to promote renewable energy sources in the early stages of their development. Governments offer tax rebates over some energy-efficient products. Simultaneously, an Energy Efficiency Act establishes the regulation for the development of the market, based on globally established standards. Government, jointly with the appliances industry chamber, agrees on the labelling that will allow a comparison of the technologies utilized. An endorsement label development by an industry-wide partnership identifies the innovative products in energy efficiency, such as DC-Inverter Technology.

Another example of combined mechanisms is the development of an educational strategy that includes the public sector and specific training to incorporate DSIP in procurement practices.

While there are multiple examples of combinations of such tools, it is not common to find comprehensive and strategic articulation of long-term DSIP.

The flagship Lead Market Initiatives (LMI), which was introduced into the European Union in 2006, launched in 2008 as a pilot program, and recently evaluated, is considered a novel approach within DSIP that is grounded in the rationale of Lead Markets (Commission of the European Communities, 2007; Ozbolat, 2016).

The rationale of the leading markets derives from the identification of innovative markets territorially circumscribed that have emerged due to the singular conditions of an ecosystem in which the demand pull has made possible the market uptake. The success of the innovation is not merely due to its intrinsic superiority, but also due to converging conditions, often at a national level, such as the market players and regulations in place. It is argued that a lead market is possible where consumers are most willing to pay for the innovation,

becoming lead users. The concept is that the lead market will later expand territorially over lag markets, not automatically, but through a diffusion that is implemented through regulations adopting the standards from such a lead. An example is the adoption of specific mobile phone wireless technology which, having an early diffusion into a territory, will likely impose its technical standards on the remaining regional or global markets, since the technology is indispensable for the interoperability within the communication networks.

One the main features of the European LMI, is that the demand-side package of measures were strategically planned by sectorializing the potential markets (such as eHealth, protective textiles, bio-based products, renewable energies, among others).

Appendix 3

# CANADA

GII 2019 rank

**17**

| Output rank | Input rank | Income | Region | Population (mn) | GDP, PPP$ | GDP per capita, PPP$ | GII 2018 rank |
|---|---|---|---|---|---|---|---|
| 22 | 9 | High | NAC | 37.0 | 1,852.5 | 49,651.2 | 18 |

| | | Score/Value | Rank | |
|---|---|---|---|---|
| **INSTITUTIONS** | | **92.3** | **4** | ● |
| **1.1** | **Political environment** | **92.0** | **6** | ● |
| 1.1.1 | Political and operational stability* | 93.0 | 7 | |
| 1.1.2 | Government effectiveness* | 91.5 | 6 | ● |
| **1.2** | **Regulatory environment** | **95.1** | **8** | |
| 1.2.1 | Regulatory quality* | 92.6 | 6 | ● |
| 1.2.2 | Rule of law* | 94.0 | 10 | |
| 1.2.3 | Cost of redundancy dismissal, salary weeks | 10.0 | 29 | |
| **1.3** | **Business environment** | **89.8** | **4** | ● |
| 1.3.1 | Ease of starting a business* | 98.2 | 3 | ● ◆ |
| 1.3.2 | Ease of resolving insolvency* | 81.5 | 12 | |
| **HUMAN CAPITAL & RESEARCH** | | **50.9** | **19** | |
| **2.1** | **Education** | **51.9** | **51** | ◇ |
| 2.1.1 | Expenditure on education, % GDP ⊙ | 5.3 | 33 | |
| 2.1.2 | Government funding/pupil, secondary, % GDP/cap ⊙ | 18.3 | 58 | ○ ◇ |
| 2.1.3 | School life expectancy, years | 16.1 | 33 | |
| 2.1.4 | PISA scales in reading, maths, & science | 523.3 | 5 | |
| 2.1.5 | Pupil-teacher ratio, secondary | n/a | n/a | |
| **2.2** | **Tertiary education** | **41.2** | **32** | |
| 2.2.1 | Tertiary enrolment, % gross ⊙ | 67.0 | 33 | |
| 2.2.2 | Graduates in science & engineering, % | 21.3 | 55 | ○ |
| 2.2.3 | Tertiary inbound mobility, % | 11.9 | 14 | |
| **2.3** | **Research & development (R&D)** | **59.5** | **15** | |
| 2.3.1 | Researchers, FTE/mn pop. ⊙ | 4,274.7 | 22 | |
| 2.3.2 | Gross expenditure on R&D, % GDP ⊙ | 1.7 | 21 | |
| 2.3.3 | Global R&D companies, avg. exp. top 3, mn US$ | 69.6 | 19 | |
| 2.3.4 | QS university ranking, average score top 3* | 80.2 | 6 | ● |
| **INFRASTRUCTURE** | | **58.5** | **27** | ◇ |
| **3.1** | **Information & communication technologies(ICTs)** | **85.0** | **21** | |
| 3.1.1 | ICT access* | 80.0 | 29 | |
| 3.1.2 | ICT use* | 76.1 | 25 | |
| 3.1.3 | Government's online service* | 93.1 | 17 | |
| 3.1.4 | E-participation* | 91.0 | 27 | |
| **3.2** | **General infrastructure** | **55.4** | **8** | |
| 3.2.1 | Electricity output, GWh/mn pop | 18,368.9 | 4 | ● ◆ |
| 3.2.2 | Logistics performance* | 77.8 | 20 | |
| 3.2.3 | Gross capital formation, % GDP | 23.8 | 56 | |
| **3.3** | **Ecological sustainability** | **35.1** | **79** | ○ ◇ |
| 3.3.1 | GDP/unit of energy use | 5.5 | 103 | ○ ◇ |
| 3.3.2 | Environmental performance* | 72.2 | 24 | |
| 3.3.3 | ISO 14001 environmental certificates/bn PPP$ GDP | 0.7 | 76 | ○ ◇ |
| **MARKET SOPHISTICATION** | | **80.4** | **2** | ● ◆ |
| **4.1** | **Credit** | **85.0** | **[4]** | |
| 4.1.1 | Ease of getting credit* | 85.0 | 11 | ◆ |
| 4.1.2 | Domestic credit to private sector, % GDP | n/a | n/a | |
| 4.1.3 | Microfinance gross loans, % GDP | n/a | n/a | |
| **4.2** | **Investment** | **77.7** | **4** | ● ◆ |
| 4.2.1 | Ease of protecting minority investors* | 78.3 | 10 | ◆ |
| 4.2.2 | Market capitalization, % GDP | 125.1 | 7 | |
| 4.2.3 | Venture capital deals/bn PPP$ GDP | 0.5 | 1 | ● ◆ |
| **4.3** | **Trade, competition, & market scale** | **78.6** | **13** | |
| 4.3.1 | Applied tariff rate, weighted avg., % | 1.5 | 16 | |
| 4.3.2 | Intensity of local competition† | 74.5 | 31 | |
| 4.3.3 | Domestic market scale, bn PPP$ | 1,852.5 | 17 | |

| | | Score/Value | Rank | |
|---|---|---|---|---|
| **BUSINESS SOPHISTICATION** | | **49.9** | **22** | |
| **5.1** | **Knowledge workers** | **56.4** | **28** | ◇ |
| 5.1.1 | Knowledge-intensive employment, % ⊙ | 43.7 | 19 | |
| 5.1.2 | Firms offering formal training, % firms | n/a | n/a | |
| 5.1.3 | GERD performed by business, % GDP | 0.8 | 24 | |
| 5.1.4 | GERD financed by business, % | 40.9 | 43 | ◇ |
| 5.1.5 | Females employed w/advanced degrees, % | 17.6 | 31 | |
| **5.2** | **Innovation linkages** | **48.4** | **15** | |
| 5.2.1 | University/industry research collaboration† | 63.0 | 20 | |
| 5.2.2 | State of cluster development† | 62.0 | 22 | |
| 5.2.3 | GERD financed by abroad, % | 10.9 | 36 | |
| 5.2.4 | JV-strategic alliance deals/bn PPP$ GDP | 0.3 | 1 | ● ◆ |
| 5.2.5 | Patent families 2+ offices/bn PPP$ GDP | 2.1 | 20 | |
| **5.3** | **Knowledge absorption** | **44.9** | **28** | |
| 5.3.1 | Intellectual property payments, % total trade | 2.2 | 11 | |
| 5.3.2 | High-tech imports, % total trade | 10.0 | 30 | |
| 5.3.3 | ICT services imports, % total trade | 0.9 | 77 | ○ ◇ |
| 5.3.4 | FDI net inflows, % GDP | 2.6 | 64 | |
| 5.3.5 | Research talent, % in business enterprise ⊙ | 56.7 | 18 | |
| **KNOWLEDGE & TECHNOLOGY OUTPUTS** | | **41.3** | **19** | |
| **6.1** | **Knowledge creation** | **50.5** | **13** | |
| 6.1.1 | Patents by origin/bn PPP$ GDP | 2.3 | 38 | ◇ |
| 6.1.2 | PCT patents by origin/bn PPP$ GDP | 1.3 | 27 | ◇ |
| 6.1.3 | Utility models by origin/bn PPP$ GDP | n/a | n/a | |
| 6.1.4 | Scientific & technical articles/bn PPP$ GDP | 20.6 | 22 | |
| 6.1.5 | Citable documents H-index | 80.0 | 4 | ● ◆ |
| **6.2** | **Knowledge impact** | **41.5** | **43** | |
| 6.2.1 | Growth rate of PPP$ GDP/worker, % | 0.7 | 68 | ○ |
| 6.2.2 | New businesses/th pop. 15-64 | 0.1 | 104 | ○ ◇ |
| 6.2.3 | Computer software spending, % GDP | 0.7 | 5 | ● |
| 6.2.4 | ISO 9001 quality certificates/bn PPP$ GDP | 3.4 | 73 | ○ ◇ |
| 6.2.5 | High- & medium-high-tech manufactures, % | 0.4 | 24 | |
| **6.3** | **Knowledge diffusion** | **32.0** | **27** | |
| 6.3.1 | Intellectual property receipts, % total trade | 0.8 | 21 | |
| 6.3.2 | High-tech net exports, % total trade | 4.9 | 31 | |
| 6.3.3 | ICT services exports, % total trade | 1.5 | 68 | ○ |
| 6.3.4 | FDI net outflows, % GDP | 5.0 | 12 | |
| **CREATIVE OUTPUTS** | | **41.4** | **27** | |
| **7.1** | **Intangible assets** | **50.7** | **31** | |
| 7.1.1 | Trademarks by origin/bn PPP$ GDP | 58.5 | 37 | |
| 7.1.2 | Industrial designs by origin/bn PPP$ GDP | 0.5 | 86 | ○ ◇ |
| 7.1.3 | ICTs & business model creation† | 75.7 | 16 | |
| 7.1.4 | ICTs & organizational model creation† | 77.0 | 11 | |
| **7.2** | **Creative goods & services** | **24.7** | **45** | |
| 7.2.1 | Cultural & creative services exports, % total trade | 0.8 | 34 | |
| 7.2.2 | National feature films/mn pop. 15-69 | 3.5 | 53 | |
| 7.2.3 | Entertainment & Media market/th pop. 15-69 | 59.4 | 10 | |
| 7.2.4 | Printing & other media, % manufacturing | 1.5 | 34 | |
| 7.2.5 | Creative goods exports, % total trade | 1.0 | 43 | |
| **7.3** | **Online creativity** | **39.4** | **17** | |
| 7.3.1 | Generic top-level domains (TLDs)/th pop. 15-69 | 76.5 | 6 | ● ◆ |
| 7.3.2 | Country-code TLDs/th pop. 15-69 | 29.4 | 19 | |
| 7.3.3 | Wikipedia edits/mn pop. 15-69 | 49.0 | 25 | |
| 7.3.4 | Mobile app creation/bn PPP$ GDP | 18.8 | 24 | |

NOTES: ● indicates a strength; ○ a weakness; ◆ a strength relative to the other top 25-ranked GII economies; ◇ a weakness relative to the other top 25-ranked GII economies; * an index; † a survey question. ⊙ indicates that the economy's data are older than the base year; see Appendix II for details, including the year of the data, at http://globalinnovationindex.org. Square brackets [ ] indicate that the data minimum coverage (DMC) requirements were not met at the sub-pillar or pillar level.

**Appendix 4 (From the Conference Board of Canada)**

**What does the Conference Board's report card measure?**

The report card measures how well Canada and its provinces and territories are meeting the goal of creating a high and sustainable quality of life for all Canadians.

What is meant by "a high and sustainable quality of life for all Canadians"?

The Conference Board considers a high and sustainable quality of life for all Canadians as being achieved if Canada and the provinces and territories record high and sustainable performances in six performance categories:

- Economy
- Society
- Innovation
- Environment
- Health
- Education and Skills

The word "sustainable" is a critical qualifier. It is not enough for Canada to boost economic growth if it is done at the expense of the environment or social cohesion. For example, to take advantage of high commodity prices by mining and exporting all our natural resources may make the country rich in the short term, but this wealth will not be sustainable in the long or even medium term. The Conference Board has consistently argued that economic growth and sustainability of the physical environment need to be integrated into a single concept of sustainable national prosperity—what we call here a "high and sustainable quality of life for all Canadians."

While there are many definitions and approaches to the notion of sustainability, the most widely used is from the United Nations' Brundtland Commission: "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."[1]

**How does the Conference Board choose indicators?**

How Canada Performs: A Report Card on Canada attempts to grade only "outcome" indicators—indicators that tell us what Canada is achieving, rather than what efforts it is making. In the Innovation category, however, have used several input indicators as proxies for outputs.

How Canada Performs also focuses on indicators that can be influenced by public policy—that is, factors contributing to quality of life that can be modified by individual, organizational, or public efforts. Policy may influence outcome indicators directly (such as a law requiring everyone to vote) or indirectly—by influencing inputs, which in turn affect output (such as a policy that attempts to change smoking rates in order to reduce mortality rates). Some indicators emphasize a gap in performance (i.e., differences in levels among countries); others emphasize progress toward closing a gap (i.e., differences in growth rates among countries).

All indicators used to measure performance meet the following criteria:

- The indicator provides valuable information on the performance or status of a particular category.

- The indicator can be affected by policy and is relevant to policy.
- The indicator data are reliable and have timely availability.
- The data are sufficiently consistent to permit benchmarking over time and across countries.
- There is general agreement that a movement in the indicator in one direction is better than movement in the other.

**Where does the Conference Board obtain the data?**

About 80 percent of the data used for the international benchmarking report are supplied by the Organisation for Economic Co-operation and Development (OECD). The rest come from other reliable sources, such as the United Nations, the World Bank, and the Yale Center for Environmental Law and Policy.

Statistics Canada is the source of almost all of the provincial and territorial data. For the complete list of data sources, please see the "Data Sources" pages.

The most recent year of data is used for each indicator.

**How does the Conference Board choose the 16 peer countries?**

We begin with the countries deemed "high income" by the World Bank; this is the group of countries likely to have achieved a high and sustainable quality of life and would therefore serve as a worthy peer group. We use three filters to determine which of these 38 countries would stay in our analysis:

- **Population**: We eliminate countries with populations of less than 1 million. Nine countries drop from the list—Luxembourg and Iceland, for example.
- **Geographic land mass**: We eliminate countries of less than 10,000 square kilometres to restrict our analysis to countries that are more than city-states. Singapore drops from the list.
- **Income (gross domestic product) per capita**: We rank the remaining countries using a five-year average of real income per capita and include only countries that rank above the average. Thirteen countries drop off the list—Spain, New Zealand, and Israel, for example.

Using these criteria, 16 countries, including Canada, form our comparator group:

Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Japan, The Netherlands, Norway, Sweden, Switzerland, United Kingdom, United States

The comparator group remains constant across performance categories. This ensures that the best-performing country (in each category and on each indicator) is included in all analyses and allows us to compare performance over time.

When timely data are not available for a country for a particular indicator, we do not include that country in that particular report card.

**How does the Conference Board assign a grade to each indicator?**

We use a report card–style ranking of A–B–C–D, to tie in with the title A Report Card on Canada. We assign a grade level to each indicator using the following method:

- For each output indicator, we calculate the difference between the top and bottom performers and divide this figure by 4, into four quartiles.

- A country receives a report card rating of "A" on a given indicator if its score is in the top quartile, a "B" if its score is in the second quartile, a "C" if its score is in the third quartile, and a "D" if its score is in the bottom quartile.

For example, on the Innovation indicator "Scientific articles per million population," the top performer (Switzerland) produced 1,176 scientific articles per million population in 2005 and the bottom performer (Japan) produced 424 articles. Using our method for ranking, the ranges for A–B–C–D are:

A: 988–1,176 scientific articles

B: 800–987 scientific articles

C: 612–799 scientific articles

D: 424–611 scientific articles

(Note: In this example, a high score indicates a high level of performance. For indicators where a low score signifies a high level of performance—such as scores on poverty in the in the Society category—the ranking levels are reversed.)

One indicator is not graded using the standard methodology—inflation—and two indicators—GDP growth and labour productivity growth—used a modified methodology during the 2008–09 recession.

**Inflation**

We award an "A" grade to inflation that falls within the Bank of Canada's inflation-control target range, which is between 1 and 3 per cent. Inflation outside this target range (either above or below) is awarded a lower grade. The further away from the target range, the lower the grade. Countries with inflation between 0 and 1 per cent or between 3 and 4 per cent earn a "B" grade. We grade inflation between 0 and 1 per cent to be a "danger zone" because it may signal that a country is slipping into deflation. The one exception is when inflation between 0 and 1 per cent is due to currency appreciation or strong productivity growth—these countries are awarded an "A" grade. Inflation between 0 and −2 per cent (deflation) or between 4 and 6 per cent is given a "C" grade. The lowest grade, "D," is given if inflation is above 6 per cent or if prices are falling by more than 2 per cent, an indication of more severe deflation.

**GDP and Labour Productivity Growth**

During the 2008–09 recession, most countries recorded negative GDP and labour productivity growth, and so we modified the grading formula for that time period to ensure that no "A" or "B" grades were given to a country with negative growth.

Using the following formula, "A" or "B" grades are awarded to countries with positive growth and "C" or "D" grades to countries with negative growth:

- We calculate the difference between the top performer and zero, and divide this number by 2. A country receives a report card rating of "A" on growth if its score is in the top half of this number and a "B" if its score is in the bottom half.

- We calculate the difference between zero and the bottom performer, and divide this number by 2. A country receives a report card rating of "C" on growth if its score is in the top half of this number and a "D" if its score is in the bottom half.

**How does the Conference Board assign a grade to each overall performance category?**

We first convert the individual indicator data to a common unit by normalizing each data point using the following formula:

$$\text{Normalized value} = \frac{\text{(indicator value – minimum value)}}{\text{(maximum value – minimum value)}} \times 100$$

Using this formula results in a data series where the best-performing country has a score of 100 and the worst-performing country has a score of zero.

A composite index for each country is then calculated by averaging all the normalized indicator values. No attempt is made to give explicit differential weights to indicators according to importance; we are implicitly giving equal weight to each indicator. This is the standard approach used by most organizations in the absence of any compelling reason to apply different weightings.

We assign a grade level to the category performance using the following method:

- We calculate the difference between the category composite index of the top and bottom performer and divided this by 4, into four quartiles.

- A country receives a report card rating of "A" for the category if its score is in the top quartile, "B" if its score is in the second quartile, "C" if its score is in the third quartile, and "D" if its score is in the bottom quartile.

**How does the Conference Board benchmark the provinces' performance?**

For most indicators, the provinces are benchmarked to the 16 peer countries using the same A–B–C–D grading range as used in the international benchmarking. This allows us to gauge provincial performance in an international context and ensures that the grades awarded to the provinces fairly reflect performance.

For example, for the indicator assessing high-school attainment, the worst-performing province—Newfoundland and Labrador—gets a "B" grade because its high-school attainment rate of 82.4 per cent is higher than eight international peer countries. In the worst-performing country, Belgium, only 71.3 per cent of the adult population graduated from high school. If we were to award A–B–C–D grades to the provinces solely based on provincial scores, Newfoundland would get a "D" grade even though it performs relatively well in an international context. Similarly, on the indicator measuring the number of PhD graduates, all provinces perform poorly. Yet if we were to assign grades based solely on provincial scores, the top-performing province, Quebec, would automatically get an "A" grade, even though its performance is weak compared with international peers.

To benchmark the provinces in an international context, we calculate the A–B–C–D grades using the data for the 16 peer countries.

- For each indicator, we calculate the difference between the top and bottom international performers and divide this figure by 4, into four quartiles.

- A province receives a report card rating of "A" on a given indicator if its score is in the top quartile, a "B" if its score is in the second quartile, a "C" if its score is in the third quartile, and a "D" if its score is in the bottom quartile.

- If a province performs better than the top-performing peer country, it receives an "A+" grade.

- If a province performs worse than the worst-performing peer country, it receives a "D–" grade.

If comparable international data are not available for a given indicator, then the provincial data are used to compute the A–B–C–D quartiles. The inflation indicator is graded using a different method as described above.

The category grades are assigned in the same manner as is done for the international benchmarking. Peer country data are included in the calculations. For a given category, each data point for each indicator is normalized and a composite index for each province and country is then calculated by taking the average of all the normalized indicator values. A–B–C–D grades levels are then assigned to each of the provinces' and countries' composite index scores.

In addition to ranking the provinces against Canada's international peers, the provinces have been compared with each other and placed into three categories: "above average," "average," and "below average."

- For each indicator, we first determine the average score and standard deviation of the provincial values. The standard deviation is a measure of how much variability there is in a set of numbers. If the numbers are normally distributed (i.e., the distribution is not heavily weighted to one side or another and/or does not have significant outliers), about 68 per cent will fall within one standard deviation above or below the average.

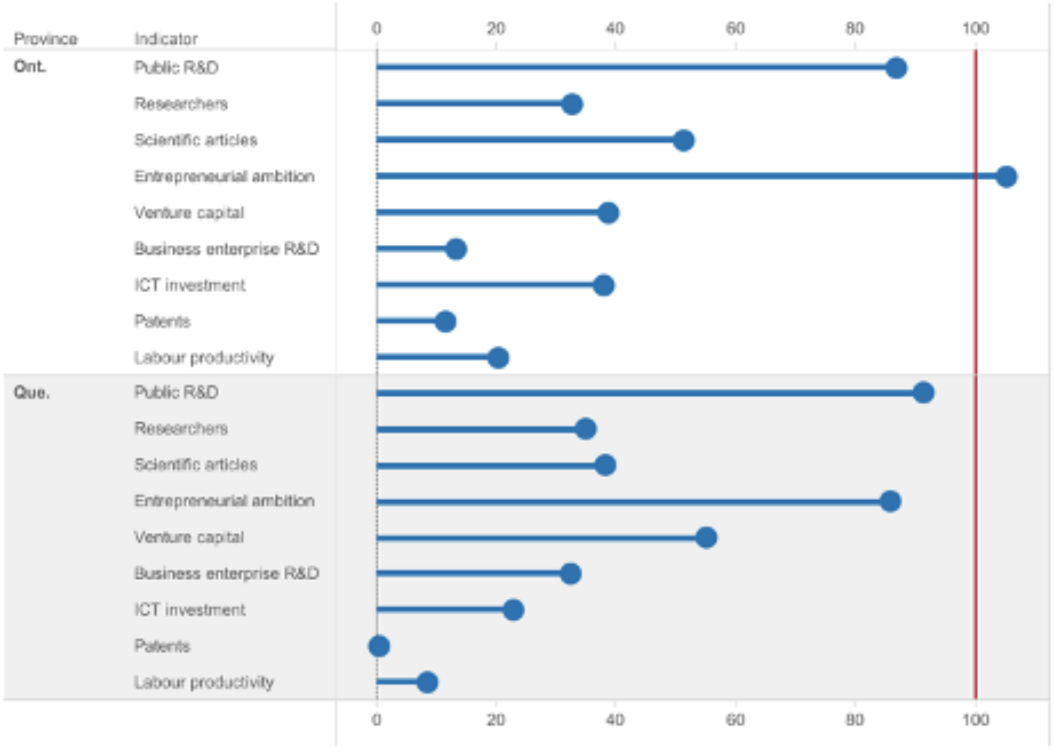
- Any province scoring one standard deviation above the average is "above average." Provinces scoring less than the average minus one standard deviation are "below average." The remaining provinces are "average" performers.

**How does the Conference Board benchmark the territories' performance?**

To date, the territories are included only in the overall Health report card because data are not available for many of the indicators included in the other report card categories. The Conference Board is, however, committed to including the territories in our analysis, and so we produce separate territorial indicator report cards when data are available, as was done for the Economy category. Indicator and category grades are computed for the territories the same way as for the provinces.

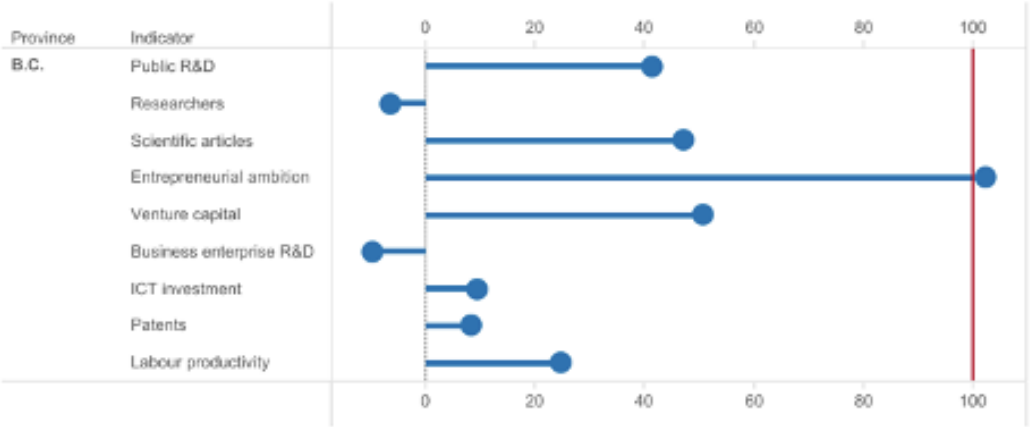
## Appendix 5

Ontario and Quebec Are the Top-Ranked Provinces
(index, top-performing peer country = 100)



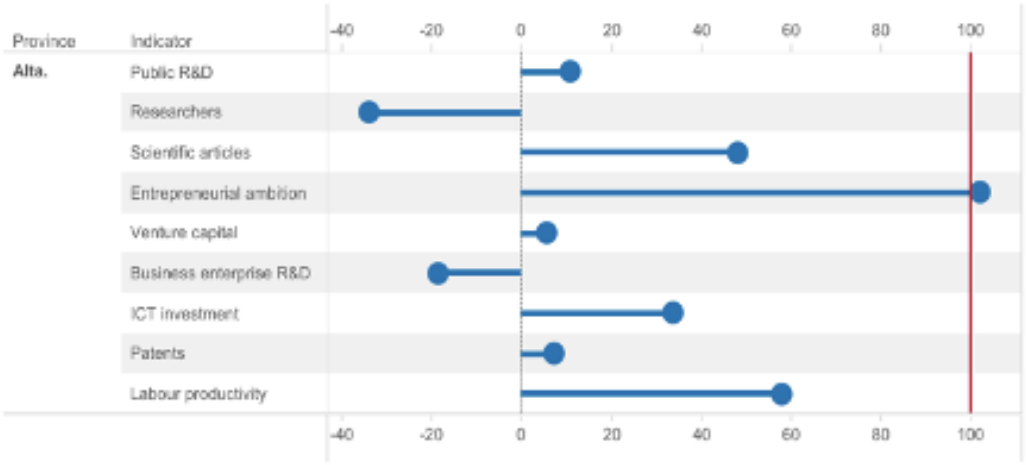

Note: The red line (i.e., an index score of 100) represents the top-performing peer country on each of the indicators. The dashed line (i.e., an index score of 0) represents the worst-performing peer country on each of the indicators.
Source: The Conference Board of Canada.

British Columbia's Performance Falls Significantly
(index, top-performing peer country = 100)



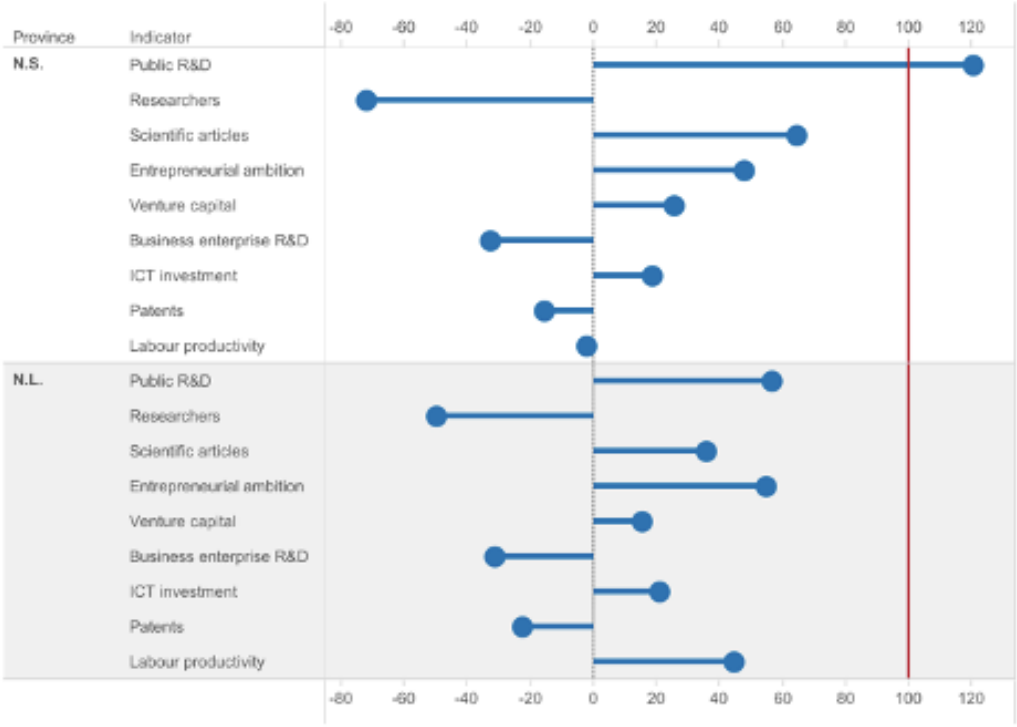

Note: The red line (i.e., an index score of 100) represents the top-performing peer country on each of the indicators. The dashed line (i.e., an index score of 0) represents the worst-performing peer country on each of the indicators.
Source: The Conference Board of Canada.

Alberta Scores High on Scientific Articles, Entrepreneurial Ambition, and Labour Productivity
(index, top-performing peer country = 100)



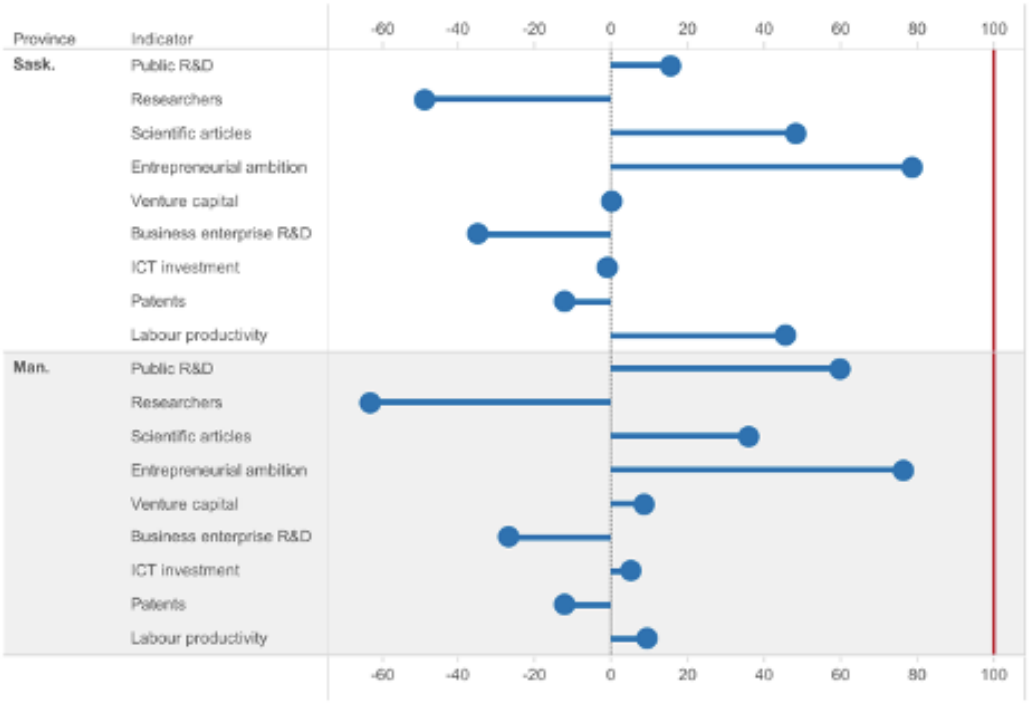

Note: The red line (i.e., an index score of 100) represents the top-performing peer country on each of the indicators. The dashed line (i.e., an index score of 0) represents the worst-performing peer country on each of the indicators.
Source: The Conference Board of Canada.

Nova Scotia and Newfoundland and Labrador Fare Worse Than the Poorest-Performing Peer Country on Researchers, Business R&D Spending, and Patents
(index, top-performing peer country = 100)



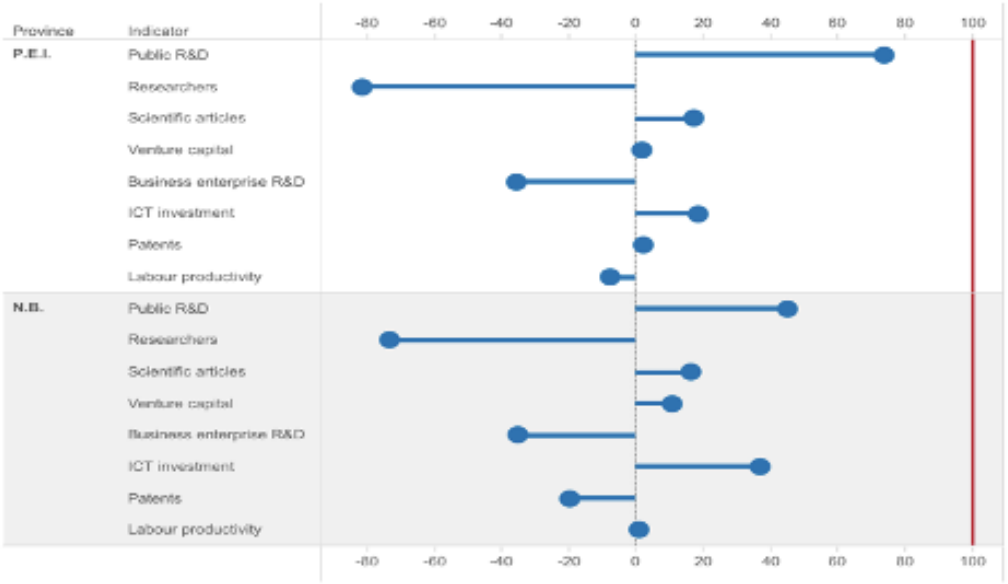

Note: The red line (i.e., an index score of 100) represents the top-performing peer country on each of the indicators. The dashed line (i.e., an index score of 0) represents the worst-performing peer country on each of the indicators.
Source: The Conference Board of Canada.

Saskatchewan and Manitoba Score High on Entreprenurial Ambition but Do Poorly on Most Indicators of Innovation
(index, top-performing peer country = 100)




Note: The red line (i.e., an index score of 100) represents the top-performing peer country on each of the indicators. The dashed line (i.e., an index score of 0) represents the worst-performing peer country on each of the indicators.
Source: The Conference Board of Canada.

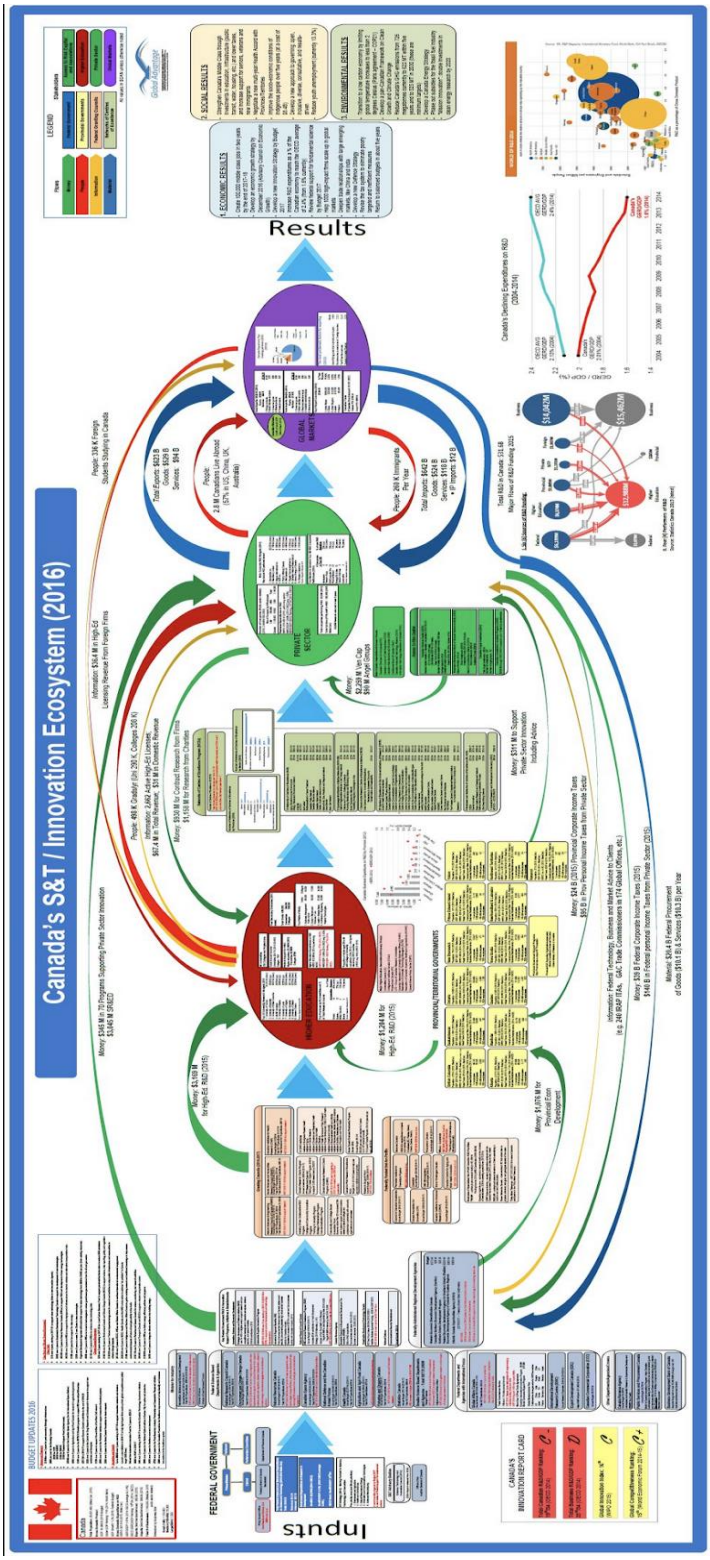
P.E.I. and New Brunswick Are the Worst-Ranked Provinces
(index, top-performing peer country = 100)




Note: The red line (i.e., an index score of 100) represents the top-performing peer country on each of the indicators. The dashed line (i.e., an index score of 0) represents the worst-performing peer country on each of the indicators.
Source: The Conference Board of Canada.

**Appendix 6**

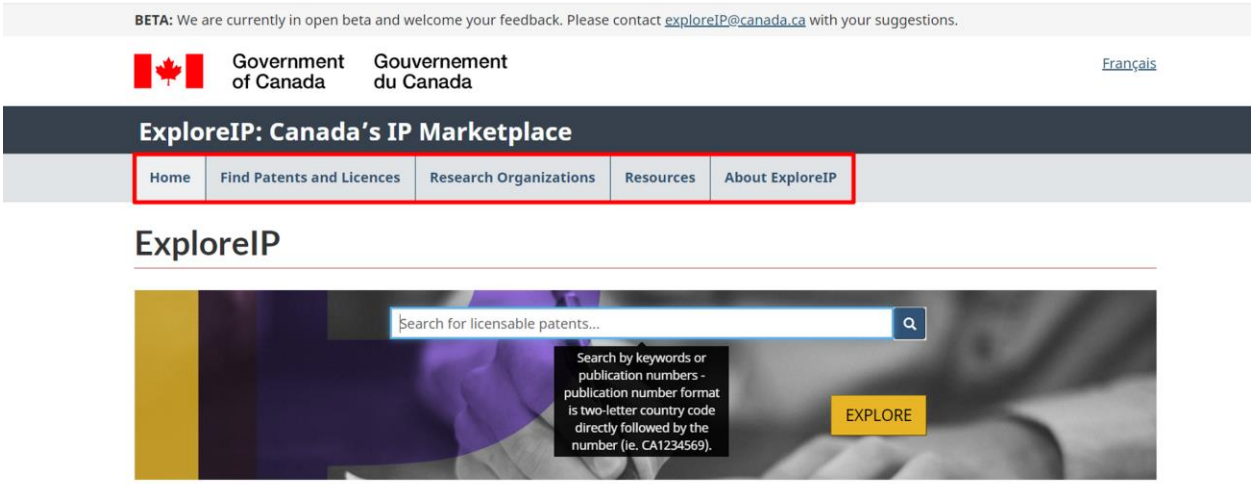
Canada's 2016 Science & Technology Innovation Ecosystem Map.




Source: Church, P. (2016).

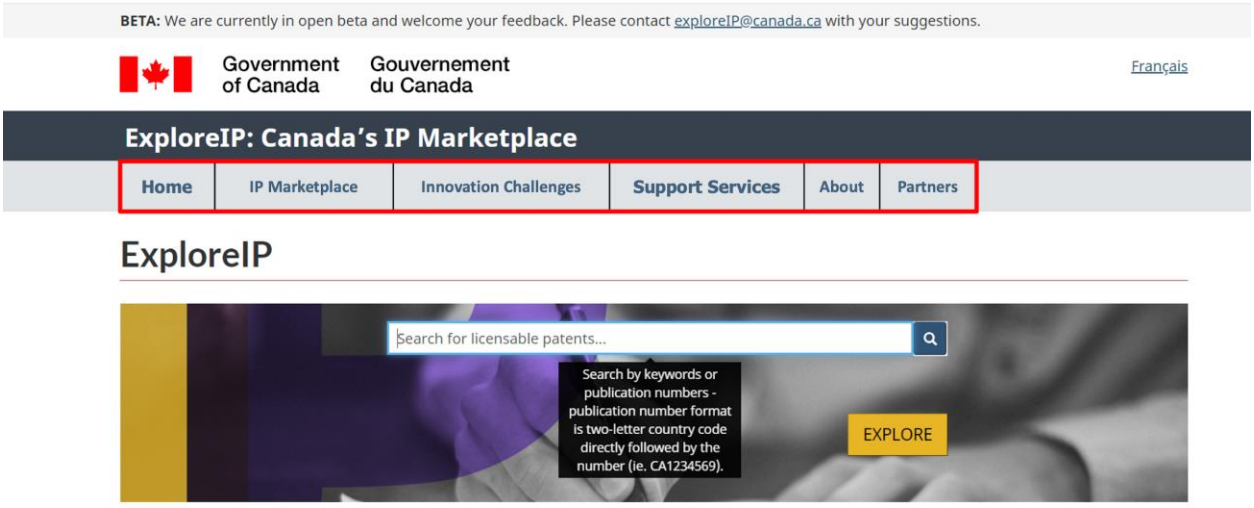
**Appendix 7**

## ExploreIP: Existing View




The figure above shows the existing view of the ExploreIP website home page.

## ExploreIP: Proposed View




The figure above shows the proposed view of the ExploreIP website home page, adapting to the report's recommendations.

**Appendix 8**

Our team has mapped initial networks of innovation from underrepresented groups in Canada, outlined below. These preliminary review serves as an example, it is recommended to expand this research and identify more networks, especially in contact with provinces and territories.

| **Name of network** | **Website** |
|---|---|
| Black Professionals in Tech Network | https://www.bptn.ca |
| Mars Center for Impact investing | https://www.marsdd.com |
| Animikki- Indigenous Technology | https://www.animikii.com/home |
| MaRS Women entrepreneurship initiative | https://www.standupvc.com/philosophy |
| Black Innovation Fellowship (boosting black entrepreneurs) | https://dmz.ryerson.ca/bif/ |
| Society for Canadian Women in Science and Technology | https://scwist.ca |
| Digital Justice Lab | https://digitaljusticelab.ca |

# 9. Glossary

DE-Digital Ecosystems

DSIP- Demand Side Innovation Policy

GCI-Global Competitive Index

GCR-Global Competitiveness Report

GII- Global Innovation Index

IP- Intellectual Property

ISED- Innovation Science and Economic Development

IT- Information Technology

OECD- Organization for Economic Co-operation Development

PE-Physical Ecosystems

R&D- Research and Development

SIBS-Survey of Innovation and Business Strategy

STEM- science, technology, engineering and mathematics

WIPO- World Intellectual Property Organization