A Green Entrepreneurial State as Solution to Climate Federalism

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INTRODUCTION

Federalism presents a political challenge for Canadian climate change policy. In the wake of participating in international climate negotiations in Paris, Canadian Prime Minister Justin Trudeau has promised to negotiate with the provinces to produce a new climate plan for Canada.[1] If history is any guide, the discussions among the provinces will face many of the same challenges as the negotiations among countries at the international level.[2] Disagreements occur among the provinces because the federation's energy systems are regionally diverse—based on different natural resources such as oil, coal, and hydroelectricity with different carbon intensities. Previous attempts to reach Canadian agreements have stalled as provinces argue over how to share the "burden" of greenhouse gas reduction goals.[3]

The recognition that regional diversity complicates Canadian climate policy has led economic policy experts to modify proposals for "market-based" climate policy instruments. Most prominently, the 2015 Ecofiscal Commission recommended that provinces design carbon pricing systems to fit their own realities.[4] Likewise, Prime Minister Trudeau did not commit to implementing a national carbon price in the 2015 federal election, suggesting that provinces should be given flexibility to design their own carbon pricing policies.[5]

A uniform federal carbon price faces political challenges because it has different economic consequences for Canada's diverse energy systems. However, as noted by political scientist George Hoberg, regionally segmented carbon pricing "blinds us [to] the obvious merits of federal leadership" and will produce uneven economic incentives and fairness concerns because emitters could end up paying significantly different prices to pollute across provincial borders.[6] Moving away from national carbon pricing could make it less effective, but some are convinced this is the second best policy path given Canada's potential for regional political conflict.

1 James Fitz-Morris and Catharine Tunney, "Justin Trudeau Promises 'Canadian Approach' to Climate Change," *CBC News*, November 23, 2015, http://www.cbc.ca/news/politics/trudeau-first-ministers-meet-climate-change-1.3331290

2 The Paris agreement has been celebrated as a success, as the nations of the world will seek to limit global temperature increases to 1.5 degrees Celsius. However, the agreement lacks both financial commitments and country-level targets consistent with meeting this goal. The Paris agreement is seen as a breakthrough, despite its obvious deficiencies, because of the difficulty in reaching any international agreements.

3 See Mark Winfield and Douglas Macdonald, "Federalism and Canadian Climate Change Policy," in *Canadian Federalism: Performance, Effectiveness, and Legitimacy*, 3rd ed., ed. Herman Bakvis and Grace Skogstad (Don Mills, ON: Oxford University Press, 2012), 241–60.

4 Chris Ragan et al., "The Way Forward" (Ottawa: Canada's Ecofiscal Commission, 2015).

5 See "Remarks by Liberal Party of Canada Leader Justin Trudeau at the Canadian Club of Calgary on February 6, 2015," https://www.liberal.ca/justin-trudeau-pitches-medicare-approach-to-fight-climate-change-in-canada

6 George Hoberg, "Lament for a Nation – The Climate Version," GreenPolicyProf, 2015, http://greenpolicyprof.org/wordpress/?p=1079

This paper argues that Canada should look beyond "market-based" climate strategies to resolve climate federalist challenges. A policy mix more targeted towards specific technology systems can tailor approaches to Canada's different regional circumstances and is thus best suited to grapple with Canada's regional political reality. Rather than weakening carbon pricing proposals or opening up a new round of debates on emissions reduction "burdens," the federal government should aim to turn regional diversity into a strength by creating a uniquely Canadian version of a *Green Entrepreneurial State*.

This essay will start by introducing the concept of the Entrepreneurial State, which explains the government's role in recharging and redirecting innovation. The second section will examine how Canadian governments have succeeded or neglected to play this entrepreneurial role in the energy sector, and will discuss the current innovation direction promoted by Canadian policies. The next sections will explain why market-based climate policies are insufficient, and why regional low-carbon innovation pathways could help create both the political and economic momentum needed for Canadian climate policy to succeed. The paper will conclude by discussing the role of a uniquely Canadian version of the Entrepreneurial State aiming to catalyze low-carbon innovation and turn Canada's regional diversity into an asset.

THE ENTREPRENEURIAL STATE AND GREEN INNOVATION

Mariana Mazzucato introduced the concept of the Entrepreneurial State.[7] One key message is that governments play a fundamental role in changing economies by promoting innovation. Innovation refers to the process of putting a new idea into practice.[8] It includes the creation of new technologies, the diffusion of existing technologies, and social and organizational changes. Innovations can lead to changes in economic structure, and can redirect social and technological evolution.[9]

Today, we find ourselves locked into a carbon-intensive economic structure because of the diffusion of previous innovations such as the automobile, oil refining, and business strategies promoting mass consumption.[10] To escape from "carbon lock-in," we need a *Green Entrepreneurial State* directing innovation towards reducing greenhouse gas emissions.[11]

Mazzucato shows that governments play a fundamental role in changing economic direction by *creating* and *shaping* markets. Governments have created new markets based on sectors such as information technology, nanotechnology, and clean technology by mobilizing public investment and public organizations to explore innovations that the private sector found too risky. The government takes on risks at research and development stages, and at stages of technological diffusion by supporting manufacturing and commercialization.

The state also shapes markets because of the numerous roles it plays in the economy. Governments influence the direction of innovation when they manage training and educational institutions, produce information, set regulations, supply funds (with conditions attached), purchase goods and services, and sets targets. Governments—including Canadian governments—have played an entrepreneurial role throughout history, yet this role is infrequently acknowledged.

7 Mariana Mazzucato, *The Entrepreneurial State: Debunking Public vs. Private Sector Myths* (London: Anthem Press, 2013).

8 Jan Fagerberg, "Innovation: A Guide to the Literature," in *The Oxford Handbook of Innovation*, ed. Jan Fagerberg, David C. Mowery, and Richard R. Nelson (Oxford: Oxford University Press, 2005), 1–27.

9 Chris Freeman and Luc Soete, *The Economics of Industrial Innovation, Third Edition* (Cambridge: MIT Press, 1997).

10 Christopher Freeman, *The Economics of Hope: Essays on Technical Change, Economic Growth, and the Environment* (London; New York: Pinter Publishers; Distributed exclusively in the U.S. and Canada by St. Martin's Press, 1992); Brendan Haley, "From Staples Trap to Carbon Trap: Canada's Peculiar Form of Carbon Lock-In," *Studies in Political Economy* 88 (2011): 97–132.

11 Gregory C. Unruh, "Escaping Carbon Lock-In," *Energy Policy* 30, no. 4 (2002): 317–25; Mariana Mazzucato, "The Green Entrepreneurial State" (SPRU Working Paper, 2015).

THE DIRECTION SET BY CANADIAN ENERGY INNOVATION PRIORITIES

Two Cases in Canadian Energy Innovation History

In Canada, our most impressive energy innovation came from governments acting as entrepreneurs, and some of the biggest missed opportunities occurred when governments neglected to play their role in promoting innovation.

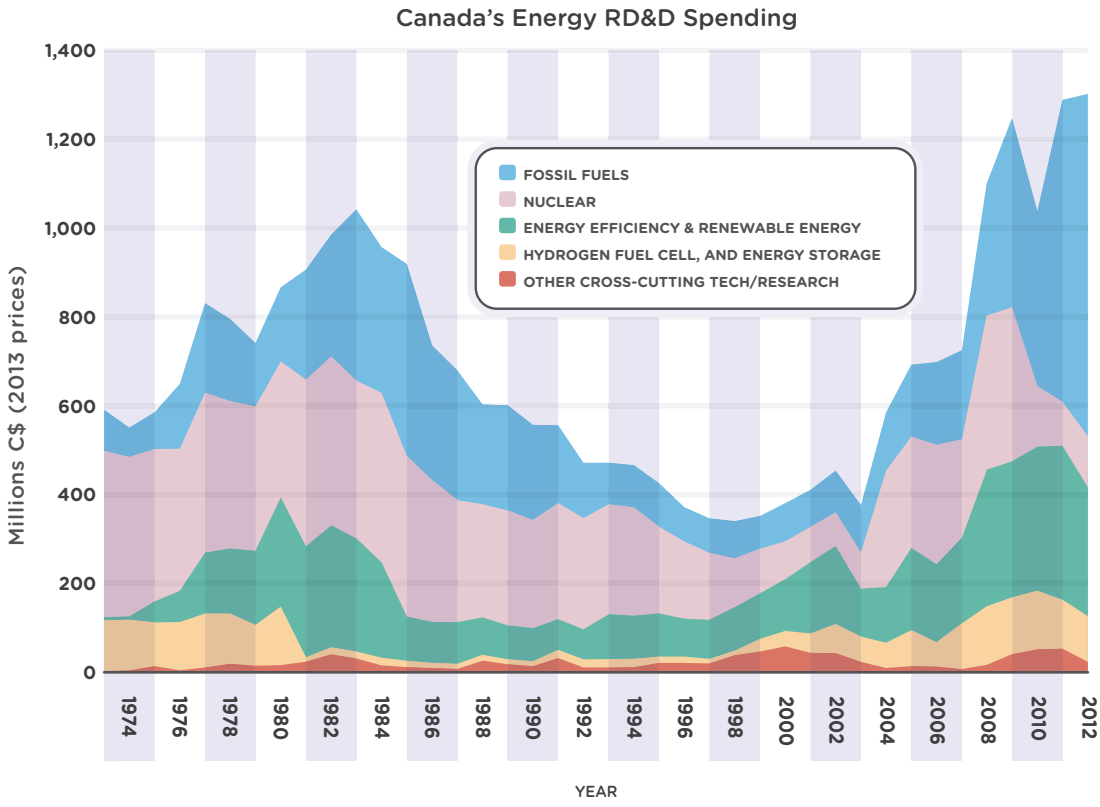
Figure 1 shows the direct investments of Canadian federal and provincial governments in energy research, development, and demonstration activities (RD&D). Canada's energy RD&D efforts have fluctuated over time as the political economy of energy has changed. Spending increased in the 1970s and early 1980s in response to the energy crisis. It was during this period that Canada launched a mission to accomplish one of its most impressive technological feats—extracting oil from sand.

In 1974, the Alberta government created the Alberta Oil Sands Technology and Research Authority (AOSTRA), a crown corporation tasked with developing technologies to extract unconventional oil deposits. The Steam Assisted Gravity Drainage (SAGD) technology evolved over decades with government support for pilot plants and early commercial-scale plants. In the mid-1990s, the Alberta government introduced an attractive royalty regime for unconventional oil and worked with industry and the federal government to create a "collaborative alliance" to grapple with sector-specific issues. This consistent support for the technology created the potential for bitumen sands production to expand rapidly when oil prices started to increase in the 2000s.[12]

The oil sands provide an example of government setting a mission and taking on many of the risks of R&D, as well as early manufacturing and commercialization, and then shaping the environment for the technology through regulatory changes and partnerships with the private sector. This is an example of the government acting as an entrepreneur.

12 See Larry Pratt, The T*ar Sands: Syncrude and the Politics of Oil* (Edmonton: Hurtig, 1976); Tony Clarke, *Tar Sands Showdown: Canada and the New Politics of Oil in an Age of Climate Change* (Toronto: J. Lorimer & Co., 2008); Clare Demerse and Dan Woynillowicz, "A New National Prize: Making Clean Energy the Next Oil Sands," *Policy*, 2014, http://policymagazine.ca/pdf/9/PolicyMagazineSeptember-October-14-DemerseWoynillowicz.pdf

Figure 1[13]



RD&D in energy efficiency and renewable energy technologies also increased in reaction to the 1970s energy crisis. A variety of technologies were supported and Canada achieved some technological feats. The Science Council of Canada, a federal government advisory board, was promoting a "Conserver Society" agenda.[14]

In 1977, researchers from the National and Saskatchewan Research Councils built the "Conservation House" in Northwest Regina. This house achieved dramatic efficiency improvements through superinsulation and other novel design features and eliminated the need for a conventional heating system. However, this pilot project did not receive the same level of consistent support as the bitumen sands technologies. The initial success of the Conservation House was not followed up with further demonstration, labour-market development, supply chain

13 Source: International Energy Agency, RD&D Statistics.

14 Science Council of Canada, "Canada as a Conserver Society: Resource Uncertainties and the Need for New Technologies" (Ottawa, 1977).

coordination, and changes in codes and standards that would have helped diffuse these building practices. Another country benefited from Canada's innovation, as the demonstration attracted the attention of German building engineers. A German research institute focused on "passive house" design was created in 1996, and today the Germans have become leaders in this type of super-efficient construction.[15]

The contrast between the development of the bitumen sands and the Conservation House demonstrates that the larger policy context determines the ultimate success or failure of RD&D initiatives. The bitumen sands were supported throughout, while the Conservation House dwindled in Canada because governments failed to create and shape markets to further the green technology's evolution. The benefits of the initial RD&D investment were lost to another country. The Conservation/Passive House demonstrates what happens when Canadian governments neglect to play an entrepreneurial role.

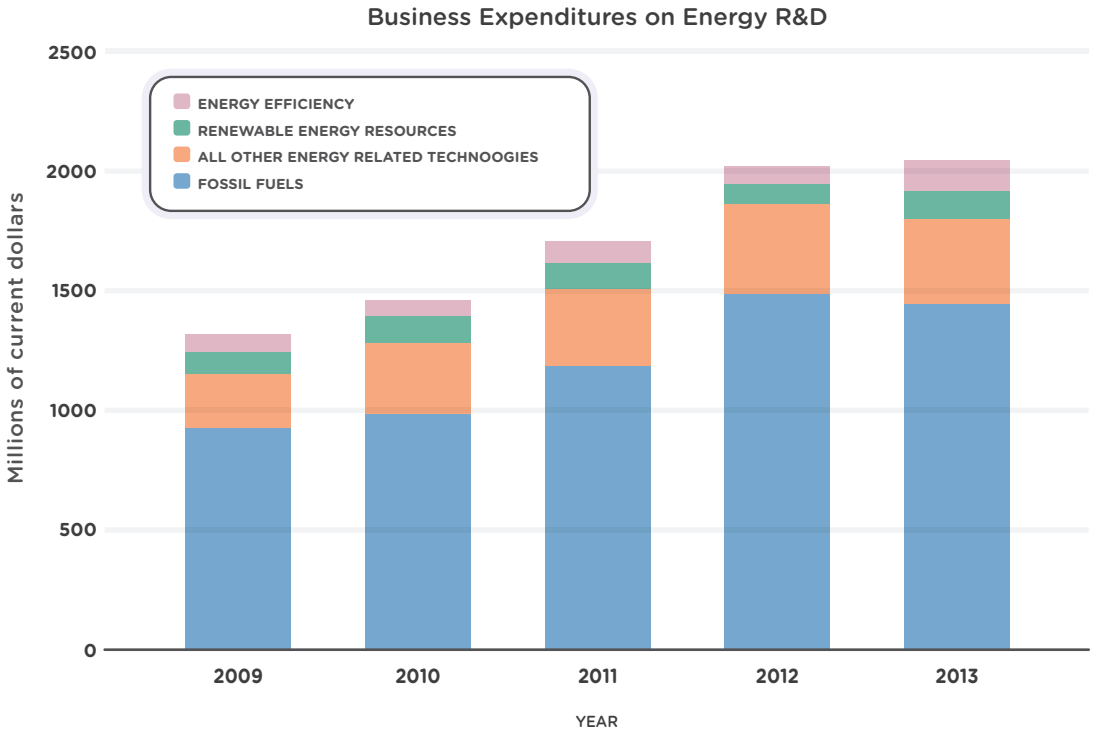
Are Canadian Governments Currently Playing a Green Entrepreneurial Role?

Are Canadian governments creating and shaping markets by developing new energy technologies today, and are the innovation directions they are promoting preparing Canada for a low-carbon transition? The mid-2000s saw another big increase in RD&D investments, much of it focused on fossil fuels. The fossil fuel portfolio is principally related to carbon capture and storage (CCS) and a technology to replace coal burning with a coal gasification process (integrated gasification combined cycle (IGCC)). Canada's business sector has also increased R&D spending on fossil fuels (Figure 2), principally in the "oil sands and heavy crude oil" category. Much of this research is aimed at improving operational efficiencies (reducing steam-to-oil ratios), which produces incremental environmental benefits because of reduced energy usage. Other investments are focused on attempting to clean up tailings ponds.[16]

15 Canadian Passive House Institute, "First Passive Houses," 2015, http://www.passivehouse.ca/first-passive-houses-2/; Passivhaus Homes, "History of Passivhaus," 2015, http://www.passivhaushomes.co.uk/passivhaushistory.html; Nichole Huck, "'Passive Home' Movement a Success in Germany, but Not in Saskatchewan Where It Started," CBC News, 2015, http://www.cbc.ca/news/canada/saskatchewan/passive-home-movement-a-success-in-germany-but-not-in-saskatchewan-where-it-started-1.3179851

16 See Council of Canadian Academies, "Technological Prospects for Reducing the Environmental Footprint of Canadian Oil Sands," http://www.scienceadvice.ca/en/assessments/completed/oil-sands.aspx

Figure 2[17]



These fossil fuel-based research priorities could yield environmental improvements, yet the innovation trajectory is incremental and motivated by the need to maintain market share. The bitumen sands have faced increasing scrutiny because of their impact on the environment. It is commonly accepted that reductions in carbon intensity and other environmental improvements are needed to increase the "social license" of the sector.[18] These fossil fuel-based technologies will help reduce carbon intensity, but they cannot eliminate emissions. Carbon capture and storage technologies within the bitumen sands are most applicable to the upgraders that help convert the heavy crude oil extracted into synthetic crude oil so it can be refined. CCS technologies could capture only 20 to 40 per cent of upgrader emissions.[19]

17 Source: CANSIM Table 358-0214, "Industrial energy research and development expenditures and extramural payments outside Canada, by area of technology." These data include in-house and outsourced R&D, as well as R&D by industrial non-profit organizations. Other energy-related technologies include nuclear fission and fusion; electric power; hydrogen and fuel cells; carbon capture; transport and storage related to fossil fuel production and processing; electric power production; and industry in the end-use sector, such as steel production, manufacturing, and energy system analysis.

18 See Sven Teske et al., "Energy [r]evolution: A Sustainable Energy Outlook for Canada" (Greenpeace Canada, European Renewable Energy Council, August 2010), 23–24.

19 Council of Canadian Academies, "Technological Prospects for Reducing the Environmental Footprint of Canadian Oil Sands," 172.

Carbon capture and storage as well as coal gasification could have a more significant emissions impact on coal-fired power plants. Saskatchewan is demonstrating CCS technology in a coal plant. Yet many provinces are reducing coal emissions in other ways, suggesting that different technological options might be more appropriate. Nova Scotia is using a combination of energy efficiency, domestic renewables, and hydroelectric imports. Ontario completely phased out coal and Alberta has announced a plan to do the same.

The prioritization of CCS and other fossil fuel-based low-carbon technologies, to the exclusion of other green energy options, could reinforce fossil fuel lock-in and lead to a technological dead end, where Canada is unable to reach the objective of full decarbonization. CCS is a "heavy technology" because it is capital intensive, has long lead times, is large scale, and requires the installation of elaborate infrastructures for transport and storage of carbon dioxide.[20] If the CCS technology fails to perform, it could make it even more difficult to transition away from fossil fuels.

The risk of fossil fuel lock-in can be reduced by promoting a *diversity* of other technological options.[21] It falls to the government to explore different technological paths, since Canada's incumbent energy players can be expected to focus on incremental improvements within the fossil fuel technological paradigm.

At the Paris climate conference, Canada pledged to double its investment in clean energy research, development, and demonstration, which holds the promise of making Canada's energy RD&D portfolio more diverse. This could add to the expenditures already being made on efficiency and renewable RD&D (most of it focused on biofuels over the last 10 years).

However, governments must not limit themselves to research and development. The lesson from the Conservation House example is that RD&D investments must be reinforced with a comprehensive policy framework to support technologies across all stages of innovation. Thus far, Canada has not created a mission-oriented approach to support a diversity of low-carbon technologies, and it is slipping in the international clean energy race. Analytica Advisors reports that the global market for environmental goods was close to $1 trillion in 2014, yet Canada's share

20 Simon Shackley and Michael Thompson, "Lost in the Mix: Will the Technologies of Carbon Dioxide Capture and Storage Provide Us with a Breathing Space as We Strive to Make the Transition from Fossil Fuels to Renewables?" *Climatic Change* 110, no. 1–2 (2011): 101–21; Philip Vergragt, "Carbon Capture and Storage: Sustainable Solution or Reinforced Carbon Lock-In?" in *Governing the Energy Transition: Reality, Illusion or Necessity?*, ed. Geert Verbong and Derk Loorbach (New York: Routledge, 2012), 101–24.

21 Jeroen van den Bergh et al., *Evolutionary Economics and Environmental Policy* (Northampton: Edward Elgar, 2007).

of the global manufactured environmental goods market has declined by 41 per cent since 2008.[22]

Limiting Canada to an energy technology trajectory largely focused on making incremental improvements to fossil fuel systems could result in a dead end and leave the country vulnerable in the event of a shift towards a green economic paradigm globally.[23] Canadian governments should not only be seeking to maintain existing market shares for fossil fuels by reducing carbon intensity, but should also be preparing Canada to participate in a green industrial revolution. This requires an Entrepreneurial State because the private sector in Canada has yet to direct its resources towards exploring alternative technology paths. Governments taking on an entrepreneurial role would implement policies to create both economic and political momentum for low-carbon innovations in Canada.

22 Analytica Advisors, "2015 Canadian Clean Technology Industry Report (Synopsis)" (Ottawa, 2015).

23 See Haley, "From Staples Trap to Carbon Trap: Canada's Peculiar Form of Carbon Lock-In."

CREATING ECONOMIC MOMENTUM THROUGH MARKET-BASED AND INNOVATION-BASED CLIMATE POLICIES

Contemporary policy ideologies can restrict governments from creating enough economic momentum to transition to a low-carbon economy. As Mazzucato argues, the scope of government action is often limited to fixing "market failures."[24] This fixing role suggests that the direction of economic change supported by markets is desirable, and that governments should simply intervene to reallocate resources.[25]

Translated to climate policy, this idea calls for a carbon price to make businesses and consumers pay the cost of pollution. While market-based policies like a carbon price have their strengths and should play a prominent role, these approaches are inadequate because the price system only partially influences green innovation. Innovation is a social and organizational process in addition to being a process influenced by markets. The multidimensional nature of innovation requires the use of a more comprehensive suite of policy tools to redirect social and technological systems towards a green economic future.

The exchange of knowledge that contributes to learning is a fundamental innovation process that is mediated through organizations and social networks, rather than markets. Bengt-Åke Lundvall calls innovation a process of "interactive learning," emphasizing how networks involving economic actors such as producers, users, government labs, and universities collaborate to create new products and processes.[26]

An example of how organizational structures facilitated interactive learning to develop a green technology comes from Denmark. Danish "wind group" meetings facilitated exchanges between wind users and manufacturers, which helped develop safer and more reliable turbines. This iterative, collaborative approach led to a turbine design that outperformed U.S. turbine models developed by aeronautical engineers.[27]

24 Mariana Mazzucato, "Building the Entrepreneurial State: A New Framework for Envisioning and Evaluating a Mission-Oriented Public Sector," Working Paper (Levy Economics Institute, 2015); Mazzucato, *The Entrepreneurial State: Debunking Public vs. Private Sector Myths*.

25 See William J. Baumol, *Welfare Economics and the Theory of the State*, 2nd edition (London: London School of Economics, 1965).

26 Bengt-Åke Lundvall, ed., *National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning* (London: Pinter Publishers, 1992).

27 Raghu Garud and Peter Karnøe, "Bricolage versus Breakthrough: Distributed and Embedded Agency in Technology Entrepreneurship," *Research Policy* 32, no. 2 (February 2003): 277–300; Linda M. Kamp, "Socio-Technical Analysis of the Introduction of Wind Power in the Netherlands and Denmark," *International Journal of Environmental Technology and Management* 9, no. 2/3 (2008).

There are also a series of formal and informal rules (what economists call "institutions"), such as regulations and standards, as well as cultural norms and habits, that can block or enable innovation. Energy efficiency provides an example of a low-carbon technology that faces institutional barriers. Energy efficiency options are already cost competitive with fossil fuels, yet energy savings opportunities remain unexploited.[28]

One reason efficiency opportunities are lost is that the regulation of energy utilities is geared towards increasing sales of kilowatt hours of electricity and cubic metres of natural gas, instead of selling energy services such as heat and light as efficiently as possible. In addition, energy planning has traditionally focused on supplying energy by purchasing fuel, power plants, and infrastructure instead of looking to curb demand to avoid these expenses.

Governments can encourage robust energy efficiency strategies by creating specialized energy efficiency agencies, decoupling utility revenues from sales, and mandating that utility regulators consider energy efficiency programs before approving new energy supply projects.[29] Efficiency provides an example where government actions that change institutional rules and organizational structures have potentially greater impact than making efficiency even more cost competitive through a carbon price.

A host of other social, organizational, and market-based processes determines whether a given technology succeeds or fails to develop. Other factors that influence innovations include the availability of financial capital, human resources and skills, and physical infrastructures.[30]

An Entrepreneurial State would use a comprehensive mix of policy tools to target the multiple factors that influence green innovations. A list of innovation policy actions could include building up new networks of public and private organizations to facilitate knowledge exchange;[31] changing regulations and standards;[32] introducing feed-in tariffs and public procurement systems to create niche

28 See International Energy Agency, "Energy Efficiency Market Report 2013."

29 See Brendan Haley, "Energy Not Wasted: The History of Efficiency Nova Scotia," *Between the Issues*, 2014; Maggie Molina and Marty Kushler, "Policies Matter: Creating a Foundation for an Energy-Efficient Utility of the Future" (American Council for an Energy-Efficient Economy, 2015); Regulatory Assistance Project, "Revenue Regulation and Decoupling: A Guide to Theory and Application," 2011.

30 A good review of innovation barriers can be found in Simona O. Negro, Floortje Alkemade, and Marko P. Hekkert, "Why Does Renewable Energy Diffuse So Slowly? A Review of Innovation System Problems," *Renewable and Sustainable Energy Reviews* 16, no. 6 (2012): 3,836–46.

31 Andrew Schrank and Josh Whitford, "The Anatomy of Network Failure," *Sociological Theory* 29, no. 3 (2011): 151–77.

32 Chris P. Knight, "Failure to Deploy: Solar Photovoltaic Policy in the U.S.," in *State of Innovation: The U.S. Government's Role in Technology Development*, ed. Fred Block and Matthew R. Keller (Routledge, 2011).

markets for new technologies;[33] creating mission-oriented agencies to support technologies across all stages of innovation;[34] and creating development banks to provide patient capital to help manufacture and deploy green technologies.[35]

When and how to use this more comprehensive list of policy tools requires a thorough knowledge of particular technological barriers and opportunities. Thus, innovation policies need to be highly tailored to particular technologies and sectors. Innovation policies are "technology-specific," which distinguishes them from market-based policies that claim to be "technology neutral" because they are limited to sending broad signals across the economy.[36]

Carbon pricing is insufficient not only because it fails to change many of the factors that influence the development of a particular technology, but also because it does a poor job of promoting a diversity of technologies. The implicit model of a low-carbon transition driven by carbon pricing foresees technologies developing one after the other—the lowest cost first, followed by the next-lowest cost, and so on.[37] This means the market model "picks" a certain technology and neglects the other technologies until prices send the right signals.

The problem with this sequencing pattern is that it is unlikely to develop a sufficient number of clean technologies in the time required. It can take more than 20 years for energy technologies to pass through formative phases of development, and diffusion can take just as long.[38] Given the need for multiple technologies to create a green paradigm shift, we need more than market signals. Rather than developing technologies in sequence, a variety of technologies should be developed in parallel, with policy actions tailored to each technology's stage of development.

33 Miguel Mendonça, David Jacobs, and Benjamin Sovacool, *Powering the Green Economy: The Feed-In Tariff Handbook* (London: Earthscan, 2009); Charles Edquist et al., *Public Procurement for Innovation* (Cheltenham: Edward Elgar, n.d.).

34 Laura Díaz Anadón, "Missions-Oriented RD&D Institutions in Energy between 2000 and 2010: A Comparative Analysis of China, the United Kingdom, and the United States," *Research Policy* 41, no. 10 (December 2012): 1,742–56.

35 Mariana Mazzucato and Caetano C.R. Penna, "Beyond Market Failures. The Market Creating and Shaping Roles of State Investment Banks" (Working Paper, University of Sussex, Science Policy Research Unit, 2014), http://marianamazzucato.com/wp-content/uploads/2014/12/2014-21_SWPS_Mazzucato-and-Penna.pdf

36 For a critique of the technology neutrality claim, see Christian Azar and Björn A. Sandén, "The Elusive Quest for Technology-Neutral Policies," *Environmental Innovation and Societal Transitions* 1, no. 1 (2011): 135–39.

37 The following point is made by Staffan Jacobsson and Anna Bergek, "Innovation System Analyses and Sustainability Transitions: Contributions and Suggestions for Research," *Environmental Innovation and Societal Transitions* 1 (2011): 41–57.

38 Charlie Wilson, "Historical Diffusion and Growth of Energy Technologies," in *Energy Technology Innovation: Learning from Historical Successes and Failures*, ed. Arnulf Grübler and Charlie Wilson (Cambridge: Cambridge University Press, 2013), 54–74.

To create economic momentum towards decarbonization, both market-based policies that send broad signals across the economy *and* technology-specific policies that encourage particular innovation processes are required. Carbon pricing can help fix market failures and guide entrepreneurial searches towards lower-carbon options. Complementing carbon pricing with a more comprehensive mix of innovation policies is critical to alleviate the unique challenges faced by different technologies, and to develop a diversity of technologies in sufficient time.

CREATING POLITICAL MOMENTUM

Any policy agenda—whether based on market or innovation policy approaches—must consider how it can be implemented politically. Even if a carbon price could, by itself, trigger a low-carbon transition, it is not clear that the political conditions are present to implement it at sufficiently stringent levels. The highest carbon price in Canada is $30/tonne of emissions (in British Columbia, and scheduled to be implemented in Alberta in 2018). Yet to meet greenhouse gas (GHG) reductions consistent with targets informed by climate science, previous studies suggest carbon prices starting at $50/tonne and rising to $100 or $200/tonne by 2020 and $300/tonne by 2050.[39]

Carbon pricing faces a political challenge because while everyone will benefit from the incremental GHG reductions, these benefits are spread weakly across a large number of people, making it difficult to mobilize a supportive political coalition. While the benefits are diffuse, the costs can be quite concentrated on a few powerful carbon-intensive industries and other constituencies, which can more readily organize to resist policy actions.[40]

In Canada, the perceived costs of carbon pricing are quite focused in certain carbon-intensive regions (such as Alberta, Saskatchewan, and Nova Scotia) that are represented by provincial leaders who have traditionally "vetoed" more ambitious national climate policies.[41] Perhaps the core reason market-based policy approaches are insufficient is that they fail to develop political coalitions for stronger climate policy.

Canadian energy expert Ralph Torrie produced Figure 3 to explain the political barriers to low-carbon transitions. The horizontal axis represents a spectrum from political infeasibility (on the left) to political enthusiasm (on the right). The vertical axis represents the level of GHG emissions, from a low level of GHG reductions (at the bottom) to decarbonization (at the top). Torrie argues that the current policy menu becomes less politically feasible the more intensely it is applied to reduce GHG emissions. The carbon price falls into this problem of decreasing political feasibility. While a $30/tonne price might be politically possible, prices in the

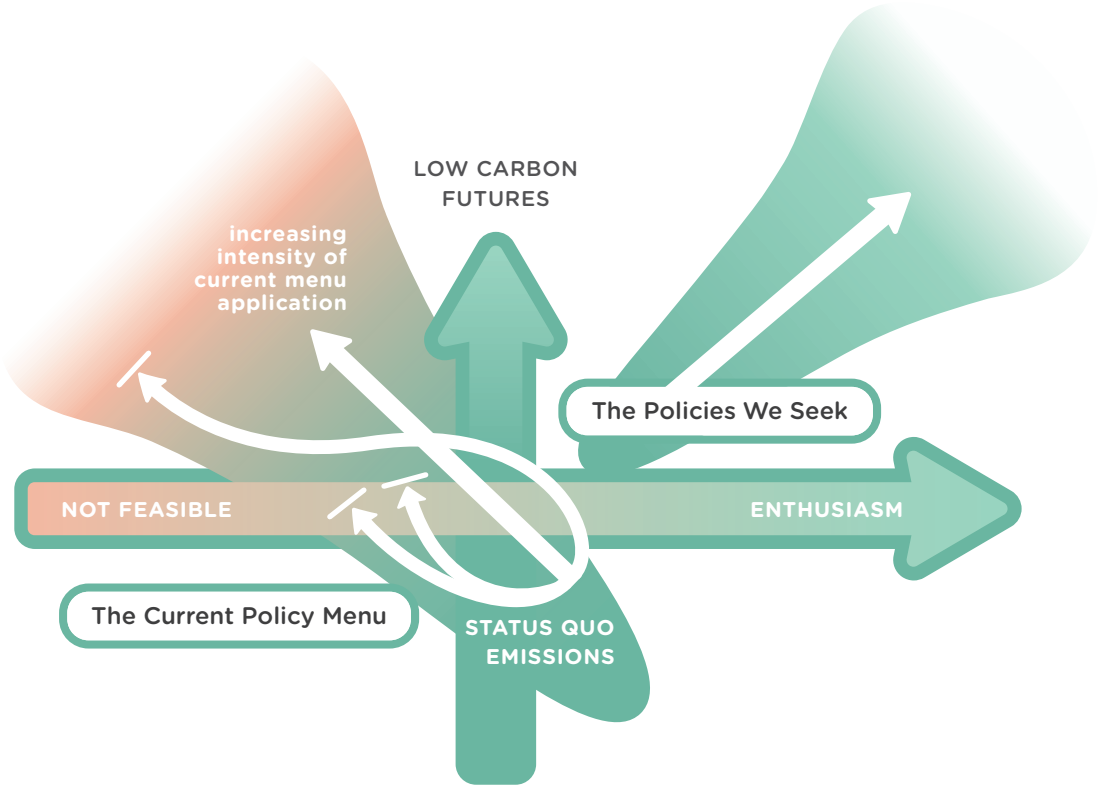
39 Matthew Bramley, Pierre Sadik, and Dale Marshall, "Climate Leadership, Economic Prosperity" (Pembina Institute and David Suzuki Foundation, 2009); NRTEE, "Achieving 2050: A Carbon Pricing Policy for Canada" (National Round Table on the Environment and the Economy, 2009), http://neia.org/wp-content/uploads/2013/04/carbon-pricing-advisory-note-eng.pdf

40 Jonas Meckling et al., "Winning Coalitions for Climate Policy," Science, 2015; Kenneth A. Oye and James H. Maxwell, "Self-Interest and Environmental Management," *Journal of Theoretical Politics* 6, no. 4 (1994): 593–624.

41 Winfield and Macdonald, "Federalism and Canadian Climate Change Policy."

hundreds of dollars are not seriously considered in political discourse.[42] The other line on the diagram shows that the policies we should be seeking are those capable of producing positive feedback between GHG reductions and political support.

Figure 3[43]



In contrast to market-based policies, more technology-specific green innovation policies have potential to encourage the creation of political coalitions, therefore producing positive feedback between policy implementation and political feasibility. These policies concentrate the attention of developers and users of specific technologies, who can more readily organize within industry associations or groups of users and investors.[44] Specific technologies can also produce benefits other than GHG reductions that build political momentum. For instance, we know that many people participate in energy efficiency programs not only to benefit

42 For a review of the politics of adopting the B.C. carbon tax, see Clare Demerse, "How to Adopt a Winning Carbon Price" (Clean Energy Canada, 2015).

43 From Ralph Torrie, "Reflections on Climate Change Response Policy" (Sustainable Canada Dialogues, 2015).

44 See John Zysman and Mark Huberty, *Can Green Sustain Growth?: From the Religion to the Reality of Sustainable Prosperity* (Stanford Business Books, 2013), http://www.sup.org/books/title/?id=22378; Michaël Aklin and Johannes Urpelainen, "Political Competition, Path Dependence, and the Strategy of Sustainable Energy Transitions," American Journal of Political Science 57, no. 3 (2013): 643–58.

the environment, but also to improve the comfort and performance of homes or businesses.[45] These co-benefits have the potential to create a political demand for more GHG reductions.[46]

"Technology-specific advocacy coalitions" played an important role in creating political momentum for Germany's energy transition.[47] RD&D projects created initial political coalitions that formulated visions of how renewables could play a prominent role in electricity generation. These political coalitions advocated for feed-in tariffs, which, once implemented, led to the creation of new investors and renewable energy-based firms and unions. This expanded political coalition was strong enough to resist attempts to roll back renewable energy supports and make the energy transition a mainstream political priority. While political battles over renewable energy are still present in Germany, this history provides an example of positive feedback between technology-specific policies and political coalition formation.

45 IEA, *Capturing the Multiple Benefits of Energy Efficiency* (International Energy Agency, 2014), https://www.iea.org/publications/freepublications/publication/capturing-the-multiple-benefits-of-energy-efficiency.html

46 See Anthony Giddens, "The Politics of Climate Change," Cambridge, U.K., 2009

47 Staffan Jacobsson and Volkmar Lauber, "The Politics and Policy of Energy System Transformation—Explaining the German Diffusion of Renewable Energy Technology," *Energy Policy* 34, no. 3 (2006): 256–76; Staffan Jacobsson and Anna Bergek, "Transforming the Energy Sector: The Evolution of Technological Systems in Renewable Energy Technology," *Industrial and Corporate Change* 13, no. 5 (2004): 815–49.

THE GEOGRAPHY OF INNOVATION AND IMPLICATIONS FOR CLIMATE FEDERALISM

Innovation is often a geographically specific process because institutional environments differ by region, and interactive learning processes can be very localized.[48] A technology can develop and diffuse in a certain place because that place has the right mix of factors to support it, such as specialized skills, research organizations, financial institutions, regulatory frameworks, and political legitimacy.

The types of technologies that have the greatest probability of evolving in a certain region are often linked to existing industrial structures.[49] For example, wind energy development in Denmark is linked to agricultural industries. The Danish developed turbines in the same way they developed farming machinery, and the agricultural industry developed co-operative organizations that facilitated community wind investments and knowledge exchanges between wind users and manufacturers.[50] These unique linkages with institutional environments and existing technology structures call for policies that are targeted to unique regional circumstances.

The fact that patterns of innovation are often linked to geography means that the technology-specific advocacy coalitions previously discussed are likely to also be regionally specific, which has implications for managing Canada's regional politics. Different political coalitions could develop based on different areas of regional low-carbon advantage and the diverse transition challenges faced by each province. A regional low-carbon innovation strategy in Alberta, for example, might seek to identify areas of overlap between the bitumen sands sector and green industries. Policy makers might explore whether the knowledge and skills in drilling and geological exploration developed from oil production could help create an enhanced geothermal industry,[51] or whether Alberta's combination of agricultural and oil refining capabilities could link up with bio-refining.

48 Lars Coenen, Paul Benneworth, and Bernhard Truffer, "Toward a Spatial Perspective on Sustainability Transitions," *Research Policy* 41, no. 6 (2012): 968–79; Bjørn Asheim and Meric S. Gertler, "The Geography of Innovation: Regional Innovation Systems," in *The Oxford Handbook of Innovation*, ed. Jan Fagerberg, David C. Mowery, and Richard R. Nelson (Oxford University Press, 2005), 291–317.

49 Frank Neffke, Martin Henning, and Ron Boschma, "How Do Regions Diversify over Time? Industry Relatedness and the Development of New Growth Paths in Regions," *Economic Geography* 87, no. 3 (2011): 237–65; Ron Boschma and Koen Frenken, "Technological Relatedness and Regional Branching," in *Beyond Territory: Dynamic Geographies of Knowledge Creation, Diffusion and Innovation*, ed. H. Bathelt, M. Feldman, and D. Kogler (London: Routledge, 2011), 64–81.

50 Garud and Karnøe, "Bricolage versus Breakthrough."

51 See the Helmholtz-Alberta Initiative: http://www.helmholtzalberta.ca/Research/EnergyAndEnvironment/HAI%20EandE%20-%20Phase%201/GeothermalEnergy2.aspx

Exploring the potential to develop these green linkages requires policies tailored to particular technologies and regional environments. Identifying these transition pathways could initiate the development of political coalitions that will support these technology futures and shine a light on the types of policy supports that Alberta should demand instead of what policies it should resist.

Canada is seen as a climate laggard and has missed out on first-mover advantages in many environmental technologies. There are, however, opportunities to develop Canadian specializations in the production of new technologies, the diffusion of technologies, and the development of new configurations involving old technologies. For instance, software platforms are changing how we organize transportation systems through car sharing and bike sharing services.[52] Canadian cities like Waterloo and Ottawa have software design capabilities that could help reconfigure how we move people and goods.

In addition, while wind is a mature technology pioneered outside of Canada, its continued diffusion requires changes in electric system operations, and Hydro-Québec has developed specialized software to help integrate wind energy into electricity systems.[53] Wind energy is also being developed in more remote areas, such as mining sites, and Canadian consulting engineering companies have specialized competencies in managing wind farm logistics in these environments.

While Canada is a late participant, the global low-carbon transition has only just begun. A strategy is needed to find areas where Canadian regions can plug into global networks of low-carbon innovation.

Regional low-carbon innovation strategies differ greatly from older industrial policy approaches, which have often been dismissed as "picking winners" policies. In the 1970s and '80s, the leading industrial policy models involved a centralized and powerful state co-ordinating activities to support a few key sectors.[54] In this context, Canada's regional diversity and federal political institutions were seen as a source of weakness.[55] National policies targeted towards particular sectors threatened to create different regional costs and benefits.[56]

52 For a discussion on the sharing economy, see Juliet Schor, "Debating the Sharing Economy," 2014, http://www.greattransition.org/publication/debating-the-sharing-economy

53 See Brendan Haley, "Promoting Low-Carbon Transitions from a Two-World Regime: Hydro and Wind in Québec, Canada," *Energy Policy* 73 (2014): 777–88.

54 Chalmers Johnson, *MITI and the Japanese Miracle: The Growth of Industrial Policy, 1925–1975* (Stanford, California: Stanford University Press, 1982).

55 Michael M. Atkinson and William D. Coleman, *The State, Business, and Industrial Change in Canada* (Toronto: University of Toronto Press, 1989).

56 Michael Jenkin, *The Challenge of Diversity: Industrial Policy in the Canadian Federation* (Ottawa: Science Council of Canada, 1983); Richard Simeon, "Federalism and the Politics of a National Strategy," in *The Politics of an Industrial Strategy: A Seminar* (Science Council of Canada, March 1979), 5–54.

Today, innovation policy approaches recognize the importance of promoting variety to keep options open and learn from different experiences.[57] We also find that innovation specialization is often more regional than national. In the modern economy, Canada's economic diversity can promote technological and institutional variety, opening up new innovation pathways and contributing to learning. The potential for learning from diversity is enhanced if knowledge can be shared at a national level. Thus, with the right policy framework, Canadian federalism can be a source of strength.

57 R. Kemp, D. Loorbach, and J. Rotmans, "Transition Management as a Model for Managing Processes of Co-Evolution towards Sustainable Development," *International Journal of Sustainable Development & World Ecology* 14 (2007): 78–91; Yevgeny Kuznetsov and Charles Sabel, "New Open Economy Industrial Policy: Making Choices without Picking Winners," in *Making Innovation Policy Work: Learning from Experimentation*, ed. Mark. A. Dutz et al. (Organisation for Economic Co-operation and Development, 2014), http://www.keepeek.com/Digital-Asset-Management/oecd/science-and-technology/making-innovation-policy-work_9789264185739-en#page1

A CANADIAN GREEN ENTREPRENEURIAL STATE

This paper argues that the way to manage Canadian climate federalism is to expand the types of climate policy approaches. Market-based policies and innovation policies have different strengths. The strength of a carbon price is that it sends a broad signal across the economy, changing the inhospitable environment that green energy technologies often encounter. The strength of a more targeted innovation policy framework is its ability to tailor policy actions to specific technologies and regions, and create positive political feedback for further climate action.

The Ecofiscal Commission sought to take the politics of federalism seriously and downplayed the notion of a national carbon price. Prime Minister Trudeau's election platform seemed to be inspired by this recommendation. The commission was limited, however, by its focus on fiscal policy instruments. Its narrow focus on market-based approaches led to recommendations that would make carbon pricing less effective in an attempt to deal with regional diversity. Yet Canada's suite of climate policy options goes well beyond a carbon price, and the solution to Canada's climate federalist challenges lies in using policies that actually *increase* in effectiveness with greater regional differentiation.

An innovation policy approach would seek to find areas of regional low-carbon advantage and support them through technology-specific policy measures. This agenda has greater potential to create bottom-up technology advocacy coalitions in each region that would reinforce climate policies at all levels of government. If these coalitions were to gain enough power, inter-provincial squabbling over the strength of climate policy could become intolerable and illegitimate. Changing the technological and economic conditions in each region is perhaps the key to changing the political dynamics. Of course, this process will not happen overnight—it will require sustained policy efforts.

A *Green Entrepreneurial State* could implement a comprehensive and sustained green innovation policy. It would need to have a uniquely Canadian configuration, based on promoting bottom-up energy transitions from different regional environments, catalyzed and complemented by federal leadership. Different levels of government would use the policy instruments best applied at national, provincial, and local levels. Carbon pricing is most effective and fair when uniformly applied, so federal political leaders should not back away from national carbon pricing. However, the government should also not limit itself to market-based approaches, since other policy actions are needed to create low-carbon economic and political momentum.

The federal government can support the development of low-carbon transition pathways[58] by providing analytical tools in areas such as GHG accounting, energy systems analysis, and scenario development. The results can inform the allocation of federal R&D efforts, infrastructure funds, and green development bank investments.[59] The federal government would be making a "big push"[60] towards a green economy, and relying on regional priorities to make its policy actions more effective. An Entrepreneurial State attuned to regional needs and catalyzing concrete low-carbon innovations could be what Canada needs to make climate federalism a source of strength rather than a political barrier.

58 Note support for this idea in James Meadowcroft, "Let's Get This Transition Moving!" (Sustainable Prosperity Big Ideas Conference, Ottawa, 2014).

59 On a green development bank, see Broadbent Institute and Mowat Centre, "Step Change: Federal Policy Ideas Toward a Low-Carbon Canada," 2015.

60 Mazzucato, "The Green Entrepreneurial State."