

**Accelerating Clean Innovation in Canada's Energy and Natural Resource Sectors – The Role of  
Public Policy and Institutions**

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## Key Messages

- Promoting clean innovation is a growing policy priority given the need to promote greener growth in a way that builds on the natural resource and knowledge-based nature of Canada's economy. Government has an important role to play in fostering clean innovation: both to correct market and system failures, and to strategically leverage the efforts of private actors in this emerging area.
- The academic literature includes a variety of different perspectives on innovation, which offer distinct policy insights. A pipeline model counsels both supply-push policies like R&D spending and demand-pull policies like carbon taxes. Systems approaches add insights on the importance of sharing knowledge through networks, analyzing the structural environment that impedes innovations, and promoting a diversity of technological niches. Evolutionary economic geography adds a spatial perspective, which can be critical to policymakers concerned with issues of regional prosperity and competitiveness.
- Canada performs well compared to the rest of the world on general innovation drivers due to a high quality university system and entrepreneurial aspirations. It has also developed a cadre of smaller clean technology companies judged to have high innovative potential. Canada falls short in the commercialization and deployment of technologies and the creation of policies specifically targeted to the needs of clean technology sectors. These shortcomings appear to be leading to a truncation of Canada's clean technology sector.
- Clean innovation offers significant opportunities for Canada's energy and natural resource sectors, both to meet growing market demand for environmental performance and to generate innovative products and processes that could be valuable – both for them and other sectors – in the emerging low carbon global economy.
- A more targeted policy strategy that avoids the dangers of “picking” undesirable technology paths will require both strategic policy decisions by government, and more effective public institutions to ensure policies are effectively implemented, evaluated, and adjusted based on regional and sectoral requirements. Such approaches are often referred to as *diagnostic monitoring*, where governments support a portfolio of projects or experiments and continuously detect and correct errors in light of experience.
- Boosting clean innovation will require not only well-designed policies but also a suite of organisations to support innovation. This includes the creation of institutions focused on scaling up clean technology companies by offering financing and market supports, organizations focused on innovation experiments, and intermediary organizations making new connections between innovation actors.
- Future research priorities include: the collection of better data; ongoing analysis of Canada's potential clean innovation strengths; studying the design and mix of policies to boost clean innovation and remove impediments; and examining how the public sector can be designed to promote experimentation and to value critical, but less tangible, innovation activities.

## **Executive Summary**

There is a growing interest in developing a more robust clean innovation framework in Canada. The federal and provincial governments have committed to increasing investment in this area, and the March 2016 First Ministers meeting struck a working group on “clean technology, innovation, and jobs”.

This report undertakes a review of existing knowledge within Canada and internationally to answer three questions. First, how do we understand innovation and what are the analytical frameworks that guide innovation policy? Second, what is unique about the Canadian context and what are the country’s strengths, weaknesses, and opportunities? This includes considering the role of Canada’s natural resource sectors in clean innovation. Third, what policy actions can accelerate clean innovation and what types of policy structures should be created?

### ***Innovation Perspectives***

The report discusses three conceptual models and their different policy implications: the linear/pipeline model, systems approaches, and evolutionary economic geography perspectives. We consider the implications for “clean innovation”, which are changes linked to reducing environmental impacts or improving environmental outcomes.

The linear or pipeline model views innovation as a series of sequential stages from basic research to commercial entry. Public policies can seek to provide a supply-push to innovation by promoting research, development and demonstration, which helps correct market failures associated with incomplete internalization of knowledge spillovers. Public policies can also seek to provide demand-pull for innovation by introducing policies such as carbon pricing or renewable energy standards. These policies help correct environmental externality market failures whereby environmental costs are not reflected in prices. The literature within this framework suggests both supply-push and demand-pull policies are needed. While demand-pull helps provide stimulus for market adoption, supply-push policies are needed to direct technological change trajectories, increase knowledge spillovers which could be substantial, and avoid premature lock-in within a given technology.

The systems of innovation perspective highlights the importance of interactions between different innovation actors such as users and producers. It views economic development as an evolutionary process driven by innovations that produce a diversity of new options/developmental potentials and a structural environment that selects against these innovation options. This process of diversity generation and selection generates different innovation trajectories. These perspectives highlight *systems failures* that relate to problems with the direction created by innovation searches and structural impediments. Systems failures can include social networks that are too closed or disconnected and institutional failures related to financial, educational, and regulatory systems. Policies to alleviate systems failures often need to be tailored to innovation gaps or weaknesses in particular sectors and technological areas.

Evolutionary economic geography perspectives highlight innovation as a spatial process. Innovation is geographically rooted because specific places can have the right configuration of social, institutional, and political factors for a technology to evolve, or access to relevant

knowledge inputs from the global environment because of cognitive, organizational, or social proximity. Evolutionary economic geography perspectives counsel policymakers to avoid regional lock-in within industries inconsistent with a decarbonized and sustainable economy, and also highlight the variety of horizontal linkages between old and new sectors that could promote new economic pathways.

It is widely accepted that government has an important role to play in advancing clean innovation – both to address underlying market and system failures, and to strategically intervene in ways that support and catalyze private efforts in this emerging area.

### ***Canada's Clean Innovation Context***

There are signs of a trajectory towards clean innovation in Canada. Environmental patents are growing faster than the average rate of patenting and employment in clean technology companies is growing faster than the rest of the economy. However, Canada's growth in clean technology development is failing to keep up with the global economy.

Comparisons with the rest of the world demonstrate that Canadians perform well in general innovation drivers due to a high quality university system and entrepreneurial aspirations. Canada has also developed clean technology companies judged to have high innovative potential. Despite Canada's high potential it performs poorly in actually commercializing or scaling-up and deploying clean technologies. This means Canada is not reaping environmental benefits from its research and inventions. The lack of scale-up and deployment is demonstrated by a clean technology industrial structure made up of smaller, older, and R&D intensive firms. A reason for the truncated state of Canada's clean technology industry could relate to the lack of policies specifically targeted towards the sector, in comparison with other countries. These issues resemble the general innovation policy discussion where experts are increasingly questioning the policy emphasis on non-targeted measures such as tax credits rather than sector specific interventions.

Clean innovation policy in Canada should include a significant focus on natural resources and energy, which are key parts of Canada's economy. Clean innovation is critical for this sector to meet the growing market demand for improved environmental performance while maintaining cost competitiveness, and to help Canada meet its global climate commitments. Moreover, since most innovation springs from areas of existing expertise and focus, Canada's strength in resources offers tremendous opportunity to develop innovations that boost that sector's own competitiveness – in a global economy with increasing emphasis on resource efficiency and clean performance – and also generate spin-off innovations that are valuable to other parts of the economy. Both Canadian and international literatures point towards the need to consider linkages between natural resource sectors and a greener economy. Some Canadian resource sectors are already moving in this direction. For instance, the forestry sector is exploring the creation of light-weight composites for automobiles and bio-plastics. Governments, working with private actors, might consider more actively searching out areas where natural resource sectors can advance and complement clean innovations, and where the clean technology sector can be linked more directly to support the sustainable growth of energy and natural resource industries across Canada.

### ***Policies and Institutions***

A sustainability transition will need to involve multiple producers and users as well as a diverse array of technologies and new social practices. This makes the policy model more complex than projects focusing on creating a single technological breakthrough, or with a single technology buyer. Policies to accelerate clean innovation in energy and natural resource sectors in particular will need to be targeted towards the specific problems encountered by certain sectors and technological areas within diverse regional contexts, while supporting a variety of technologies to guard against uncertainty.

A targeted policy strategy that avoids the dangers of following undesirable technology paths will be part of this process. While some studies have sought to identify Canadian clean innovation strengths, they have been one-off and inconsistent. Designing innovation policies and institutions using a diagnostic monitoring approach to continuously re-examine technological choices with new insights from on the ground experience could assist policymakers.

A clean innovation policy framework needs to be highly adaptive, tailored to sectoral and regional contexts, and comprehensive – supporting all innovation functions across the entire innovation pipeline. Research has identified key attributes of effective clean innovation policies, e.g. stringent, predictable and flexible. Of equal importance, policy design strategies should focus on the suite of *institutions* required to support innovation – the main focus of this paper.

Given the scale-up challenge Canada might consider creating an organization that would help finance developments beyond the demonstration stage and be tailored to clean technology needs and risk profiles. Governments can also promote the scale-up of companies and deployment of new technologies through public administration reforms that better support green public procurement and export promotion. While a focus on scale-up is crucial, a policy framework cannot neglect the need to continuously produce a variety of new technological and social options to support greener growth. The creation of technological diversity will ensure scale-up organizations have good options from which to choose. Canadian policymakers might therefore also consider creating an innovation agency tasked with promoting experiments linked to the anticipated Canadian demands in a low-carbon economy.

There is also a critical role for *intermediary organizations* whose primary function is to create new connections between innovation actors such as users and producers, experts and entrepreneurs in different sectors. These organizations can help explore different innovation pathways, and might be particularly important to exploring clean innovation opportunities involving natural resource sectors.

Key areas for future research include: producing better quality data to track clean innovation; supporting ongoing analyses of innovation strengths, opportunities, and gaps (including in resource sectors); examining the extent to which clean innovators use existing government programs, and how they can be improved; exploring the mix and design of policies best suited to advance clean innovation and remove impediments; examining institutional configurations in Canada's regionally diverse federation; and developing new public administration structures and practices capable of catalyzing critical innovation processes such as knowledge exchange, visioning, and experimentation (which must accept openness to failure).