ALBERTA INNOVATES

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A COMPENDIUM OF TOOLS, INSTRUMENTS AND POLICIES TO SUPPORT AND STIMULATE INNOVATION

Prepared for Alberta Innovates' Impact Action Lab

Jonathan Grant and Amanda Ribeiro
July 2022

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Different Angles

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About the Impact Action Lab (IAL)

The Alberta Innovates Impact Action Lab partners with ecosystem players to amplify and activate the collective economic and societal impact of research and innovation investments. The IAL is made up of global and local impact experts that help generate actionable insights to not only make an impact but to maximize the impact. The IAL is creative in designing, implementing, assessing, managing and improving "fit for purpose" approaches to both action real change and scale for impact. We work with organizations to enhance their capacity by incorporating performance and impact management systems to generate value and benefits to their communities.

About this Report

This report was conducted to understand the current and emerging tools used by policy makers and funders to help foster stronger and vibrant research and innovation ecosystems. Alberta Innovates as the province's innovation engine has both direct and indirect impact on the research, innovation and entrepreneurial ecosystem in Alberta. The tools and instruments outlined in this report have different goals and features and can be used as levers for change. Understanding jurisdictional gaps and assets across the research and innovation continuum and designing portfolios of programs that include, objectives, the economic and societal impacts, beneficiaries and design the journey from the user perspective is a useful heuristic for stimulating innovation. This compendium is a starting point in providing a lay of the land and will be used to inform portfolio and program decisions for making a difference to those in our research and innovation ecosystem.

A COMPENDIUM OF TOOLS, INSTRUMENTS AND POLICIES TO SUPPORT

Table of Contents

Introduction

The purpose of this report is to provide a set of tools, instruments and policies that Alberta Innovates (AI) and partners can use to support and stimulate innovation within the province. The motivation for this is an acknowledgement that there *may* be improvement opportunities and that the development and application of a strategic framework may contribute to both the efficiency and effectiveness of the portfolio of programs (as highlighted by a recent Auditor General report[1]. The intent of this document is to update the "toolbox" of policy and funding instruments used globally to effect desired change and outcomes. At the same time there are considerations about how a suite or mix of tools and instruments could be combined in new ways, as well as considering tools to be removed or adding novel tools and instruments that have yet to be used in existing or new portfolio of investments and/or programs.

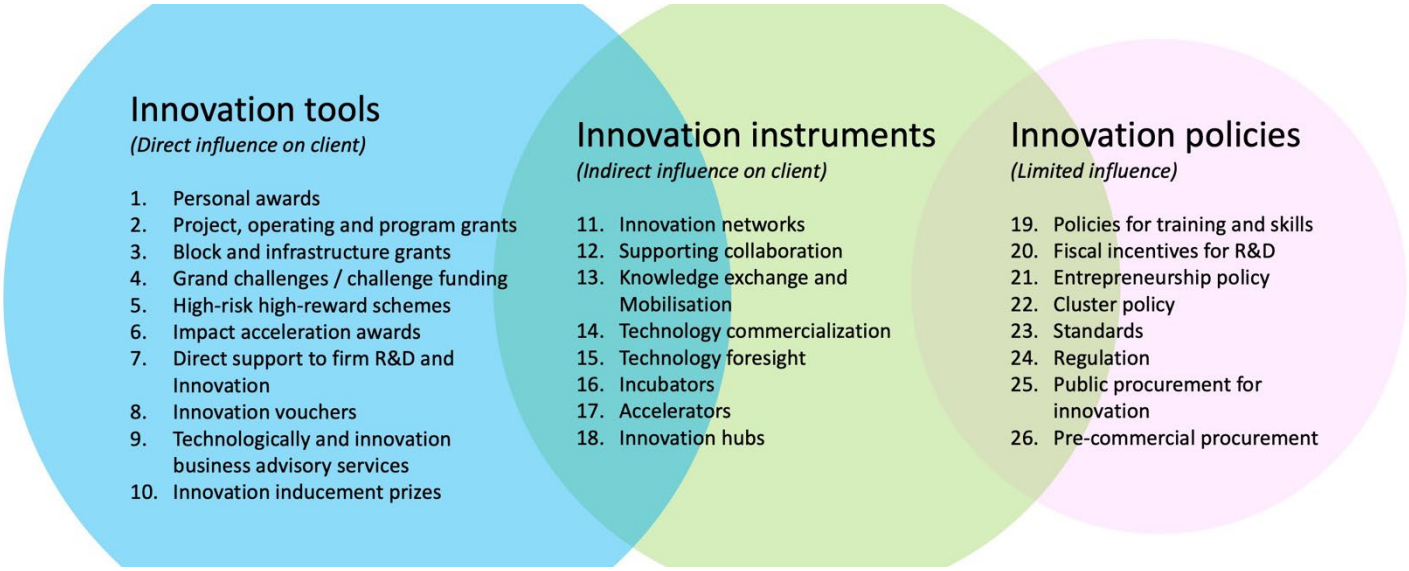
As a funder AI has direct and indirect impact on the research, innovation and the entrepreneurial ecosystem in Alberta.

In reviewing the literature and existing practice, 26 tools, instruments and policies were identified, as documented in Appendices A to C.[2] This compendium of innovation levers were sourced from a number of key studies[3] and websites[4], and supplemented with a review of AI portfolio of programs, interviews with a handful of AI staff and the authors knowledge. In conceptualising a long list of potential interventions, it is important to distinguish between tools, instruments and policies as summarised in Figure A.

In Figure A, ten 'innovation tools' are defined as being where AI (and other funders of innovation) have a direct influence on the entrepreneurial ecosystem through, for example, grants for research, innovation vouchers or providing advice on commercialisation. Appendix A details the tools identified in this group. In contrast, 'innovation instruments' typically involve orchestrating other intermediaries or providers in delivering programs to achieve an outcome, and here we identified eight examples. As such AI has an indirect influence on the entrepreneurial ecosystem. Examples include regional innovation networks and incubators and accelerators as listed in Appendix B.

[1] Auditor General of Alberta. 2021. *Alberta Innovates: Processes to report on value generation*. Report of the Auditor General.
[2] For each tool, instrument or policy a 1-2 page summary is provides a description, its primary and secondary objectives, some of the core policy characteristics, an assessment of the evidence as to whether it works, a brief commentary from the authors and further reading.
[3] Eg: *Nesta (2018)*; *Cirera et al (2020)*; and *Edler et al (2016)*.
[4] *https://www.innovationpolicyplatform.org/www.innovationpolicyplatform.org/frontpage/index.html*.

Figure A: Summary of reviewed innovation tools, instruments and policies



The final group of eight 'innovation policies' are where AI has no or limited influence but has a growing interest in enabling a supportive innovation ecosystem. This is because such policies are set at a provincial or federal level with examples including regulation and standards and policies for training and skills (along with others listed in Figure A and Appendix C). Whilst it is important for AI to input into such policy debates, a more holistic approach may in fact work counter to pure innovation objectives. For example, in the field of health there is an innovation advantage in making open patient data but clearly this can conflict with concerns about privacy, data security and protecting Intellectual Property. As such AI has limited influence over such policies but does have an interest in their outcomes.

Important to acknowledge that different tools and instruments have different goals and features.

Whilst the framing of the tools and instruments against AI's strategic research and innovation continuum is helpful in portfolio/program design, it also operates at a high level. We also acknowledge that instruments can be agnostic to the life cycle, e.g. centers of excellence can be deployed at the Discovery stage but also at the Develop stage with a focus on technology and innovation and at the Use stage focusing on commercialization with an industry demand. So, in Table A, the innovation tools and instruments have been mapped against a series of strategic objectives providing a more specific focus.

Table A: Innovation tools, instruments and policies by strategic goal

	Advancing knowledge	Increasing R&D spend	Talent & Skills	Access to expertise	Improve ecosystem capability /capacity	Enhance demand for innovation	Developing trusted relationships	Investing in impact (and impact acceleration).
Innovation tools								
1. Personal awards	✓✓✓		✓✓✓					
2. Project, operating grants and program grants	✓✓✓		✓					
3. Block and infrastructure grants	✓✓				✓			
4. Grand Challenges / Challenge funds	✓✓		✓	✓		✓		✓
5. High Risk – High Reward schemes (	✓✓✓		✓			✓		✓
6. Impact acceleration awards			✓					✓✓✓
7. Direct support to firm R&D and innovation		✓✓✓				✓		
8. Innovation vouchers		✓✓				✓✓✓		
9. Technology and innovation business advisory services				✓✓✓			✓✓	
10. Innovation inducement prizes						✓✓✓		
Innovation instruments								
11. Innovations networks			✓	✓	✓✓✓		✓✓	
12. Supporting collaborative	✓✓	✓✓	✓✓	✓✓✓	✓✓✓	✓✓		
13. Knowledge translation and mobilisation	✓		✓	✓✓			✓✓	
14. Technology commercialization			✓	✓	✓✓	✓	✓	
15. Technology Foresight	✓		✓	✓	✓		✓✓✓	
16. Incubators	✓		✓	✓✓	✓✓		✓	
17. Accelerator			✓	✓✓	✓✓		✓	✓✓
18. Innovation hubs	✓		✓	✓✓	✓✓		✓✓	✓✓
Innovation policies								
19. Policies for training and skills			✓✓✓					
20. Fiscal incentives for R&D		✓✓✓	✓			✓		

21. Entrepreneurship policy				✓✓✓			✓✓✓	
22. Cluster policy			✓	✓	✓✓✓		✓	
23. Standards					✓✓✓	✓		
24. Regulation					✓✓✓	✓		
25. Public procurement for innovation		✓				✓✓✓		
26. Pre-commercial procurement		✓				✓✓✓		

Source: After Edler et al (2016), p.11, Table 1.1.

By combining the AI's innovation pipeline with the specific goals of different tools and instruments, it is possible to aid program design and reform

As illustrated in the Box A, in designing a program there are a number of considerations that need to be answered and in doing so they can then help inform the appropriate innovation tool or instrument (or mix thereof). For example, if you want to stimulate companies in partnering with others to develop innovation you may decide that innovation vouchers are an appropriate tool. Alternatively, if you wish to facilitate collaboration to bring different sectors and agencies together you may decide that an innovation network is a suitable instrument, but in doing so realise that you will need to partner with other actors such as universities and companies.

Box A: Key questions to address in program design

Business and Program Representatives Considerations

- What gap or need are you trying to address?
- What are your areas of strength?
- What are your strategic objective(s)?
- What outcome(s) & impacts are you targeting?
- Who is the primary beneficiary (end user?)
- What are the key targets, metrics and timelines?

Instrument Options Considerations

- What funding instrument/mechanism best fit to meeting gaps and strategic objectives?
- Will one or more instruments across discover, develop and use help me achieve the desired outcomes?

However, in taking such an approach a number of important nuances and caveats still reaming. In reviewing the compendium of innovation tools, instruments and policies a number of important caveats need to be taken into account. First it is not exhaustive but focuses on those interventions and levers used by AI currently and potentially in the future with the focus on developing a common framework and a decision matrix that could potentially help with the rationalisation of the programs, help identify portfolio/gaps across the innovation pipeline and inform decisions about the mix of tools and instruments used together to move the dial on business strategy. As such it offers an overview to the large variety of approaches that aim at incentivizing the complex and interesting phenomena that

is innovation. A second caveat is that the list of tools, instruments and policies mix long-standing innovation policy experiences with new approaches, hence there is an inevitable variation in the depth and breadth of some of the individual descriptions, not least as the evidence of whether they work is still not available. Moreover, in a field as complex as innovation, no one policy is the single cause of particular effects. Hence, while analysing the impact of each instrument, it is important to consider that they were effective in their own local, regional and national context. The third caveat is that some of the definitions are opaque or 'fuzzy', reflecting the fact that the academic innovation literature is lagging the innovation practice and trying to capture the clear definitions is sometimes an ardours task. Therefore, we have tried to signpost that throughout the work whenever possible and to inform the reader that similar structures/programs/agencies can appear with different names around the world. Finally, it is worth noting that many of the tools, instruments and policies can be described using a range of different terms reflecting the difference in local practice. Where possible this has been acknowledged in the descriptions.

In undertaking this review, it is important to be mindful that the tools and instruments are a means to an end. In the same way that policymakers have policy levers to affect change, AI has a set of tools and instruments that can be used to realize impact, creating economic activity through innovation. Quite often these tools will focus on different sectors, with different cultures, language and approaches to doing business, hence it is likely that different people will use different language to describe similar tools and instruments with similar objectives and goals. In other words, one of the challenges that a project like this faces is an inherent tension between the need for standardisation (at the 'centre') and flexible localisation (in the 'field'). That said, the aim of the compendium is to provide the reader a guide and decision matrix for exploring the different innovation tools, instruments and policies used today around the world. It aims to socialize knowledge across the different sectors of Alberta Innovates, trigger curiosity and provoke reflection on the innovation policy landscape worldwide. It is also dynamic in that portfolios/programs are being developed and sun-setted as part of the program review (evaluation) process. It does not presume to explore all the idiosyncrasies and complexities of each one of its tools, instruments and policies.

Appendix A: Compendium of innovation tools

1. Personal awards
2. Project, operating and program grants
3. Block and infrastructure grants
4. Grand challenges / challenge funding
5. High-risk high-reward schemes
6. Impact acceleration awards
7. Direct support to firm R&D and Innovation
8. Innovation vouchers
9. Technologically and innovation business advisory services
10. Innovation inducement prizes

1. Personal awards (Fellowships, PhD Training, Postdoctoral Research Grant)

Description: Personal awards refer to funding for researchers or entrepreneurs to pursue independent research and innovation projects at different career stages. Offering, for example, PhD training[5], postdoctoral research support[6], mid-career fellowships[7], short-term opportunities[8] and research chairs[9]. They provide researchers independence from university assigned research funding options and allow time for individuals to pursue their own research interests without teaching responsibilities. They can be directed at any area of knowledge and pursue different objectives. For example, expanding the frontier of knowledge in a particular field of study[10], promoting the interests of a particular social group[11] or company[12], stimulating social impact[13], promoting specific values[14], SDGs[15], or bilateral/international cooperation[16]. Although the examples listed in the footnotes are not mutually exclusive and collectively exhaustive, they help to illustrate the functioning, range and flexibility of personal awards.

Primary goal: Provide researcher training, skill development and career support.

Secondary goals: Support new discoveries; Encourage knowledge spillover from research institutions to the market; Promote public engagement of science.

Policy characteristics: Personal awards are a very flexible policy instrument that can be shaped according to the funders goals, but they are often competitive, merit-based, short- to mid-termed funding opportunities. They can be offered by national- or sub-national level funding agencies, universities, research centres, companies or by partnerships among multiple stakeholders. They are fundamentally a 'supply side' policy instrument that develops a talent pool for current and future research and innovation.

Do they work?: In a straightforward approach, yes. Personal awards are among the few innovation instruments that can be said to have relative consensus on their effectiveness, as a skilled workforce is key to innovation.

[5] PAs are most commonly directed to PhD holders, however, some of them can also support PhD candidates in their doctoral studies. E.g.: *NIHR Doctoral Fellowship*; *Marie Sklodowska-Curie Actions*;
[6] E.g.: *Canada Graduate Scholarships*, *UKRI Future Leaders Fellowships*, *Wellcome Early-Career Awards*;
[7] E.g.: *ISRF Mid-Career Fellowship Competition*;
[8] E.g.: *JSPS Postdoctoral Fellowships for Research in Japan*;
[9] E.g.: *Chair for Entrepreneurship at the University of St. Gallen*; *COPPEAD-UFRJ Research Chairs*;
[10] E.g.: *Science Policy Fellowship Program*, *Plaskett Fellowship for Research in Astronomy and Astrophysics*;
[11] E.g.: *Fondation L'Óreal For Women in Science – International Rising Talents*;
[12] E.g.: *DeepMind Scholarship program*, *Facebook Fellowship Award*, *Boehringer Ingelheim Fonds*;
[13] E.g.: *FUSE Executive Fellowship Program*;
[14] E.g.: *Michael Maggio Immigrants' Rights Summer Fellowship Program*;
[15] E.g.: *Green Talents*;
[16] E.g.: *International Affairs Fellowship in Japan*.

Comment: Sometimes the personal awards may be part of another instrument – for example a project or program grant – and when this occurs it is typically for the more junior awards e.g., PhD training and post doc support. Given the 'supply side' focus of personal awards it is interesting how little focus there is in providing fellowships in different contexts. For example, placing academic researchers in industry and industrialist within academia. Examples of this include the Danish Industrial Researcher program funded by Innovation Fund Denmark, the Research Council of Norway Industrial PhD scheme and the UK's Royal Society Industry Fellowship schemes. There are also opportunities for providing some training to those who receive personal awards – be that around specific skills (such as product development) or more generic leadership and entrepreneurship skills (for example, the Swiss Academia-Industry Training).

Another important distinction is that personal awards are non-repayable grants, differing from Higher Education Loans, which also incentivize the qualification of highly education personnel, but assume repayments from the holder.

Further reading:

- What impact has the NIHR Academic Clinical Fellowship (ACF) scheme had on clinical academic careers in England over the last 10 years? A retrospective study
- Gaining a wider understanding of impact of grants – Researchfish study for Parkinson's UK
- A Cross-Funder Review of Early-Career Clinical Academics: Enablers and Barriers to Progression

Canadian Equivalent/Example:

- Health System Impact Fellowship

2. Project, operating and program grants

Description: Project (short-term) or program (long-term) grants are one of the most established instruments in research and innovation funding[17]. They are awarded to institutions and individuals and they are a straightforward mechanism to allocate public funds to scientific research specific initiatives. There are many different types of grant schemes, varying by policy objective, mechanism, size, matching requirements, duration, eligibility criteria, payment procedures, repayment requirements and deliver mechanisms[18].

Primary goal: Allocate funding for research/innovation actors to finance all or part of a research/ innovation project.

Secondary goals: Support new discoveries; Encourage knowledge spillover from research institutions to the market; Promote public engagement of science.

Policy characteristics: Project or program grants are typically offered in a competition scheme, as the supply of funding tends to be smaller than the demand for funding.

Do they work?: It depends on the grant and how it is managed. It can often be challenging to capture the impact of project grants, especially when they are geared towards basic research. Platforms like Researchfish and other research evaluation methodologies[19] are helping funders and researchers to get a better grip on what are the impacts of their research projects overtime and build the narrative around them. However, these approaches are typically focused on supply side research impacts and often do not cover demand side activities driving innovation impacts.

Comment: It is important to stress that project grants alone will not necessarily steer innovation, but they are essential as an enabler factor of spaces for innovation to sparkle. Although project grants are a very common instrument, there is relatively limited literature around their efficacy to deliver the mission of supporting innovation and impact.

Further reading:

- A DECISIVE approach to research funding

Canadian Equivalent/Example:

- Open Operating Grant Program (OOGP) which took place at the CIHR

[17] This session understands project grants as instruments used to support universities and public research institutions. Instruments geared at firms are described in other parts of this toolkit, especially in session 12.
[18] Adapted from the *World Bank's Practitioner Guide to Innovation Policy*.
[19] For example: *DARE to be different? A novel approach for analysing diversity in collaborative research projects* (Sussex), *Bibliometrics for Research Management and Research Evaluation* (CWTS), *Altmetric*, or services provided by *Elsevier* or *Clarivate*.

3. Block and infrastructure grants

Description: Block grants are funds given to research universities and public research institutions (PRIs) to finance recurrent research expenditure. These funds are managed by the universities and research institutions themselves, usually providing institutions stable and autonomous funding. They will commonly be directed to cover salaries of research and support staff, operating and maintenance of universities and PRIs hard infrastructure, such as laboratories and libraries.

Primary goal: Provide stable funding for universities and PRIs to maintain their core activities.

Secondary goals: Provide autonomy for universities and PRIs to be able to make strategic decisions about their own investment priorities, whether in areas of research strengths or in tangible resources needed to make them more efficient or competitive in their areas of interest.

Policy/Instruments characteristics: A block grant can provide funding stability and improve operational efficiency by giving PRIs funding upfront, they can focus on recruiting the best talent and integrate the award with institutions own strategy and priority setting processes. Block grants can be used for trainee awards. The funds are given to PRIs or other training providers to finance studentships and fellowships. The institution can hold competitions, evaluate applications, and administer the funding as stipends for trainees in accordance with guidelines provided by the funder.

Do they work?: There is a general understanding that block grants work and are key to any innovation system. However, they tend to be a 'black box', difficult to evaluate, because each university manages and evaluates its own funds in its own way and because national performance-based university research funding systems[20] tend to evaluate the outputs of institutions as a whole, without differentiating the origin of the funds that financed each research project. Still, novel approaches intent to capture the effects of these instruments, such as in Exploring the value of QR in supporting researcher-scale activities, which provides insights from the management of these funds in the University of Cambridge, UK. Block grants for specific purposes – for example in supporting named infrastructures – can help to ensure a measurable outcome can be assigned to the investment.

Comment: Block grants are a key instrument for sustaining a healthy innovation system, as well-functioning universities and PRIs are essential for knowledge leaps that nurture a competitive innovation system. Still, the amounts allocated to this type of grant must be carefully measured, so that they do not reduce incentives for researchers to competitively

[20] 'Performance-based university research funding systems (PRFSs)', also called by other authors 'Performance-based research evaluation arrangements (PREAs)', are national research evaluation systems to evaluate the outputs of universities and PRIs. They had been typically focused on bibliometric results and are more recently moving towards a more impact-oriented evaluation approach.

seek resources for funding for specific projects and programs based on individual research interests. Block grants can be designed to seek other national funding.

Further reading:

- Block funding – A quick guide from The Innovation Policy Platform
- Changing research on research evaluation: A critical literature review to revisit the agenda

Canadian Equivalent/Example:

- See comment on project/operating grants

4. Grand challenges / challenge funding

Description: Grand challenges are instruments that offer funding to 'solve a problem'. They can be oriented to different areas of research and are very flexible in terms of the duration, shape and scope, but they share the clear mission-oriented approach[21].

Primary goal: Their main goal is to find a solution to a specific challenge.

Secondary goals: Accelerate innovation, boost specific areas of knowledge, bring awareness to a certain research topic, stimulate funding crowd-in effects for a specific problem and support scale up and growth to address challenge.

Policy characteristics: Grand challenges tend to be quite specific in what they need to accomplish in a given timeframe. They tend to be flexible and invite reflection on innovative in ways that a question can be answered and aim at triggering innovators to push the limits of what the obvious solutions are.

Do they work?: More than in any year, the world has seen that intense focus on one research topic can achieve extraordinary research outcomes, such as the development of the Oxford/AstraZeneca covid-19 vaccine[22].

Comment: Grand challenges share the characteristics of being a challenge-driven innovation policy with high-risk high-reward schemes. However, they can be issued by any funding agency interested in solving a given problem and does not necessarily require the DARPA-model structure (see 5. High Risk High Reward Schemes) that is typical of such schemes. An alternative short-version of a grand challenge are hackathons[23], usually a sprint-like – 24 to 48 hours – event where IT professionals 'hack' a given problem. One advantage of grand challenges is that they can be agnostic to the sector – that is they can include industry as well as universities.

Further Reading:

- Bill & Melinda Gates foundation – How do we measure the impact of grand challenges
- Who funded the research behind the Oxford-AstraZeneca COVID-19 vaccine?

Canadian Equivalent/Example:

- Grand Challenges Canada

[21] E.g.: *USA EPA Pathfinder Innovation Project*, *National Research Council Canada Challenge Program*, *UKRI Funding for COVID-19 Research*;.
[22] *Oxford/AstraZeneca Covid vaccine research 'was 97% publicly funded*;
[23] *Demystifying the hackathon – McKinsey Digital*

5. High-risk high-reward schemes

Description: Specific funding agency or program focused on transformative science with lean decision-making structures and high tolerance to risk. Often modelled off the US Defence Advanced Research Projects Agency (DARPA), which has a near-mythical reputation for funding breaking through science, including a $25m investment in Moderna in 2013 to explore the use of mRNA in vaccine development[24]. The lessons typically taken from DARPA's success is that it is strategic, scientific autonomy coupled with autonomy of decision making for its program managers (who are typically high calibre researchers in their own right) with a focus on taking risks. This unique approach is being replicated in the UK with the establishment of the Advanced Research and Invention Agency (ARIA), Germany with the Federal Agency for Disruptive Innovation (SPRIN-D) and Japan with the Moonshot Research and Development Program. Also, a number of research funders are building upon the DARPA model through specific high-risk programs such as the Wellcome Trust's Leap program.

Primary goal: Support high-risk high-reward research and innovation.

Secondary goals: Tackle societies' 'grand challenges', such as super-ageing populations and global warming. Offer a lean funding structure for ambitious projects that would either get suffocated by traditional public funding structures or would not offer enough guarantees to attract private investment.

Policy characteristics: One of the defining characteristics of high-risk, high-reward schemes is their implicit rejection of standard peer review grant funding models. It assumes regular science and research funding approaches are too conservative, take too much time to make decisions, and the transaction costs of decision-making are too high (bureaucratic).

Do they work?: There is a list of successes from DARPA *prima facia* evidence that transformative scientific and technological breakthroughs can occur through this approach to research and innovation funding. However, it is also clear many have tried to replicate the DARPA-model but failed in providing such clone agencies with the necessary freedoms from political interference and from standard public-sector procurement rules they need to thrive.

Comment: Alternative language around high-risk high-reward schemes involve terms such as challenge-driven or mission-oriented innovation policy[25]. Although high-risk high-reward agencies share the characteristics of high tolerance to risk, a highly experimental approach and a mission orientation, their organisational structure can vary to a large extent according to their national context and priorities, as well as specific area of work (military, energy, health, etc.).

[24] *A growing number of governments hope to clone America's DARPA*
[25] *Challenge-driven Innovation Policy: Towards a new policy toolkit*

Further reading:

- ARIA and the value of challenge-led innovation
- DARPA and its ARPA-E and IARPA clones: a unique innovation organization model ($ - behind paywall)
- Policy paper: Advanced Research and Invention Agency (ARIA): policy statement
- 10 amazing DARPA inventions: how they were made and what happened to them
- New frontiers in research fund Canada
- https://www.sshrc-crsh.gc.ca/funding-financement/nfrf-fnfr/index-eng.aspx

Canadian Equivalent/Example:

- New Frontiers in Research Fund 2022 Transformation Competition
- AOSTRA – Alberta Oil Sands Technology and Research Authority

6. Impact acceleration awards

Description: Impact acceleration awards (IAAs) are strategic grants made to institutions to support knowledge exchange and impact arising from more traditional grant funding (such as personal awards, project and program grants). The idea is to provide institutions (typically universities) with 'soft' funding that can be applied in flexible and creative ways to respond in a timely manner to opportunities as and when they arise. Responsibility for the management of IAAs is typically devolved to the institution with limited oversight from the funder. In practice the awards made at an institutional level are quite varied, ranging from visiting fellowships (for non-academics to spend time in a research setting), to 'researcher in residence' schemes (where academic researchers will be placed, for example, in a government department), to support for workshops, and the development of communication material. Some IAAs also include training elements to improve 'impact literacy' of academic researchers (see Box B).

Box B: Strategic aims of UKRI IAA

- Strengthen engagement with users in order to accelerate the translation of research outputs into impacts
- support, develop and foster strategic partnerships for knowledge exchange and impact, including across disciplines and sectors
- build and maintain an environment and culture that enables effective and ambitious knowledge exchange and impact, including development of skills, capacity and capability within research organisations
- provide early-stage support for progressing research outputs towards the next stages in the impact pipeline, for example proof of concept projects, commercialisation, market validation and activities targeting policy, business and the third sectors
- drive continuous improvement in impact by supporting innovation, enabling 'fast failure', and capturing learning through appropriate mechanisms
- enable flexible and adaptive approaches to knowledge exchange and impact, including the ability to respond quickly to emerging opportunities.

Primary goal: To increase the likelihood of and secure research impact from funded research.

Secondary goal: To improve knowledge and skills of researchers in securing research impact.

Policy characteristics: The focus of IAAs is on enabling a flexible and creative approach to be adopted by institution in securing research impact. The devolved and autonomous nature of IAAs makes them less accountable than other forms of 'supply side' research funding, but given the relatively low levels of resources involved, and the potential upside in securing research impact, this is seen as a manageable risk.

Do they work?: A number of UK research councils began introducing IAAs in 2014. Recently, with the advent of UK Research and Innovation (UKRI), these have been

consolidated into a single IAA with a remit that covers all research disciplines[26]. As yet, no formal evaluations have been conducted of the scheme, but the perception is that they provide a useful resource for maximising research impact. The local autonomy, small amounts of funding and rapid deployment are all seen as positive characteristics of the schemes, although to date there is no formal evidence that they actually increase research impact, or the time it takes to achieve that impact.

Comment: The key characteristics of IAAs is to ensure that they are very light touch in terms of decision making and accountability. With such schemes there is often a tendency for them to become more 'rigid' over time and thus it needs active management to avoid this risk or a conscious strategy of re-invigorating every few years.

Canadian Equivalent/Example:

- Impact Assessment Agency of Canada

[26] *https://www.ukri.org/opportunity/improve-and-accelerate-the-impact-of-your-organisations-research/*

7. Direct support to firm R&D and Innovation

Description: Direct financial support for companies to perform their research, development (R&D) and innovation activities. It is one of the most widely spread policy instruments, mainly due to its direct association with the linear innovation model[27].

Primary goal: Provide funds for firms to develop their R&D activities.

Secondary goal: Reduce the risk of R&D and innovation investments for companies.

Policy characteristics: Most common types of direct measures:

Funding approaches	Description
Grants	Cover all or a share of budgeted or actual costs of corporate R&D costs. They can be allocated via competitive bids or on a first-come-first-served basis.
Soft loans	Can be granted by a government agency, commercial banks, or other intermediaries. They can be conditionally reimbursable (only if the project succeeds and generates profits for the company) or non-reimbursable regardless of the outcomes.
Government loan guarantees	Usually guarantees loans from commercial banks, but in which the government comes in to reduce the needs for collaterals from the company side. (It is worth noting that Innovation Act of 2016 prevents Alberta Innovates from providing loans and/or Loan Guarantees).
Government support to private investors	Government support private intermediaries like seed capital, business angel networks, and early-stage venture capital funds.

Source: Cunningham et al (2016) in Edler et al (2016), page 60.

Do they work?: Yes. Direct support measures have been thoroughly studied in the research and innovation policy literature, and there is plenty of evidence that they positively contribute to innovative corporate performance. Yet, funders should keep in mind that a rigorous selection process and offering support and advice to beneficiaries are essential measures to ensure the success of these investments. It Is also important to highlight that there is discussion within the policy and academic literature about which type of recipient

[27] i.e., more science leads to more innovation that leads to more competitive advantages and more economic growth. More theory on the linear innovation model can be found in footnote number 5, under Innovation Network Policies.

(for instance, large or smaller companies) would get more additionality gains from direct investments, but no conclusive results yet.

Comment: When compared to indirect instruments, direct support tends to be a more straightforward tool, especially for specific target areas of interest that could benefit from governmental intervention. For example, in cases where the ROI is too uncertain or the barriers for change are way too high, as in complex socio-technical systems[28] (such as in energy and transports systems, for example).

Further reading:

- The Impact of Direct Support to R&D and Innovation in Firms

Canadian Equivalent/Example:

- R&D Associates
- Alberta Enterprise Corporation
- National Research Council of Canada Industrial Research Assistance Program (NRC IRAP)
- AVAC
- Alberta Enterprise Corporation

[28] "*The governance of sustainable socio-technical transitions*" provide useful rationale and justification for policy intervention on complex socio-technical systems.

8. Innovation vouchers

Description: According to the Innovation Policy Platform, Innovation Vouchers are usually small lines of credit, offered by governments to SMEs to purchase services from universities and public research institutions. They work as a cash injection for small businesses to invest in innovation and increase their efficiency. They are often used as the tool that allows SMEs to access technology and innovation advisory services[29].

Primary goal: Reduce the barriers that prevent SMEs to innovate, promote economic growth by increasing SMEs efficiency.

Secondary goal: Fill knowledge gaps in SMEs, promote collaboration between SMEs and public research institutions, promote knowledge exchange between industry and academia.

Policy characteristics: Innovation Vouchers can be structured as a partial fund (every dollar granted by the funder requires another dollar from the company) or fully funded non repayable funds. The funders of innovation vouchers can opt for how much control they wish to have over the building of these partnerships. Establishing, for example, how selective they wish to be about the SMEs entitled to receiving them or which institutions can provide the technology and advisory services. They can also be geared at promoting specific goals, such as committing to greener technologies.[30] Alberta Innovates, for example, requires a 25% contribution from the SME to a maximum of $100k with the funding going via a service provider.

Do they work?: Yes. Despite being a relatively simple instrument with straightforward impact on small and medium-sized enterprises, innovation vouchers have proven to be effective in increasing the productivity of these businesses.

Comment: From a funders perspective, they can be a relatively simple design and low-cost instrument that offers good results for companies by incrementally supporting their innovative activity. They also offer great flexibility in terms of policy design, being suitable for programs of larger or smaller scale, open or specific scope.

Further reading:

- The long-term impact of Dutch innovation vouchers: Back to the future with randomised controlled trials
- Brandenburg Innovation Voucher (BIG)
- Evaluation of the Innovation Vouchers Program – Invest Northern Ireland

[29] As explained in instrument number 16, "Technology and innovation advisory services".
[30] *The impact of innovation vouchers on green innovation efficiency.*

Canadian Equivalent/Example:

- Nova Scotia Business – Productivity and Innovation Voucher Program
- Ontario Voucher for Innovation and Productivity (VIP)
- Alberta Innovates Voucher Program

9. Technologically and innovation business advisory services

Description: Technological and innovation advisory services are offered to small and medium-sized enterprises (SMEs) to improve their industrial or services performed. They can be provided via the intermediation of a governmental innovation agency, specific government shaped programs, technology extension services[31], innovation vouchers[32] or other mechanisms. The rationale for this type of public policy instrument is that SMEs, which contribute heavily to job creation, generally do not have the funds or the risk appetite to invest in innovation. Hence, a government intervention that covers these problems can contribute to crafting more productive and lucrative SMEs, workforce, and society.

Primary goal: Provide expert knowledge to SMEs, helping them to develop their innovative capabilities, as coaching and mentorship.

Secondary goal: Contribute to productivity increases in SMEs to generate a widespread effect of gains in the economy.

Policy characteristics: These services are relatively low cost for both the public and the private sector and focus on incremental improvements to each SME impacted by them. Their low cost and relatively simple structure make them a straightforward tool to be implemented in different contexts and agencies.

Do they work?: As these services are usually provided in a highly fragmented manner, it is difficult to capture the aggregated effect on the economy. Studies suggest that they positively impact SMEs individually and can make a difference between the make or break of a small enterprise.

Comment: When designing this type of tool, policymakers should bear in mind that some intermediary role might be necessary to align supply-demand expectations (see Table B). Secondly, governmental agencies need to consider whether the expertise is available in their professional networks, research centres or educational institutions that could provide the services. However, this availability of qualified professionals and experts will result from other policies in this compendium.

Further reading:

- OECD - Strengthening SMEs and entrepreneurship for productivity and inclusive growth
- European Union Innovation Voucher Programs
- Western Australia Innovation Vouchers Program

[31] *Technology extension services - Innovation Policy Platform.*
[32] *Innovation vouchers – Innovation Policy Platform.*

Canadian Equivalent/Example:

- National Research Council of Canada Industrial Research Assistance Program (NRC IRAP)
- Alberta innovates Technology Development Advisors

Table B: Intervention logic for technology and innovation advisory services

Inputs and actions	Immediate outputs	Business outcomes	Broader outcomes
• **Initial matchmaking with experts** • **Diagnostic, benchmarking and advisory services** • **Project scoping and development** • **Referral to other qualified sources of assistances** • **Access to source of project finance** • **Investment of company's own resources (money and people) in project development**	• Enhanced innovation strategy • Investment in process or facility improvements • Acquisition of new technology • New product or service development initiated • Training and skill development • Access to financing • New supplier, customer, vender relationships • Increase collaboration with universities, technology centre and private experts	• Improved workforce productivity • New sales, including new export sales • Cost savings • Reduced waste • Improved quality • New products or services launched in the market • Jobs created or retained • Improved profitability	• Enhanced contribution to regional and national gross added value • Strengthening of industrial sectors and clusters • Improvement in sector, regional and national innovation capabilities • Enhanced regional national industrial competitiveness • Greater coordination and effectiveness of private and public support services

Source: Shapira and Youtie (2016) in Edler et al (2016), Table 6.2, page 171.

10. Innovation inducement prizes

Description: As its name suggests, innovation inducement prizes are awards given to inventors who provide a fast and efficient solution to a problem. This type of award is one of the most long-standing instruments of innovation, going back to examples such as the invention of canned food to feed the Napoleonic army and the Longitude Prize[33] in the UK to solve the problem of maritime navigation in the 18th century. This type of instrument has regained some traction in recent years with the re-launch of the New Longitude Prize, managed by Nesta.

Primary goal: Push innovative solutions to solve a given problem identified by the award funder, by offering a straightforward financial reward for an invention.

Secondary goal: Attract non-traditional actors to innovation processes, raise awareness for a health, social, engineering or any other area of knowledge challenge. Stimulate public engagement in innovation.

Instrument characteristics: Edler et al. suggest some typologies of prizes, as follows: i. *ex-post* recognition prizes (e.g. Nobel), *ex-ante* inducement prizes (Longitude), *one-winner-takes-all* of *multiple winners.* They can also be given to *a finalized product* or by achieving certain *milestones*, be *specific* or *general* prizes.

Do they work?: There is little evidence that IIPs work and there are actually arguments that suggest that they only function when there is a clear path to a solution and the technologies needed are widely available/democratise amongst actors. Therefore, IIPs are not an effective innovation policy on its own, but could be seen as a final push to a process that has already had previous incentives and resources.

Comment: Another term for IIPs is challenge prizes, as covered elsewhere in this compendium (4. Grand challenges / challenge funding). The difference between them is that IIPs only offer a final rewarding prize, while grand challenges usually offer the conditions and funding for researchers to purses a certain investigation topic. An important aspect of IIPs is that they are not a systemic measure that supports the innovation process, but a rewarding mechanism to ideas that being formed/developed in society with the support of other innovation instruments.

Further reading:

- And the winner is… Capturing the promise of philanthropic prizes
- Using Innovation Inducement Prizes for Development: What more has been learned?
- Innovation Inducement Prizes at the National Science Foundation
- The Great Innovation Challenge

[33] *The History of the Longitude Prize*

Canadian Equivalent/Example:

- Alberta Small Business Innovation and Research Initiative (ASBIRI)

Appendix B: Compendium of innovation instruments

11. Innovation networks
12. Supporting collaboration
13. Knowledge Translation and Mobilisation
14. Technology commercialization
15. Technology foresight
16. Incubators
17. Accelerators
18. Innovation hubs

11. Innovation networks

Description: Innovation networks are formal instruments to form and develop interactions between actors in an innovation system, such as academia, industry, and government. Innovation networks can be established within regions and between countries, research institutions, firms, or by a combination of actors' policymakers to achieve a specific result. These policies are based on the fundamental premise that innovation is a complex phenomenon, which happens in a non-linear manner[34], but arises from diverse interactions and feedback loops between the multiple actors in an innovation system. Hence, the more those interactions happen, the greater the potential for positive, innovative outcomes.

Primary goal: Facilitate the creation of networks between researchers, innovators, and companies to facilitate the exchange of knowledge between these actors and the diffusion of innovations through those networks leading to tangible impacts on local economies.

Secondary goal: Create communities of practice and networks of excellence in different fields; socialise discoveries, standards and best practices in research; reduce transactional costs for knowledge transfer initiatives.

Policy characteristics: Innovation network are the result of collaborative actions, which require strong engagement from actors involved, being in the public or in the private sectors. Therefore, policymakers should aim at providing the adequate means for collaboration networks to flourish, such as continuous funding for exchange programs, funding for the organisation of conferences, research seminars and similar events, adequate language training for researchers to access global networks, and even migration policies that do not hinder the participation of foreign researchers[35].

Do they work?: Given their intrinsically diffuse nature, it is difficult to capture the direct results of innovation networks. Lately, the rise of bibliometrics and other data analytics tools allow for more insights into their efficiency as an innovation instrument[36]. For instance, social network analysis tools have been increasingly used to make sense of innovation networks, by mapping correlations based on publications[37] or patents[38] data between individuals and companies.

[34] The "linear model of innovation" has underpinned innovation policies for many decades, based on the ideas proposed by Vannevar Bush in his influential report "*Science: The Endless Frontier*" from 1945. This theory has been strong due to the straightforward statistical correlation between investment in science and economic growth. However, more modern innovation theories recognise that innovation is a more complex phenomenon, as suggested, for example, in "*Innovation: A Guide to the Literature*" and "*The Linear Model of Innovation: The Historical Construction of an Analytical Framework*".

[35] *The hidden costs of being a scholar from the global south - Nihan Albayrak-Aydemir at LSE Blogs.*

[36] *Managing research and innovation networks: Evidence from a government sponsored cross-industry program.*

[37] *Interactive Overlays: A New Method for Generating Global Journal Maps from Web-of-Science Data.*

[38] *Patent overlay mapping: Visualizing technological distance.*

Comment: Apart from networks between research institutions, laboratories, and firms themselves, innovation networks also involve with important intermediaries, especially in the international relations dimension, with many countries investing in science diplomacy initiatives. For example, the Dutch Nuffic Neso, the Swiss Swissnex network and the UK Science and Innovation Network (SIN).

Further reading

- UK Science and Innovation Network Impact Stories
- Social Network Theory – a literature review for understanding innovation programs

Canadian Equivalent/Example:

- Alberta Innovates Regional Innovation Networks
- Ontario Reginal Innovation Centres
- Innovates BC Venture Acceleration Program

12. Supporting collaboration: Consortia, Alliances, Interdisciplinary & Collaborative Grant

Description: Interventions directed at enhancing collaboration between different actors of a system of innovation, such as higher education institutions, especially research-oriented universities, public laboratories, and firms, increase the innovative activities that can arise from those interactions. They can have different configurations by linking two or more research institutions nationally or internationally, two or more firms, two or more research institutions with firms or suppliers, for example, depending on the objective of the collaboration.

Primary goal: Promote knowledge, skills, capabilities, and competencies sharing between the actors of an innovation system.

Secondary goal: Create networks of researchers, innovators and professionals with a joint knowledge base, ease technology transfer from research institutions to the industry, among others.

Policy characteristics: These types of instruments are often quite diverse in character, ranging from membership type fees to alliances to informal in-kind participation in loose forms of consortia. From a funder's perspective, specific grants that bring together researchers and innovators across either different fields or different localities and jurisdictions to work together on a single project are quite common. One issue to consider is whether such grants are aimed at starting up new and novel collaborations or supporting existing ones.

Do they work?: Yes. Collaboration support is a well-established instrument in the innovation policy mix.

Comment: Supporting collaboration via consortia, alliances or collaborative grants is based on the premise that science and knowledge are collective public goods that can be shared and recombined in infinite ways. There are plenty of examples of how they can be structured. For instance, the European Organization for Nuclear Research (CERN) is an example of international collaboration on a venture that required massive investment and expertise to investigate highly complex issues such as the nature of the universe. The UK's Doctoral Training Centres[39] (DTCs) and the Finnish Centres of Excellence (CoEs) are also interesting examples of a national level collaboration initiative that ties funding to collaboration between excellence research institutions and industry. Other examples are the European Energy Research Alliance (EERA), the European Union Industrial Alliances, the Drugs for Neglected

[39] The Medical Research Council webpage is only one example of the DTC scheme. All other UK Research Councils, now under the umbrella organisation UKRI, have their own DTCs.

Diseases initiative (DNDi) Global Networks or the Transformative Innovation Policy Consortium (TIPC).

Further reading:

- PhDs leave the ivory tower - Nature

Canadian Equivalent/Example:

- CANARIE (funded by ISED)
- CNSLP (now CRKN) (funded by CFI)

13. Knowledge Translation (KT) & Knowledge Mobilisation (KM)

Description: The term 'Knowledge Translation' was coined by the Canadian Institute of Health Research (CIHR)[40] in 2000 and then adopted by the World Health Organisation (WHO) in 2005 to the following definition: the synthesis, exchange, and application of knowledge by relevant stakeholders to accelerate the benefits of global and local innovation in strengthening health systems and improving people's health.

Primary goal: Make sure that scientific knowledge produced by researchers reaches its knowledge users and positively impacts society.

Secondary goal: Disseminate scientific findings to specific audiences (e.g.: policy briefing, educational sessions with patients, media engagement, etc); Commercialize scientific discoveries.

Policy characteristics: According to its original CIHR definition, knowledge translation activities can be delivered at the end of a given grant or as an integrated activity[41]. They often involve contributions to research agenda, theory and methods (within the academic context) and inform public debate, policies, practices and others.

Do they work?: Different areas of knowledge require different tools for translation, hence 'Knowledge Translation' (KT) and 'Knowledge Mobilisation' (KM) instruments will vary accordingly with different levels of efficacy, but overall as a generic innovation instrument, the evidence would suggest that they do work.

Comment: The prompts provided by the Canadian Social Sciences and Humanities Research Council do offer an interesting perspective on the type of questions that must be considered in order to 'put knowledge into action':

- To whom should research results be communicated?
- How is the process of communicating research results best mapped?
- How will the proposed knowledge mobilization activities advance the stated research goals?
- Will interactions with knowledge users be fed into research design?
- How will interactions be sustained beyond the life of the project?"[42]

[40] According to CIHR's page on *Collaboration.*
[41] More information can be found on the *CIHR* webpage.
[42] Available at: *https://www.sshrc-crsh.gc.ca/funding-financement/policies-politiques/knowledge_mobilisation-mobilisation_des_connaissances-eng.aspx*.

Further reading:

- What is knowledge mobilisation and why does it matter to universities?
- Defining Knowledge Translation
- Guidelines of Effective Knowledge Mobilisation

Canadian Equivalent/Example:

- Knowledge Translation Canada

14. Technology commercialization

Description: Technology commercialisation[43] defines the process through which knowledge developed at public research institutions reaches the market, capturing the financial value of a process, product or service innovation. The rationale for policy intervention on technology commercialisation is based on the understanding that the invention itself is just one of the components of the innovation process, which in its turn, is by no means a linear or straightforward one. In fact, to profit from innovators often need different complementary assets[44] to be able to profit from scientific invention, such as competitive manufacturing facilities, appropriate distribution channels, complementary technologies, and marketing services. It usually includes the identification of new technologies, the protection of these technologies with the most adequate Intellectual Property Right instrument, and the development of commercialisations strategies, commonly, via licensing a technology to another company or creating technology-based start-ups.

Primary goal: Support the capturing of the economic benefits of publicly funded research, build links between industry, innovators and scientists.

Secondary goal: Supporting faster and more efficient technology commercialisation processes can also improve process innovation and increase productivity in the industry.

Policy characteristics: Technology commercialisations processes will commonly involve scientists, engineers, universities, public research institutes, technology transfer officers, incubators, accelerators, or science parks. They will aim to provide the know-how to prepare and support inventors and/or scientists with the necessary procedures to ensure the appropriate value capture (usually through Intellectual Property Regimes) and commercialisation strategy to a given product or process innovation.

Do they work?: They are considered to generate positive impact for economic development.

Comment: It is important to observe that a technology commercialisation process does not need to wait for a finalised product to be presented to the market. Often enough, minimum viable products, prototypes, a pilot service/platform or a beta version can be part of a technology commercialisation pipeline so the final user/client can also bring inputs to the creation process. Currently, the number of universities and public research institutions with

[43] The "*Process of technology transfer and commercialisation*" on the Innovation Policy Platform offers a good initial understanding about technology transfer and commercialisation.

[44] *Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy* – Despite being from 1986, this David J. Teece publication is a seminal paper on the economic returns of innovation and helps to explain the rationale for policy intervention in improving technology commercialisation processes.

business and entrepreneurship skills, as well as with access to business accelerators and incubators has considerably grown, helping such processes of technology commercialisation.

Further reading:

- UK Technology Strategy Board – Concept to Commercialisation
- Commercializing Technology: What the Best Companies Do
- The Technology Commercialization Process
- Technology Commercialisation and Universities in Canada
- Boosting Knowledge Transfer Between

Canadian Equivalent/Example:

- University of Alberta Technology Commercialization Centre

15. Technology Foresight

Description: Technology foresight is the term given to systematic, participatory, and forward-looking exercises that explore, anticipate, or shape desirable future scenarios. This approach draws on strategic planning, future studies, and public policy. This type of exercise is used in both the public and private sectors[45] [46]. In the former, it is generally used to contribute to the scoping of technology trends that impact society or to the collective building of what a community imagines as its future scenario, considering mainly the role that technology will play in this forward-looking perspective. In the latter, it tends to be used as a roadmap for prioritizing research/technology development and innovation, plan new products development, make strategic technology licensing decisions and, overall, ensuring firms remain innovative and competitive in the long run.

Primary goal: Inform decisions in the present that can support the crafting of a desirable future, particularly considering the role of technology in building such a scenario.

Secondary goals: Analyse the future potential of technologies, support policy or strategy development, network building (by facilitating dialogue among actors in an innovation system), priority setting for S&T (by adding multiple actors to the conversation), methodology and capacity building (by socialising knowledge within a community of practice), articulating supply and demand (by aligning expectations and promoting dialogue between both sides), promote public engagement.[47]

Policy characteristics: Technology foresight exercises can widely vary in their focus area, actors involved, objectives, and methods utilized. However, the feature that binds them as a innovation instrument is their forward-looking approach; and orientation towards managing the intrinsic uncertainty about the future in an informed manner, based on collective intelligence and accountability.

Do they work?: The evidence for innovation policy impact from technology foresight is limited. However, Table C - formulated by Edler et al.[48] - provides interesting insight on the short-, medium- and long-term potential and expected impact of foresight activities. This table broadly concludes that foresight exercises are effective if they are targeted and the sponsor has a clear understanding of the key objectives or impacts, as given in the table.

[45] *An Introduction to Corporate Foresight* by *ARUP.*
[46] *Corporate foresight: Its three roles in enhancing the innovation capacity of a firm* ($ - behind paywall).
[47] Adapted from Georghiou and Harper (2011, p. 244), in Edler p.485.
[48] Handbook of innovation policy impact – Chapter 16.

Comment: Technology foresight can also be found in the literature as 'futures studies', 'futures research', 'futurology', 'foresight', 'forecasting', 'prognostics' or 'prediction'. Despite potential debate over the academic definition of each term, they share the characteristic of encapsulating the idea of gazing into the future for answers to the present. The Top Ten Toolkits for Futures gathers useful off-the-shelf tools for Foresight for Innovation Policy from the UK[49], Canada[50], and the EU[51], and others. The Finnish Societal Transformation 2018-2037, published by the Finnish Parliament's Committee for the Future in 2018, called the Radical Technology Inquirer, was evaluated as one of the best national technology foresight exercises. Their robust method aimed at identifying three things: (i) the 100 most promising technologies; (ii) the 100 legislative objectives to streamline the adoption of those technologies; and (iii) the 200 professions of the future "to be able to prepare for upcoming challenges with the right knowledge and skills".

Further Reading:

- European Foresight Platforms - Methods
- Technological Forecasting – A Review - CISL, Sloan School of Management, MIT
- Evaluation of technology foresight projects
- The development of technology foresight: A review

Canadian Equivalent/Example:

- https://nrc.canada.ca/en/corporate/planning-reporting/horizon-several-perspectives-canadas-technology-future-2030-35

[49] *UK Government Office for Science.*
[50] *Canada's Policy Horizons.*
[51] *Europe Political Strategy Center.*

Table C: Hierarchy of targeted foresight innovation impacts

Immediate impacts (Short term)	Intermediate impacts (Medium term)	Ultimate or end impacts (Long term)
• **Bringing new actors into the strategic debate** • **Creating new networks and/or realigning existing networks** • **Linkages across fields, sectors and markets or around problems** • **Mapping the totality of the R&I ecosystem, demonstrating current and emerging technological opportunities** • **Scanning and exploring future opportunities to set priorities for investment in R&I and identifying niche areas of competitive advantage** • **Enhancing interactions and learning, including science-industry link and user supplier links and interactions across and between domains and across sectors and markets or around problems and challenges** • **Identifying barrier to innovation** • **Producing significant strategy and policy documents**	• Strengthening the R&I ecosystems including building, transforming or reorienting the system • Setting up new R&I programs and measures • Creating critical mass through technology platforms and clusters • Demand-driven innovations based on enhanced understanding of user needs and user-supplier link.	• Improvement in national innovation performance • Strengthening national competitiveness • More competitive products and services

Source: Harper (2016) in Edler et al (2016), Table 16.3, p502, building on Andersen and Anderson (2012).

16. Incubators

Description: Incubators are spaces that provide offices, access to networks, laboratory/technical resources and other targets resources for early-stage start-ups (Gregson 2019).[52] The concept of incubators can be associated with two main structures: public funded incubators, usually associated with universities or research institutions[53], and private incubators[54]. The first aim to support the structuring of business that spin-out of scientific research, while the second tend to rely on office renting as its main source of income. In both cases, the two major attractions of business incubators are the provision of physical infrastructure and access to networks that can accelerate the business development process of an early-stage business.

Primary goal: Offer early-stage start-ups with the physical structure and network opportunities they need to grow.

Secondary goal: Reduce the distance between like-minded entrepreneurs and opportunities to access early-stage funding.

Policy characteristics: For publicly funded incubators, their policy rationale is usually to de-risk ventures for future private investment, by supporting early-stage entrepreneurs in structuring and validating their business model before being exposed to the 'real business world'. They tend to work on a rolling admission system, have open-ended contracts with its resident companies, who pay them fees to be part of their ecosystem.

Do they work?: The analysis on whether business incubators work is twofold. From the business side, its success indicator is an incubator's survival in the market, due to the relevance of its services to its clients. In terms of its success as a policy intervention measure, the literature is less compelling with a number of evident challenges including the high failure rates, the protection of mediocre venture and undue attention on financial metrics (Gregson, 2019).

[52] https://albertainnovates.ca/wp-content/uploads/2021/03/AI-Incubator-and-Accelerator-FINAL-Report-01-05-19.pdf.
[53] For example, the Swiss biopôle, which apart from the traditional incubation services also counts with 15 research platforms from its associated universities. This hub is supported by the public-private innovation agency Switzerland Innovation.
[54] For example, Level39 in London. A private business incubator specialised in cybersecurity, fintech, retail tech and smart cities. Or Cubo Network in São Paulo,

Comment: Incubators are commonly confused with accelerators. However, these two models serve distinct purposes, even though there may be significant overlap between many of their activities. The main differences are summarised in Figure D.

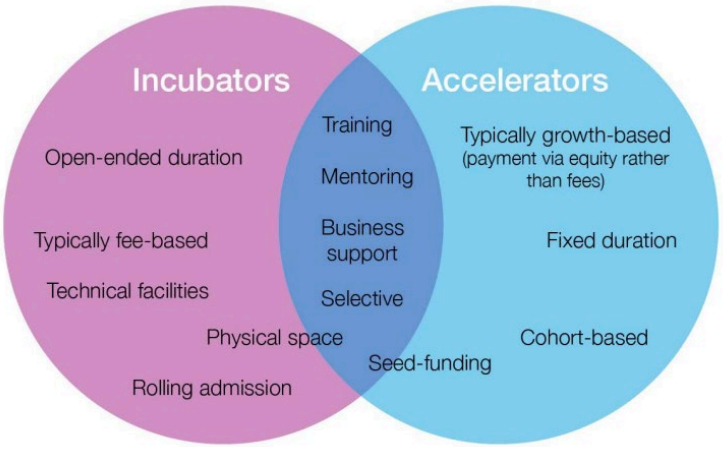


Figure D – Extracted from the Business Incubators and Accelerators: The National Picture – BEIS research paper number 7

The lines between business incubators and accelerators are blurred and is not unusual to see an incubator offering all its traditional services (office space and networking) as well as organising acceleration programs to its resident companies or external ones. Acceleration programs within business incubators are an interesting idea as they combine venture capitalists' investment appetite with the pool of business ideas or technologies cultivated by an incubator. In comparison with accelerators, incubators are not required to be as selective as accelerators about the business they bring to their ecosystem[55], as they do not invest any financial resources in their resident businesses.

Finally, the main clients of business incubators are on one side, the start-ups that benefit from its ecosystem and on the other, corporate clients that benefit from the offer of new technologies and talents to search potential partners for technology acquisition or open innovation agreements, for example. In other words, business incubators are a meeting point for an informed community of stakeholders from both the supply and demand side of innovation.

Further reading:

- The Impact of Business Accelerators and Incubators in the UK - BEIS Research Paper Number 2019/009
- Accelerators Vs. Incubators: How to Choose the Right One

Canadian Equivalent/Example:

- Agrivalue Processing Business Incubator (APBI)

[55] Common term in the entrepreneur environment to define the network of professionals connected to the incubator.

17. Accelerators

Description: Accelerators "have become an umbrella term for many programs providing a service structure of mentorship, networking opportunities and access to funding" (Gregson 2019).[56] They are spaces/structures that offer education, mentoring and access to funding to late-stage start-up through fixed-term acceleration programs. They formally differ from incubators mainly due to their business model and the later stage when they take a start-up on board. In terms of the business model, accelerators invest financially in the start-ups participating in their programs, receiving equity in return. In terms of stage, accelerators generally require participants to already have a validated minimum viable product (MVP), supporting their growth strategy from there onwards. They are closely related to entrepreneurship policy as they are pretty much focused on training and connecting an entrepreneur to the elements that can help them succeed.

Primary goal: Speed up the business learning process of late-stage start-ups, supporting their scale up and growth whilst offering the complementary assets it needs to turn their idea/innovation into a market product/service.

Secondary goal: Reduce the barriers to success of late-stage start-up so they can become more competitive and contribute to economic growth.

Policy characteristics: The programs delivered by accelerators are usually fixed-termed (usually, 3 to 6 months), cohort-based, mentorship-driven, usually ending with pitching sessions on a final 'demo-day' for a group of investors or interested parties, depending on the type of accelerator. Often, seed capital[57] is also offered to promising accelerated businesses. Like incubators, collaboration is a key value of start-ups acceleration spaces. In terms of content, acceleration programs commonly offer entrepreneurs insights about strategic management, marketing and legal advice, the different stages of venture capital fundraising[58], pitch training, and others.

Do they work?: The boom in accelerators in recent years is beginning to be studied recently. However, as they involve private capital, and therefore need to generate more immediate financial results for their investors, there is evidence to believe that they work.

Comment: It is important to bear in mind that the structure of the programs offered, and the quality of the ecosystems set up in an accelerator are key to its success and usually this requires strong networks within the business sector. From a funder's perspective, a policy intervention should consider that an accelerator needs a strong private component and any aid for these initiatives should be geared to function as partnerships with the private sector and that it does not compromise the drivers of private sector participation, such as a lean

[56] *https://albertainnovates.ca/wp-content/uploads/2021/03/AI-Incubator-and-Accelerator-FINAL-Report-01-05-19.pdf*.
[57] "Seed capital", "seed money" or "seed financing" refers to the initial investment made into a start-up. It's usually money from friends, family, business angels and the counterpart to this investment tends to be equity, i.e., percentage of company's share.
[58] *Start-up funding explained: from seed to IPO.*

business model, fast-pace, and a certain level of pressure for financial returns. Examples of start-up accelerators: On the private side: techstars, the Founder Institute, Google Campus London and the Y Combinator. On the public side: ClimAccelerator by Climate-KIC, funded by the European Union and with a specific mission of pushing green technologies.

Further reading:

- The Impact of Business Accelerators and Incubators in the UK - BEIS Research Paper Number 2019/009
- Accelerators Vs. Incubators: How to Choose the Right One
- What Start-up accelerators really do
- What do Accelerators Do? Insights from Incubators and Angels
- Do Accelerators work? If so, how?

Canadian Equivalent/Example:

- Alberta Scaleup and Growth Accelerators Program
- Waterloo Accelerator Centre

18. Innovation hubs (Parks, corridors, districts, hubs)

Description: Innovation parks, corridors, districts, or hubs are different terms to refer to the many different initiatives that aim at reducing the geographical distance between innovation actors – firms, research institutions and government agencies – and promote incentives for their collaboration. They will usually differ based on the physical structure they are naming, for example: an innovation park concentrates research facilities, technology advisors and start-up incubators and accelerators, as Switzerland Innovation Park Biel/Bienne, and a corridor connects different cities with prominent innovation activities in a specific region such as the Chinese Guangzhou-Dongguan-Shenzhen Science and Technology Innovation Corridor and the UK London-Cambridge Innovation Corridor. Despite the diversity of shapes and names these instruments appear in the innovation literature and practice, they are connected by the underpinning idea that connectivity and physical proximity are key enablers of innovation, and that intervention should facilitate the concentration, interaction, and cross-pollination of idea between the right actors, conveniently located in the same areas, with easy access to shared facilities and transport infrastructure, for example.

Primary goal: Geographically concentrate actors of a given system of innovation to better manage knowledge flow, interactions, cross-pollination of ideas and innovation outcomes.

Secondary goal: Concentrating high intensity knowledge creation centres to facilitate government/foundation interaction with private sector actors in an innovation system.

Policy characteristics: Innovation hubs are characterised by its specialised labour markets – which reduces training costs and facilitate knowledge sharing and spill-overs, foster competition and ease complementarity in products and technologies. These characteristics leverage innovation and productivity. The University of Cambridge 2017 STI Management Program lists 7 outstanding features that characterise innovation hubs.

Do they work?: The strong growth tendency in innovation hubs all over the world are a relatively strong rationales for their effectiveness. However, proper evaluation tools for innovation hubs are difficult to shape, since the concept encapsulates so many different initiatives and arrangements, which leads to barriers in establishing which metrics would be important to measure.

Comment: These hubs open an opportunity for policymakers to collaborate and co-create policies directly with actors in the innovation system. From the concentration of players, policymakers can create spaces for dialogue with companies and researchers about market or regulation failures, or what types of support would benefit the system the most.[59] The

[59] Such initiatives fit under the category of "Policy Innovation" rather than "Innovation Policy" and they stand for studies/practices in the realm of novel ways to run the policy cycle, including a more bottom-up and co-creative approach. More can be found at *Policy Innovation – what, why and how?* and *Co-creation in Government*.

Covid-19 pandemic has also showcased the resilience and potential to explore digital connectivity options benefiting from the existing networks created at innovation hubs[60].

Further reading:

- Hubs of Innovation: A Playbook for Place Leaders.

Canadian Equivalent/Example:

- Alberta Innovation Corridor
- Toronto Waterloo Corridor

[60] More on the *Connected Places Catapult report* about the role of innovation hubs in a Covid-adjusted economy.

Appendix C: Compendium of innovation policies

19. Policies for training and skills
20. Fiscal incentives for R&D
21. Entrepreneurship policy
22. Cluster policy
23. Standards
24. Regulation
25. Public procurement for innovation
26. Pre-commercial procurement

19. Policies for Training and Skills

Description: Training and skills policies prepare the human resources required for innovation to take place. They are divided in three main strands of policies:

1) The formation of human resources in science, technology (HRST[61]) – i.e., tertiary education of qualified scientific research personnel.
2) The provision of Technical and Vocational Training[62] (TVET) - i.e., apprenticeships or any other post-secondary path that offers on-the-job training coupled with technical training delivered by an educational institution.
3) The offering of Lifelong Learning[63] (LLL), especially due to the accelerated speed of technological change and the need to renew skills and knowledge of existing workforce.

All of the policies are based on the underpinning idea that a qualified workforce is a vital enabling factor for innovation and, consequently, economic growth. They can be elaborated and implemented by international, national, and regional organisations, or even by companies interested in elevating their workforce skills.

Primary goal: Train qualified workers to create, transfer and diffuse knowledge in society.

Secondary goal: Increase firm's absorptive capacity, increase individuals' employability levels and earning potentials.

Policy characteristics: These policies are geared at the people shaping and interacting in innovation systems. They are usually mid-to long-term, as educational processes are time-consuming. Despite mainly being a supply-side innovation policy, their design needs to be aligned with the needs of the working world.

Do they work?: There is strong evidence to suggest that these policies work[64].

Comment: Training and Skills policies have often been overfocused on preparing highly skilled HRST, but missed preparing more technical level personnel, resulting in scarcity of well-trained middle skilled workers. Therefore, policymakers should be mindful to properly balance the three strands of training & skills policies. In the UK, one approach that has been adopted to support the training of skilled workers (largely through non degree routes) is the Apprenticeship Levy. This in effect is a payment that large employers make towards funding

[61] As defined by the *Canberra Manual*.
[62] As for example *Alberta's Apprenticeship and Industry Training* options.
[63] As offered in Canada – *Supporting lifelong learning report*
[64] The following publications provide evidence and measuring tools for these policies: UK Department for Business Innovation & Skills - Research Paper: *The relationship between graduates and economic growth across countries*, *McKinsey's & Company - Creating an effective workforce system for the new economy* and the UNESCO *practical guide on understanding the return on investment from TVET.*

apprenticeships and training, with the aim of increasing the number and quality of such courses in the future.

Further reading:

- Human Resources Policies for Innovation – OECD STI Policy Profiles

Canadian Equivalent/Example:

- https://www.conferenceboard.ca/research/there's-a-revolution-happening-in-skilled-trades
- https://caf-fca.org/caf_research/national-strategy-for-supporting-women-in-the-trades/
- Job Pathways Playbook, 2021 edition.

20. Fiscal incentives for R&D

Description: Fiscal incentives for R&D are concessions granted by governments to reduce firms' tax burden – such as reducing employers' social security contributions or reducing taxes over capital investments for R&D – depending on their current size or expansion of eligible R&D activities. R&D tax incentives offer an alternative to traditional ways of raising funds for innovation investment in the corporate world, such as direct government investment, project grants, venture capital or loans.

Primary goal: Reduce financial barriers that hinder investment in innovation in companies.

Secondary goal: Offer alternative R&D funding, encourage investments in R&D from the industry as a whole

Policy characteristics: Fiscal incentives are geared at firms and are usually granted *a posteriori* to the investment as a tax deduction. They can have different objectives depending on how they are designed, as some of the examples in the following table:

Type of incentive	Description	Examples
Tax credits	Allow companies to deduct specific elements of their R&D expenses from their taxes. This is the most widespread type of instrument used nowadays.	Italy, Netherlands, Canada, Korea, Spain, France.
Accelerated depreciation schemes	This scheme allows companies to use the corporate finance method of accelerated depreciation[65] for investments in machinery, equipment, buildings and/or intangibles used for their R&D activities. They can be used for the industry as a whole or as an incentive to specific areas of interest, such as in the example from India.	Italy, India
R&D allowances	Allows companies to deduct over 100% of their taxable income from their R&D expenditures.	UK
Wages or Social Taxes	Incentives that allow companies to deduct R&D labours costs such as pension contribution or social taxes.	Netherlands
Patent Box	Grants lower corporate tax rate on profits generated from patents that are held in a certain country.	Netherlands, Belgium, Spain[66], UK.

Source: Adapted from Laredoet al (2016) in Edler et al (2016), page 20.

[65] *What is accelerated depreciation – Corporate Finance Institute*
[66] *Patent Box: new regulation in the Corporate Income Tax Act*

Do they work?: In the past decade, they have been an increasingly popular tool in OECD and non-OECD countries, and there is evidence that they do work. [67]

Comment: These instruments need to be carefully designed to encourage new innovation and not only work as a cost-reduction shortcut for well-established businesses or end up by encouraging smaller firms to invest in less productive activities. They provide a certain level of independence from external sources to fund their projects, offering more autonomy to R&D decisions to the company itself. Hence specific mechanisms to prevent fraud and maximize their efficiency should be part of their policy design. As an indirect incentive measure, fiscal policies are an excellent instrument to stimulate any industry sector to innovate. They are also considered to be less costly in terms of intermediation costs and are not as susceptible to government failure (i.e., picking the wrong projects to be funded). More recently, fiscal incentives have also been used as a possibility of steering their recipients to invest on research that aims at developing specific goals, such as climate-friendly innovation.[68]

Further reading:

- How effective are fiscal incentives for R&D? A review of the evidence
- Fiscal Incentives for R&D and innovation in a diverse world
- European patent box regimes – PwC report for JETRO

Canadian Equivalent/Example:

- Intellectual Property in Ontario's Innovation Ecosystem
- Scientific Research and Experimental Development Tax Incentive Program (SRED)

[67] Evidence of positive impact in innovation activities: "*The impact of R&D subsidies on firm innovation*", "*Who Benefits from R&D Tax Policy*?" in Spain, "*In pursuit of technological innovation: China's science and technology policies and financial and fiscal incentives*" ($ - behind paywall) in China and "*Incentives for technological innovation: a study of the public policy of tax exemption in Brazil*" in Brazil.
[68] As suggested in "*OECD – Promoting Technological Innovation to Address Climate Change*" and "*R&D incentives for Environmental Technologies*"

21. Entrepreneurship policy

Description: Entrepreneurship[69] policies are interventions by government and other agencies (including universities) that aim to stimulate the entrepreneurial potential of individuals to make a positive contribution to the economy. The rationale for implementing such policies is usually justified by the lack of information about how to build ventures, access funding and business management in general, or simply as an attractive career path. They can be educational and training measures for individuals to promote the benefits of this career path and coaching, mentoring and consultancy services for early-stage entrepreneurs or for those looking to scale up their ventures. In a broad perspective, much of the narrative around them is geared at offering support to individuals with good ideas but who might lack the knowledge, skills, or resources to bring them to life. It is essential to highlight that these measures can vary quite a lot depending on the audience they are aimed at (students, early-stage entrepreneurs, scientists, among others) and that many different instruments can fit under the 'entrepreneurship policy' category.

Primary goal: Stimulate the economy by pushing entrepreneurial activity from individuals.

Secondary goal: Remove barriers to entrepreneurial activities, as in make it as easy as possible for entrepreneurs to pursue their business ambitions.

Policy characteristics: The direct beneficiaries of these policies are usually individuals. They are usually oriented at addressing cultural/behavioural patterns or at reducing regulatory/systemic barriers to start and scale up businesses. Many stakeholders can deliver different bits of entrepreneurship policy. Here, we are considering that business incubators, accelerators or knowledge transfer officers can help entrepreneurs in topics related to doing business, such as access to funding options, how to protect intellectual property rights, how to access international markets, how to negotiate with potential clients, how to structure a business (e.g. by helping entrepreneurs understand what their optimal target audience, market access strategy), marketing tools, pitch training for investors, access to networking, alignment business objectives with sustainable development goals, among others.

Do they work?: As a novelty in the innovation policy toolbox, evidence of its effectiveness remains underdeveloped.

Comment: The needs of the beneficiaries of such policies can be quite different in an innovation system. Therefore, policymakers should be aware that their policies cater for its diverse public. As a practical example of this remark, the Swiss Innovation Agency, Innosuisse, has a robust set of tools for individuals in different moments of their entrepreneur journey, as per the following division:

[69] There is extensive discussion in the academic literature about "entrepreneurship" being a cultural or even personal characteristic and that it cannot necessarily be taught. However, for the purposes of this toolkit, we will consider entrepreneurship policy as described above.

- Start and grow your business
- Start your innovation project
- Go global
- Be connected

All the initiatives above are run in partnership with champions from the business sector with experience in venture capital and business development nationally and internationally, with the Swiss diplomatic network spread globally and with universities[70]. In recent years, many consolidated research institutions, such as NASA and CERN, launched their programs to stimulate science-based entrepreneurship.

Entrepreneurship policies can also be an instrument of economic inclusion for underrepresented groups. For instance, the United Nations Conference on Trade and Development (UNCTAD) offers extensive material for developing entrepreneurship policy. Although these resources focus on developing countries' policies, they also provide exciting resources such as the Policy Guide on Entrepreneurship for Migrants and Refugees.

Another more recent tool under the umbrella of entrepreneurship policies is 'hackathons'. They are usually 48 hours design sprint-like event which gathers developers, engineers and any other relevant professionals to develop a minimum viable product or solution to a specific problem. They are widely used by technology companies, such as *Uber Hackaton* and *Google hash code coding competitions*, for technological solution development and as a hands-on recruiting exercise. This format has been adapted for other environments such as *Harvard's Social Impact Hackathon*, *UC Davis BioTech / Health-Tech Startup Hackathon*, or in crisis context such as the Versus Virus online hackathon, which focused on developing solutions for problems brought by the Covid-19 pandemic.

Further reading:

- 6 ways governments can encourage entrepreneurship
- European Commission measures for supporting entrepreneurship
- The Better Entrepreneurship Policy Tool
- Getting to Scale: Accelerating Canada's high-growth companies (Brookfield Institute, 2021)
- SME and Entrepreneurship Policy in Canada (OECD, 2017)

Canadian Equivalent/Example:

- Getting to Scale: Accelerating Canada's high-growth companies.

[70] For example, with the University of St. Gallen, which has great expertise in business management and is a thought leader in entrepreneurship tools such as the *Start-up Navigator*.

22. Cluster policy

Description: Clusters are defined by the geographical concentration of actors, usually from a specialised industry, of an innovation system in a given region. The most noticeable example of a technology and innovation cluster is the Silicon Valley[71] in California, which initially brought together actors specialised in the production of semi-conductors, giving rise to the technology market as known. The term can also refer to innovation or science parks, corridors and districts, centres of excellence and innovation hubs – often associated to the R&D side of innovation – and more recently to incubators and accelerators – often associated with the business side of innovation. The concept and its practices have evolved over time and nowadays it can encapsulate initiatives ranging from the industrial to entrepreneurship policy spectrum, involving measures geared at researchers, SMEs, entrepreneurs, or whole industrial sectors.

Primary goal: Geographically concentrate the key drivers of innovation, such as, highly skilled workforce, financial capital available for risk investment, public investment in research and research infrastructure to reduce barriers for interaction between the actors of a system of innovation.

Secondary goal: Promote efficiency in small business, contributing to the economic growth.

Policy characteristics: As mentioned above, the term cluster defines many different arrangements. However, they are underpinned by the overall goal of reducing the distance between the stakeholders needed for innovation to happen.

Do they work?: Clusters per se do facilitate innovation. However, there is more scepticism about the role of policy intervention in creating them, with the academic evidence broadly concluding that it is hard to 'create' clusters as they evolve naturally.

Comment: Many studies show that most clusters have emerged and grown spontaneously and that government's role as clusters' brokers has been considered unimportant. Therefore, instead of focusing on promoting 'cluster policies', policymakers might wish to concentrate their policy efforts on areas known to be enabling factors for an innovation friendly environment.

[71] There is a vast discussion in the literature on innovation studies about the factors that enabled the emergence of the Silicon Valley - its origins in the research directed at facing the Second World War, the role of Stanford University in providing qualified labour and building networks of professionals which brought together qualified researchers and market interests, the affluence of venture capital, among others. Therefore, policymakers need to bear in mind that it is virtually impossible for other regions to replicate the Silicon Valley model.

Further reading:

- Policy Brief – Cluster Policies
- Cluster Observatories
- Industrial cluster policies
- The Effects of Clusters Policy on Innovation

Canadian Equivalent/Example:

- Innovation Superclusters Initiative (Canada's Superclusters - ISED)

23. Standards

Description: The textbook definition of standards, according to the Standards Council of Canada, is 'a document that provides a set of agreed-upon rules, guidelines or characteristics for activities or their results. Standards establish accepted practices, technical requirements, and terminologies for diverse fields. They can be mandatory or voluntary and are distinct from Acts, regulations and codes, although standards can be referenced in those legal instruments. Standards organisations are both national and international.

Primary goal: Promote compatibility and interoperability, ensure minimum quality and safety, reduce variety, promote information, and codify knowledge[72].

Secondary goal: By achieving their main objectives, standards also create basic references for other innovations to be created. In other words, transferring knowledge, and standards in already tested and approved technologies can help to focus efforts on solutions not yet developed.

Instrument characteristics: According to Edler et al., standardisation and standards have not been used as an innovation policy instrument per se, but can contribute to the innovation process in specifying required outcomes.

Do they work?: Standards have a positive impact on innovation, even if their initial goal is not to foster the development of new products/services itself, but to harmonise practices. The Role of Standards in Innovation help to better understand the dynamics between these elements.

Comment: While it may seem counterintuitive that standardisation can promote innovation, in the last decade there has been growing interest in the innovation studies literature on how standards support innovation by promoting distribution of knowledge and standardisation of best practices. Hence, levelling up the playing field with the safest and most reliable practices in various areas of knowledge, including of increasing importance in the future data science and artificial intelligence.

Further reading:

- Short video on Standards + Innovation by the European Committee for Standardization (CEN) & the European Committee for Electrotechnical Standardization (CENELEC)
- How standards support innovation – Training videos CEN & CENELEC
- Standards as a catalyst for national innovation and performance – a capability assessment framework for latecomer countries[73]

[72] Adapted from Edler et al.

[73] Although this article focusses on latecomer countries, like South Korea and China, which are quite different from the Canadian innovation system, it is still an interesting example of how standards can be handled as a strategic policy intervention to push innovation

- The Economics of Standardisation

Canadian Equivalent/Example:

- The Innovation Initiative – Standards Council of Canada
- ORCID Canada Consortium
- Government of Canada Digital Standards: Playbook (Treasury Board of Canada Secretariat)
- Canadian Data Governance Standardization Collaborative

by requiring a certain level of quality from a national industry (i.e., developing a national standards system) and secondly, but not less important, help to develop innovation capabilities in the industry.

24. Regulation

Description: According to the OECD, regulation is the 'implementation of rules by public authorities and governmental bodies to influence market activity and the behaviour of private actors in the economy.' It started to gain special attention from policymakers as a potential innovation policy instrument after the 2008 financial crisis, which reduced the capacity for direct investment on innovation in many countries. According to Edler et al., regulation is usually divided into three types: First, there are regulations that specifically target at promoting innovation[74], such as Intellectual Property Rights (IPRs)[75], and the Lead Market Initiative in the European Union[76]; secondly, there are regulations that while trying to achieve other specific goals within a sector end up by creating innovation pressure and opportunities for companies; and finally, regulations that constrain innovative activities by creating burden to organisations. The net impact of regulation as an incentive to innovation will result from the interaction between these three effects, which must be carefully balanced in an IP framework so that government regulation in trying to promote fair rules does not end up hindering innovation.

Primary goal: IPRs or Intellectual Property Frameworks exist to provide incentives for actors to pursue innovative activities, assuring that creators can reap the commercial benefits on the outcomes of their creative efforts, reputation, or the necessary R&D investments to develop a product or process innovation.

Secondary goal: Regulation, as a general term, usually aims at organizing complex socio-technical systems[77] and setting the rules for the action of companies in the market and ensure compliance to certain standards of quality and safety for consumers, for instance, as Health Canada's does.

Policy characteristics: Regulatory policies vary widely depending on their objectives or what sector they are geared to. One common characteristic tough is that they will aim at being technical directives or to be as clear as possible is setting up what is expected from actors in the market. Despite the wide spectrum of policies encapsulated in the term "Regulation", the Taxonomy of Regulatory Types and their Impacts on Innovation report offers a useful split between Economic and Social regulations and their main impacts (pages 8 to 12).

[74] Which will be the focus of this instrument due to Alberta Innovate's interests.
[75] IPRs are governed worldwide by the *World Intellectual Property Organisation (WIPO)* and encompass 'Copyrights', 'Patents', 'Trademarks', 'Industrial Design', 'Geographical Indication' and 'Trade Secrets'.
[76] The Lead Market Initiative is not only about Regulation, but encompasses different demand-side innovation instruments, together with Public Procurement and Standardisation initiatives in the EU. Regulation is part of this pack as a tool to reduce the market entry barriers for SMEs that are related to regulatory burdens, facilitating the creation of new innovative businesses and the Union's overall productivity.
[77] Such as standards for stakeholders in health services, pharmaceutical products, environmental, transport, taxes and business regulation to name a few.

Do they work?: As regulation has only recently come to be seen as a possible innovation tool, there is little research to date on its effectiveness as an innovation instrument. In the health sector, some others suggest that regulation has had a positive effect on continuously improving the quality of processes, but a negative effect on product or service innovation. Hence, studies on the impacts and potential new ways to implement regulation, such as the ones incentivizes by Canada's Centre for Regulatory Innovation are relevant to establish causality and deeper understanding on the potential of this instrument.

Comment: The World Intellectual Property Organization (WIPO) report on the Intersection of Intellectual Property Rights and Innovation Policy Making – A literature review offers a thorough analysis of the influence of IPRs as a policy instrument. On another topic, the massive increase on the use of data to inform business intelligence, policy and decision making process and others has highlighted the need to debate the regulation on the use of personal data by businesses and governments, as well as the guaranteeing of the appropriate IT infrastructure to comply with these rules. In the past year, the development of Covid-19's vaccines and their distribution worldwide has generated important reflections on the role of IPRs in fast-tracking innovation and the concomitant need to account for equity when distributing the benefits of research.[78]

Important landmarks in the world of regulation include the Bayh-Dole Act of 1980 in the USA is an important milestone for universities, small-businesses and non-profit institutions to retain the tiles of their publicly-funded-research and more recently the UK Patent Box tax exemption regime that aims at creating a more competitive tax environment for companies to develop and exploit patents in the UK.

Further reading:

- The influence of regulations on innovation: A quantitative assessment for OECD countries ($ - behind paywall)
- Canada's Centre for Regulatory Innovation supports the development of new and emerging products

Canadian Equivalent/Example:

- Innovative Asset Collective (IAC)
- Intellectual Property in Ontario's Innovation Ecosystem

[78] The articles "*The IP Waiver for COVID-19: Bad Policy, Bad Precedent*", "*The world leaders could end the pandemic, but they are failing us*", "*Can patents deter innovation? The Anticommons in Biomedical Research*" and "*Vaccine inequity undermining global economic recovery*" propose interesting readings on the topic.

25. Public procurement for innovation

Description: Public procurement for innovation can be defined as 'purchasing activities carried out by public agencies that lead to innovation' (Edler et al.). In fact, 'public procurement' itself is an established worldwide government activity. But in recent years, many governments have started to incorporate the 'innovation' dimension as another policy tool to push for innovative activities, based on the rationale that public procurement can act as a *lead user* in the market, assuming the risks of the initial use of a product or service. They can be designed to procure solutions for the government itself or by other end users, and each one of them offers different opportunities and challenges. In the first case, they are more likely to use existing technologies to solve issues related to the internal management of government itself (direct policy). In the second, they aim at unlocking and incentivizing markets that do not yet receive sufficient traction from the market (catapult policy). Other terms to refer to these policies are "innovative procurement" and "procurement of innovation".

Primary goal: Push innovation by incorporating innovation as a requirement for public procurement processes.

Secondary goal: Embed innovation as the default practice for public procurement.

Policy characteristics: There is still little consensus on the characteristics of this type of policy in the innovation policy literature and practice. This is the case because different countries have incorporated such tools with very different weights to their own innovation strategies – such as China aggressive investments in these policies[79] and other countries adopting a 'no policy' policy, based on premise of a perfect competition market.

Do they work?: In this case, the evidence on its effectiveness is limited because the definition of such policies is still missing, hard to find practical consensus about the definition of such policies, boundaries blurred with others such as regular procurement.

Comment: A constant impasse of public procurement tools for innovation is the fact that public procurement tends to be highly risk averse, and to strive for the rational and responsible use of taxpayers' money. These barriers are difficult to overcome due to the strong tendency to value price over quality in public procurement, the high level of scrutiny to which policymakers are subjected and the different control mechanisms to avoid conflicts of interest between buyers and sellers in public-private interactions. On the direct policy side of public procurement for innovation, some recent experiments have tried to lower the hurdles between government and potential suppliers of innovative solutions for public management, by creating 'GovTech' laboratories, such as the UK's GovTech Catalyst and the Brazilian BrazilLAB. These arrangements are focused in solving government problems that can span from the management of public services to wider society problems. They tend to have a strong focus on generating solutions for social impact. Although these mechanisms

[79] *Chapter 7* of the Public Procurement for Innovation book brings the Chinese case of use of PPI to boost the country's new energy vehicles program.

are still at a very early stage of implementation, they are an idea of a framework to open dialogue and align expectations and processes between procurers and suppliers.

Further reading:

- Public Procurement for Innovation – Good Practices and Strategies
- Public Procurement for Innovation – Eu-SPRI Forum on Science, Technology and Innovation Policy series ($ - behind paywall)
- Green Paper: Transforming Public Procurement[80]
- GovTech and Government: a new partnership
- Buying with Intent: Public Procurement for Innovation by Provincial and Municipal Governments (University of Calgary, 2020)

Canadian Equivalent/Example:

- Supply Chain Ontario on Innovation Procurement
    - REACH (Resources for Evaluating, Adopting and Capitalizing on Innovative Healthcare Technology)
    - AdvancingHealth
    - AdvancingEducation
    - MaRS Innovation Partnership: Procurement by Co-Design

[80] The section "Innovation in Procurement" brings policy rationales for incorporating an innovation dimension to public procurement and reflections on the necessary measures to make the change from traditional to innovation-friendly public procurement.

26. Pre-commercial procurement

Description: Pre-commercial procurement (PCP) is a public policy instrument that encourages innovation by offering financial resources and clear definitions on the scope and objective for SMEs to carry out Research and Development activities. They are usually taken as a demand-side innovation policy, but there are reasonable arguments to also understand them as a supply-side policy as they also aim at creating conditions for new technology development since ideation phase together with technology creators (the SMEs). The two paramount examples of these policies are the US Small Business Innovation Research Program (SBIR) and its British equivalent UK SBIR. More recently, the European Union has also invested more attention and resources to this type of schemes, usually promoting them side by side with PPI schemes as the two sides of the concept of Innovation Procurement, with some of the European countries also having their SBIR-like models, such as the Dutch SBIR Innovation competition.

Primary goal: Stimulate R&D by partnering up with SMEs to develop technologies not yet existent under the guidance of a federal/public need; Create technological solutions to social problems that require policy intervention.

Secondary goal: Reduce barriers for SMEs to innovate, build innovative capacity in a national innovation system, de-risk initial investment in new technologies.

Policy characteristics: PCP is usually defined by the partnership between government and SME in the ideation, development, and prototype building of solutions to societal challenges. They are usually implemented in a diffuse manner through various government agencies that define their own needs and requirements for the solution they target and work alongside companies in building these solutions.

Do they work?: There is strong reasons to believe that PCP programs, at least in how they are conceived in the US and in the UK, work. The publication by the National Academies Press, "An Assessment of the SBIR Program" provides valuable insight on the lessons learned by US policymakers with the implementation of these instruments, as well as its UK version.

Comment: More recently, the US SBIR has adjusted its narrative to feature the program as 'seed capital' for small businesses, incorporating the term that has become more mainstream in the innovation sector. Apart from that, other policy goals have been incorporated to the program, such as encouraging the participation of women and socially underprivileged groups in such programs.

Further reading:

- One bright idea that could transform innovation in Australia

- US Small Business Administration Full Presentation on Small Business Innovation Research Program[81]

Canadian Equivalent/Example:

- ISED Innovative Solutions Canada - Testing Stream for Government (formerly Build in Canada Innovation Program (BCIP) https://www.ic.gc.ca/eic/site/101.nsf/eng/00134.html).
- Made in Saskatchewan Technology Program (MIST).

[81] This presentation offers a hands-on guide on how the SBIR actually works.